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CONDUCTORS FOR THE PERFORMANCE OF EXPERIMENTAL ACTIVITY:
AN INVESTIGATION INTO THE DEVELOPMENT OF MODERN SCIENCE IN
REPUBLICAN TURKEY

by

PETER GWYNNE EVAN HOPKINS, M.A., CERT.Ed.

A Doctoral Thesis

Submitted in partial fulfilment of the requirements for the award of Doctor of Philosophy of the Loughborough University of Technology July, 1981

Supervisors: A. M. Duncan, M.A., M.Sc., Ph.D.
Prof. C. Yıldırım, B.Sc., M.S., Ph.D.

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Financial help was provided in the form of three scholarships from the Turkish Ministry of Education and by a generous grant from the Charnwood Research Foundation.
Notes on Turkish spelling and pronunciation

The Turkish alphabet differs from the English in the following respects. It has no q, x or w, but contains six additional letters, namely ş, soft ş, undotted ı, ö, ü and ı.

Pronunciation of these is as follows:
- ş as ch in chest
- ş usually prolongs the preceding vowel
- i as -ir in sir (with unpronounced r)
- ö as French eu in feu
- ü as French u in tu
- ş as sh in sheep

The main difference in pronunciation of the other letters is that c is pronounced as j in jam, while j is pronounced as the French j in je.

Some Turkish words which appear in the text without direct explanation are:
- felsefe - philosophy
- ferman - imperial edict
- fetva - decision on a matter of Muslim religious law
- hocam - Muslim teacher
- imam - leader in public worship (at the mosque)
- irade - decree, command
- kâfir - non-Muslim, infidel
- medrese - Muslim theological school
- seriat - the Muslim religious law
- ulema - doctors of Muslim theology

In general, the Turkish spelling of Arabic words such as madrasah has been followed, except where the word is part of a quotation.
We shall take knowledge and science from wherever they may be and we shall put them into the head of every individual in the nation. For knowledge and for science there is no restriction or stipulation. For nations which insist on holding on to traditions and beliefs which are not supported by any evidence or logic, progress is very difficult, perhaps even impossible.

(27.10.22)

The truest (spiritual) guide for everything in the world, for civilization, for life and for success is knowledge, is science. It is naive, stupid and wrong to seek for any spiritual guide other than knowledge and science.

(22.9.24)

—— Mustafa Kemal Atatürk,
Founder and First President of the Turkish Republic
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A commitment to one of the conceptual frameworks held by other scientists in the (sub-) discipline or in a potentially related sub-discipline

Methodological Conducents

A striving to use arguments which are logical and internally consistent

A striving for quantitative results and mathematical models

A readiness to interpret hypotheses empirically

A striving for objectivity in the performance of experiments

An openness to the possibility of alternative explanations

A scepticism towards the results and hypotheses of oneself and others so as to be able (i) to gain scientific recognition, and (ii) to make judgements as to which work is significant and which is not

A commitment to the use of certain instruments, and to methods and techniques involving these, which are currently held to be legitimate by other scientists in the sub-discipline or in a potentially related sub-discipline

Commitment to the Norm(s) of the Scientific Community

Acquisition of Cognitive and Manipulative Skills Relevant to Experimental Research

Formation of a High Conception of the Role of a Performer of Research

Role-Expectations (for an Academic Researcher) and the Extent of their Enforcement

Role Facilities

Time

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CHAPTER 1: GENERAL INTRODUCTION AND A SURVEY OF THE RELEVANT LITERATURE

1.1 The Research Objective and Preliminary Remarks

The aim of this thesis is to study the Turkish scientific research community and, by means of a model concerning scientific performance, to estimate the extent to which the performance of Turkish research scientists over the past fifty years has been and still is affected by their ideological and socio-economic milieu.

Turkey presents a very interesting case-study of a nation with Islamic roots which go back more than a thousand years and yet which has seen enforced westernization since the founding of the Republic in 1923. The systematic Republican policy to westernize many of the administrative and socio-cultural institutions included a vigorous attempt to develop western scientific institutions. What scientific establishments existed before the Republican era were few in number and were almost all concerned with teaching alone rather than with original research. Such establishments had been set up with the assistance of foreign instructors and advisers. There was no 'indigenous' science as such since for centuries the Muslim Ottomans had been largely indifferent and even hostile to knowledge which was unrelated to the study and practice of Islam. Furthermore, because the Ottomans did not engage in artisan labour but left this to the ethnic minority groups, scant craft skills remained among the Turks when the minorities were expatriated, died or fled the country. Thus science in Turkey is almost entirely the result of importation.

With the proclamation of the Republic, 'science' and 'scientific thinking' were made the legitimation for some of the reforms introduced by Mustafa Kemal (Atatürk) and his colleagues. Ideological support for science has remained strong since 1923. It has been backed up over the years by the establishment of a number of institutions, mainly universities, at which research can be done, and by the setting-up of a research council to promote scientific research.

However, in spite of this strong commitment to science by the Republic, there are indicators which suggest that Turkish scientists
do not produce good quality research work inside Turkey. These indicators will be considered in section I.5 below.

The question arises why this situation should obtain. Is a fifty year period of strong commitment to science not long enough for scientific institutions to become established? What factors are needed to ensure that research scientists produce original and high quality research? Which of these are missing or deficient in the Turkish case? Moreover, are these missing factors internal and less obvious, a result of influences such as negative attitudes arising out of religious belief and practice, or are they external and obvious, such as supplies and equipment?

This thesis sets out to examine these questions. At first, it attempts to identify what internal and external factors are prerequisite or conducive to the performance of scientific research in a university setting. It then takes the Turkish scientific research community which is found mainly in the (highly autonomous) universities and concentrates on a particular segment of it which appears to be less influenced by external factors than the others, the group of scientists engaged in basic scientific research. This provides opportunity to focus upon the influence of socio-cultural factors, which are often only looked at in passing in favour of direct economic factors, while not ignoring the influence of direct and indirect economic factors. At the same time, this study does not look merely at the external and internal factors affecting Turkish scientists now but attempts to trace the historical development of the ideologies and institutions which may have constituted to the formation and present state of these factors.

1.2 Hypotheses

The basis of my hypothesis is that there are certain conceptual attitudinal, methodological, sociological, economic and psychological factors which are conducive to the performance by a potential scientist of experimental scientific activity in a university setting. If the quality and quantity of experimental scientific activity by a particular academic scientist or scientists is lower than that of other academic scientists, it is very likely to be due to the absence or deficiency of one or more of these
factors in and around the particular scientists. These factors will henceforth be termed "conducents". The conducents constitute an interrelated hierarchy in which some factors are absolutely essential to the performance of experimental activity, while others to a greater or lesser extent are merely stimulative. Moreover, some conducents are external to a scientist and some are internal. The conducents model will be discussed in detail in Chapter 2.

My hypothesis is that in a country like Turkey the lack of good quality research work by Turkish scientists inside Turkey over the past fifty years and at present is related to the absence or deficiency of some of these conducents. It seems likely that the absence or deficiency of conducents in and around scientists in the Turkish scientific research community is in some way related to factors in the wider socio-economic and political environment. This is more obvious in the case of external conducents but is not so apparent where internal conducents are concerned.

As a second hypothesis, I posit that the absence or deficiency of internal factors such as conceptual, attitudinal and motivational conducents is more important a factor in the lack of good quality research work by Turkish scientists inside Turkey than the absence or deficiency of external conducents such as equipment, support personnel and salaries.

1.3 Scope of the study

The conducents model identifies a wide spectrum of factors which may operate to influence scientific performance. It does not regard scientists as beings who can be divorced from their religious, cultural and socio-economic setting. It does not concentrate merely on the development of scientific institutions. Rather it seeks to take internal factors into account without neglecting external factors. For this reason, where historical accounts are given in this thesis, they are not simply of scientific institutions but of other institutions and ideologies which could influence a potential scientist in his choice of academic scientific research as a career and in his preparation and training for such a career.

Also, in a survey undertaken in 1978 amongst Turkish research scientists, a deliberate attempt was made to direct attention towards less obvious social and cultural factors whilst not
ignoring obvious material and economic factors. In order to keep the number of external factors to a minimum, the sample was taken from scientists engaged in basic rather than applied research.

This thesis is not, therefore, merely a history of Turkish science. It is more than that in that it seeks to trace the development of related factors, both abstract and concrete, which are conducive to the performance of experimental scientific research, and also to trace how these factors have been affected by varying socio-economic and ideological milieus. Finally, it attempts to identify which of the conducive factors is still deficient or missing among research scientists in universities in Turkey today.

The period chosen for the study is from 1923 to 1978. However, to a large extent the Turkish Republic came about as a result of processes which had been going on for more than a century, and so some consideration will be given to these in order to set things in their context. In particular, the historical relationship between the Islamic religion and science will be given special attention.

This thesis takes the Turkish scientific research community as it has developed, namely as it exists within the universities. It does not address itself directly to the question of why research has not developed in the public and private sectors. It is not, therefore, primarily concerned with such questions as technological innovation and transfer and technical progress, and the interrelations between science, technology and economic growth. Also, since Turkish universities and their research activities have been fully autonomous for over a generation, the question of social demand for research is of importance only in an indirect way and so has not been given a thorough treatment.

1.4 Discussion of Terms Used

The term "conducent" has been considered in section 1.2 above and will be further discussed in Chapter 2.

"Experimental activity" denotes the observation of phenomena in the universe, if possible by means of apparatus deliberately set up in a laboratory to display particular phenomena clearly, by systematic methods such as quantitative measurement of variations in one observable feature in response to controlled variation in
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(1) Includes republics.
(2) Includes numbers separately calculated from the proportions of these numbers in 1972 and 1973.
(4) Includes all constituent republics.
another while other conditions are held constant, in order to formulate a new part of a body of theory, or to modify existing theory, or to interpret additions or modifications of existing theory, or to determine more precisely the value of variables defined within a body of theory. "Modern science" refers to the systematic attempt to comprehend the natural world since about the seventeenth century, as well as to the social institutions within which this activity has been and is carried out. When the unqualified word "science" is used in the text below, it will be in these senses, unless otherwise indicated. The Turkish Republic was founded on 29th October 1923, and so "Republican Turkey" refers to the period extending from that date until the present.

1.5 The State of Turkish Science: Some Indicators

Despite the strongly ideological commitment to science by the founders and protectors of the Turkish Republic, science in Turkey has only an average or below average productivity for the GNP and for the size of the scientific community of the country.

In 1961, the Ford Foundation sent a representative to Turkey to investigate the state of its science development. He reported as follows:

"The conditions and climate for research and communication between scientists are so bad that there is no steady output of research work, scientific publication is sporadic and sparse, and good foreign scientists - who are needed to bolster research and teaching - are discouraged from accepting any visiting appointments."(1) Turkish observers of the same period were equally pessimistic.

In 1968 the OECD Pilot Team completed its report on science in Turkey with the words: "We may conclude that Turkey has not yet been able to use the results of scientific discovery on any significant scale, nor has she been able to generate a major advance in scientific work."(2) The Pilot Team also found that the output of research was low, tending to correspond with the production of academic theses, while research in general was "severely fragmented, being largely characterised by individual effort."(3)

The Second Five-Year Development Plan stated that Turkey was only spending 0.4% of its GNP on R and D and noted the following
FIGURE 1.1
(from Kovach, 1978)

Growth Rates of Numbers of Publishing Scientists as Function of Size of Scientific Community
problems in the universities, where most of the country's research effort was concentrated: a lack of liaison between the universities and the public and industrial sectors, faculty members being overburdened by teaching and administrative duties, an environment which did not sufficiently organize, coordinate and encourage research, and libraries having insufficient facilities.  

The Third Five Year Plan, which appeared in 1973, repeated many of these criticisms and bemoaned the lack of cooperation among Turkish researchers, as well as the lack of relevance of most research topics.  

A questionnaire sent to 713 Turkish academics by Varş in 1970 showed that 54% of those questioned thought that the progress of their disciplines in Turkey was academically "inadequate" and a further 22% thought that it was "less than adequate".  

More objective data has supported the above observations. The appearance in 1967 of the International Directory of Research and Development Scientists gave a measure of how many Turkish scientists working in Turkey were actually contributing to international scientific journals. In 1971, the directory appeared under the title Who is Publishing in Science. Figures for the first ten years of the appearance of the directory show that Turkey lies in approximately 44th position in the table of numbers of scientists producing publications fit for international scientific journals, as Table 1.1. shows.  

Such data assumes that the majority of scientific work is published in the scientific and technical journals covered by WIPIS. At first sight this might seem an important objection. However, Garfield has shown that only a limited number of journals make up the main network of scientific publication and citation, and nearly all of these are covered by WIPIS. A more important distortion to the data may occur because only the first author of multiple-authored articles is listed. Sometimes the first author is the main collaborator, sometimes he is merely the senior collaborator with others having made more of a contribution, and other times he may be the junior author. There is no standard convention on this.  

In the case of Turkey, it is not clear in which direction such a distortion may occur. In any case, the number of primary
### Figure 1.2

(from de Solla Price and Gürsey, 1975)

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<td>Korea</td>
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<tr>
<td>Ethiopia</td>
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</tr>
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authors for Turkey is boosted by two factors. One is the inclusion of foreigners working in Turkey. For example, in 1969, 16 out of the 86 names listed for Turkey were those of foreigners, and in 1973 it was 17 out of 140. Since then, the numbers of foreigners working in Turkey have slowly declined. On the other hand, the foreigners may well have had Turkish collaborators whose names came after theirs.

A second factor which boosts the number of primary authors for Turkey is that many Turkish scientists do a large proportion of their experimental work abroad and then write up the work in an article written from Turkey. Various organizations such as NATO and the British Council offer, or have offered in the past, scholarships and bursaries which allow Turkish scientists to spend from six weeks to a year in a laboratory outside Turkey.

The overall increase in the number of scientists in Table 1.1 is related to two different factors. One is that the number of journals covered by IDR and DS/WIPIS has increased from about 3,500 in 1967 in Life Sciences and Physical Sciences only to about 5,000 in 1976 in Life, Physical, Chemical, Behavioral, Social, Management, Agricultural, Food, and Veterinary Sciences, Education, Engineering and Technology. The second factor is the greater number of individual scientists publishing each year. When the slope of the growth rate line for each country is considered, in absolute terms Turkey does not fare too badly, coming about 16th in line. However, when growth rates are plotted against the size of the scientific community, Turkey can be seen to be only average or even below average (Fig. 1.1).

De Solla Price and Gürsey have used the first seven years of WIPIS data to plot the logarithm of the number of scientific authors (geometric mean over seven years) per capita against the logarithm of the number of kilowatt hours of electricity per capita used in the country. They chose the consumption of electricity because they claimed that it gave a better indication of the size and development of a given country of the world than its Gross National Product or per capita GNP, the latter being unreliable and of questionable validity for those with planned economies. Their scatter plot is shown in Fig. 1.2. Israel, India, the U.A.R., Ceylon and Pakistan show a high science productivity for their level of development. Turkey, however, only shows average science
FIGURE 1.3
(from de Solla Price and Gürsey, 1975)

WORLD SCIENTIFIC AUTHORS
productivity for its level of development.

De Solla Price and Gürsey have also considered the relative rates of growth (that is, the percentage change per annum) of each country, relative to the overall increase in authors for the whole world.\(^{13}\) Thus they took the rate of change of the logarithm of the number of authors for each country and subtracted from that the overall rate of change of the logarithm for the whole world. This they then plotted against the number of publishing scientists relative to that of the whole world. (Fig.1.3). They point to a clear tendency for relative growth rates to decrease with increasing size of the country's publishing scientific community. Turkey once again shows only an average or below average growth rate below those of Iran, Nigeria, Pakistan and Kenya.

In another study of world science, Turkey does not appear in a very favourable light.\(^{14}\) Davidson Frame has calculated scientific publications for 107 countries of the world with populations of over one million. His source of data was the 1973 Science Citation Index, which covered the following fields: clinical medicine, biomedical research, biology, chemistry, physics, earth/space science, engineering/technology and mathematics. Frame considers that his count does not overlook a good deal of significant LDC research. Turkey, with 149 publications came 41st in the world below Egypt (683), Greece (289), Venezuela (200) and Iran (174). When publication counts were plotted against GNP, two distinct curves were produced, one which applied to most DCs and another which applied to most LDCs (Fig.1.4). The graph shows that production of research occurs at a higher level for the DCs than for the LDCs, and that the two publication-GNP lines are essentially parallel.

When per capita GNP was considered instead of GNP, it was found that for LDCs there was little change in the relationship. In contrast, the population variable had an important effect on the DC relationship. Frame concluded that in LDCs the production of scientific research does not seem to change much with levels of national affluence. There appeared to be an absolute 'threshold level' which had to be crossed before shifts in affluence had a substantial impact on the amount of research produced, as in the DCs. Two equations enabled predictions to be made concerning
Relationship Between Publication Output and GNP

FROM J. Davidson Frame, 1979
publication output for a country calculated from its GNP and its per capita GNP. Turkey did not match its predicted publication output as a DC, but more closely approximated the value for an LDC (Table 1.2).

As a final indicator of the state of Turkish science, let us consider science citations. Birgül, Gürsey and İnomü have investigated scientific papers by Turkish scientists which received nine or more citations between 1961 and 1971. They considered articles in the following fields: mathematics, mechanics, astronomy, physics, geophysics, and chemistry. In the ten years under consideration, 202 articles and books by Turkish scientists were cited more than nine times, one as many as 384 times. However, of these only seven papers and three books were on work performed by Turkish scientists inside Turkey. Of the research papers, the highest number of citations was 22. Only two of the papers cited were on experimental research work, the rest on theoretical work. The other cited papers were on work performed outside Turkey.

1.6 Order of Presentation

This first chapter will conclude with a review of literature which is relevant to the conducents model, to models of science development, and to the history of science development in Turkey.

Chapter 2 is a statement of the conducents model and then an extended discussion of each of the thirty-six factors involved. These are considered under various heads, namely "Conceptual and Attitudinal Conducents", "Methodological Conducents", "Commitment to the Norms of the Scientific Community", "Role Conception", "Role Expectations", "Role Facilities" and "Psychological Characteristics". The conducents are then considered in various groupings and the question discussed as to whether the conducents form a hierarchy. The interrelatedness of the conducents is also pointed out.

In Chapter 3, the conducents model is applied to pre-Republican Turkey. As this period of Turkish history was dominated by the religion of Islam, the relationship between science and Islam is examined in some depth. Attention is then paid to Turkish attitudes towards western knowledge, to education in the Ottoman Empire in the nineteenth century and to science in the period
<table>
<thead>
<tr>
<th>GNP per Capita</th>
<th>Eq. (14) Predicted Publication Output (for LDC)</th>
<th>Eq. (15) Predicted Publication Output (for DC)</th>
<th>Actual Publication Output</th>
</tr>
</thead>
<tbody>
<tr>
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<td>29664</td>
<td>118346</td>
</tr>
<tr>
<td>Sweden</td>
<td>4480</td>
<td>659</td>
<td>5432</td>
</tr>
<tr>
<td>Canada</td>
<td>4440</td>
<td>1921</td>
<td>12147</td>
</tr>
<tr>
<td>Switzerland</td>
<td>3940</td>
<td>427</td>
<td>3502</td>
</tr>
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<td>3670</td>
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<td>France</td>
<td>3620</td>
<td>3855</td>
<td>17327</td>
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<tr>
<td>Germany (FRG)</td>
<td>3390</td>
<td>4319</td>
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<td>2180</td>
<td>525</td>
<td>2472</td>
</tr>
<tr>
<td>Germany (GDR)</td>
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<td>600</td>
<td>2549</td>
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<tr>
<td>Rhodesia</td>
<td>340</td>
<td>21</td>
<td>43</td>
</tr>
</tbody>
</table>

*Countries whose actual output is more closely approximated by the DC science production function.*
leading up to the Republican era.

The conducents model is applied to Republican Turkey in Chapter 4. The influence of Mustafa Kemal Atatürk with his firm belief in science as ideology is discussed first. The results of this belief in such spheres as the educational system, the publication of books and the founding of research institutions are then considered. Scientific research and instruction in the old and new University of Istanbul are given particular attention. As many as possible of the thirty-six conducents model factors are traced from 1923 until the late 1970s. They are considered against a changing socio-economic background. The formation of the Science Research Council of Turkey (TÜBİTAK) and its efforts to promote scientific research are examined in some detail. Finally, attention is directed towards Turkish universities, and to various aspects therein of scientific instruction and research.

In Chapter 5, the results of my survey amongst 75 Turkish experimental research scientists are presented. The results are discussed in relation to the conducents model. Further information is provided by the results of a small-scale survey amongst Turkish lawyers. The conclusions from the two surveys are then given.

Chapter 6 makes some comparisons of Turkish science with science in other scientifically less developed countries. The countries whose science is considered are Spain, Israel, Egypt, India, Japan and Brazil.

The final chapter gives the conclusions of the research. It also goes on to suggest other research questions which were formulated as a result of the investigation. It concludes by putting forward a number of implications for Turkish experimental scientific research which arose out of this study.

1.7. Review of the Relevant Literature

This study is the first one in English or Turkish to consider science development in modern Turkey. Moreover, it is the first investigation of any country to be made using the conducents model, by which the development of each of a number of variables is traced over a period of time. No literature has been found which is strictly comparable to this, inter-disciplinary.
investigation. However, a vast amount of literature has some bearing upon it and some of this will now be considered under various heads. I shall give a selection only of the more important contributions.

1.7.1 Appertaining to scientific development in less developed countries. (LDCs)

A large section of the literature under this head is concerned with how science can be employed in the economic development of LDCs, early examples of which were the Proceedings of the Rehovoth Conference (Gruber, 1961) and the articles by Blackett and Powell in The Science of Science (Goldsmith and Mackay, 1964). A later monograph by Jones (1971) and a collection of papers edited by Cooper (1973) discussed important aspects of science, technology and economic development.

More apposite to the present study are works which discuss aspects of the performance of scientific research in LDCs. An early writer on this subject was Dedijer, who pointed out the extent to which research activity in an LDC was a function of the society in which it was performed (1962, 1963). The latter article was reproduced together with other articles which had appeared in Minerva in Criteria for Scientific Development, edited by Shils (1968).

In 1967, Basalla suggested that science in LDCs developed in three phases: from work done completely by outsiders to colonial, and then independent, or indigenous, science (Basalla, 1967). In the same year, Derek Price (1967) applied his statistical techniques to the scientific output of various countries and showed that nations producing good basic scientific research tended to invest at least 0.7% of their GNP in such research.

With the appearance of the Who is Publishing in Science annuals, a tool became available to plot the number of publishing scientists by country. In the 1975 annual, Price and Gürsey published an analysis of scientific productivity first by state of the United States and then by country of the world, using the first seven years of WIPIS data. Kovach (1978) did a similar analysis with data culled from a ten year period and calculated growth rates for fifty countries. Frame et al (1977) have used 1973
Science Citation Index data to display various patterns of scientific activity which vary among 61 countries. Again using 1973 SCI data, Frame (1979) has also plotted curves for the number of scientific publications of a country against its GNP, and suggests that in LDCs the size of scientific effort seems to depend on gross economic size of a country rather than on its per capita income.

Ziman (1969) has discussed problems of the growth and spread of science in LDCs, and has put forward three tentative patterns of research to overcome these (Ziman, 1971). Sabato (1970) has also discussed some of the problems faced by research scientists in LDCs, particularly by those in research centres.

The most comprehensive overview of the field of scientific development studies is by Moravcsik (1975). Besides giving a bibliography of 500 references, he summarizes findings from the literature appertaining to science education, manpower, scientific communication, the performance of research and scientific morale, amongst other topics. A study of his bibliography unfortunately reveals the paucity of empirical studies in the field. A more recent essay review of books on development studies is by Anderson and Buck (1980). Sardar and Rosser-Owen (1977) concentrate mainly on the role of science policy in economic development.

Since 1975, a series of monographs have been published by the International Development Research Centre as part of the Science and Technology Policy Instruments Project. The project was a very wide-ranging one, comparing science and technology policies in Argentina, Brazil, Colombia, Egypt, India, South Korea, Mexico, Peru, Venezuela and Yugoslavia (Macedonia). For three years, 150 researchers in research teams in the ten participating countries tried to gather, analyze, evaluate and generate information which would help policymakers and planners in re-orientating science and technology toward development objectives. The primary field of enquiry was the industrial sector. The Main Comparative Report of the project (Sagasti, 1980, p.10) notes that explicit science and technology policy instruments had little impact on technological change, particularly at the early stages of industrialization. Policies were found to be made not merely from ignorance but out of real conflicts among the interest groups which had stakes in industrial growth. The main conclusion which
emerged from the STPI project was that to be effective, science and technology policies and policy instruments must be specific (Sagasti, 1980, p. 23). A significant omission from the considerations of the STPI project was personnel training, which Sagasti admits is "one of the crucial components in building an infrastructure" (1980, p. 63). In spite of this, the project has made an important contribution to an understanding of science and technology policies and their outworking.

The development of science in individual LDCs has been documented in several cases. Scientific development in India has been the subject of several studies, notably those by Ranganathan (1958), Biswas (1969), Sinha (1970), Rahman (1970, 1972, 1973) and Morehouse (1976). Karve (1965) and Shils (1969) have highlighted some of the difficulties faced by scientists attempting to perform research in Indian universities, while another study has shown how higher education in India is straitjacketed by conservative public opinion (Karve, 1963). Aspects of research in Pakistan have been discussed by Khan (1969).

The history of science in China has been thoroughly documented by Needham in his classic series of volumes entitled Science and Civilization in China (1954-74). Needham (1956, 1963, 1964, 1969) has also addressed himself to the question as to why mathematics and science joined in a qualitatively new relation in Europe and not, for example, in China. Data on contemporary science in China has not been so easy to obtain, but Wu and Sheeks (1970) give a good general survey, while Dean and Macioti (1973) concentrate on various scientific institutions. Wu and Sheeks link resistance by the Chinese to the adoption of modern science to their disdain for things foreign in general and to their association of science with the misdeeds of foreigners in particular.

Not unnaturally, the development of science in Japan has occupied a number of historians of science. A general survey is that of Tuge (1969). Brief descriptions of institutional aspects of Japanese research are given by Cambell (1964) and Nakayama (1968). The latter also examines the role played by the universities in Japanese scientific and technological development (Nakayama, 1965), while Yuasa (1970) discusses the growth of scientific communities in Japan in general. The relationship of science to government in Japan in the post-war era is taken up by Long (1969). Various recent aspects of Japanese research are presented by Boffey (1970a, b, c). Papers by Japanese historians of science have been published in
one volume by Nakayama et al (1974). Amongst them is Eri's statistical analysis of the growth of physics in Japan (pp.108-113), and also an annotated bibliography of works in English on the social history of modern Japanese science by Bartholomew. A recent survey of the role of science and technology in the modernization of Japan, together with a survey of present trends in scientific and technological activities, is contained in the National Paper for the United Nations Conference on Science and Technology for Development (Government of Japan, 1978).

Science in the Arabic Middle East has been treated by Zahlan (1970, 1980).

The case of Israel has been taken up by Ben-David (1962) and more fully by Ezrachi and Tal (1973). A fairly recent Ph.D. dissertation on the Spanish scientific community is perhaps the first truly sociological study of scientific research in a less developed scientific milieu (Blasco, 1976).

Scientific development in Venezuela has been reported on by Roche (1966), who tries to identify social and cultural factors leading to both its strengths and weaknesses. The results of a survey of the opinions of a sample of several hundred Venezuelan scientists on such topics as the competency of Venezuelan scientists and the relevance of science to modernization in Venezuela were published by Gasparini (1969).

Despite the stimulus of the United Nations Conference on Science and Technology for Development in Vienna in August, 1979, Frame noted that "the number of recent good quality articles on science and development has been disappointingly meagre" (1979, p.233).

1.7.2 Appertaining to social and cultural factors influencing the development of science in less developed countries

Several of the papers mentioned in the previous section touch on social and cultural factors which are seen as inhibiting
the development of science. In addition, there are various papers which deal more directly with this topic, although in most cases rather unsystematically. In their studies on Nepal, Dart (1963, 1972) and Dart and Pradhan (1967) point to traditional attitudes to learning which they see as inimical to science; knowledge is considered to be closed, and obtainable either from old men or from books. Needham (1963) shows that despite the considerable advances made by Chinese science, one of the factors which hindered it from going further was the Chinese reluctance to interfere with the natural world. Oldham (1966) describes how the Chinese communists have attempted to overcome the traditional Confucian disdain for things practical, something regarded as an obstacle to science. Larwood (1961), Sinha (1967) and Morehouse (1968) deal with science and religio-cultural factors in India, the latter also covering Pakistan; while Larwood does not see religion as reconcilable with science, the other two authors do. Nicholls and Cheosakul (1969) touch on problems of doing science in Thailand, while MacKay (1973) and Dart (1973) discuss the situation in Papua New Guinea; authoritarian learning patterns and a view of science as the personal magic of the scientist apparently make science teaching difficult. Zahlan (1972) sees Arab social customs acting against the necessity for scientists to work in teams. The problems of scientific research in Asia, and especially India, are discussed by Dessau (1969), Rahman (1970) and UNESCO (1966 and 1970); factors isolated include the irrelevance of most university-based research, the greater prestige of administrative posts over research posts, and the shortage of technicians because of a disdain for vocational training. The Government of Japan (1978) has examined the religious and social context which facilitated scientific development in Japan, a matter which was earlier taken up by Craig (1955) and Lockheimer (1969); amongst the relevant factors cited are the rationality of Confucian teachings which helped the Japanese assimilate western science, the 95% primary school enrolment by 1905, the cultural and linguistic homogeneity of the country, and the lack of reliance on one particular scientifically advanced
nation. Odhiambo (1957) spells out why he sees African traditional thought as conflicting with a modern scientific world view. Horton (1967), on the other hand, sees a large number of parallels, with the essential difference lying in the respective "closed" and "open" attitudes to alternative conceptual schemes.

Especially pertinent to the present study is the influence of Islam upon the performance of experimental scientific activity, a subject which will be dealt with in more detail in Chapter 3. Historians of science such as Sarton (1927, 1951), Meyerhof (1931), Anawati (1970) and Nasr (1968, 1976) emphasize the greatness of Islamic science in works which range from detailed description to more general reviews. The problem of the decline of Islamic science has been discussed by Winter (1953), by a number of scholars who gathered at an international symposium held in Bordeaux in 1956 (Actes, 1957) by Sayili (1960, Appendix 2), and by Saunders (1963). Various aspects of Islamic philosophy and theology which might appear to be inadmissible to the practice of modern scientific activity are touched upon by Montgomery Watt (1948, 1952, 1973) and Grunebaum (1961). Nasr (1968, 1976) has attempted to defend such implied criticisms of Islam by invoking neo-Platonic concepts found within Sufism.

"Science and the Islamic World" was the subject of the May-September 1976 issue of Impact of Science on Society, with articles by several Islamic scholars.


1.7.3 Appertaining to science in Turkey, and related topics

Most of the works mentioned here are considered in more detail in Chapters 3 and 4.
The only general survey of science in Ottoman times is the classic by Adnan-Adivar (1943). Unfortunately, it does not go much beyond the beginning of the 19th Century. From that date until the present day, there has been no satisfactory historical study of science in Turkey. The results of a survey by Özımönu (1969, extended version 1970) provide a reasonable overall view of the numbers of university lecturers engaged in research in "the positive basic sciences" (mathematics, physics, astronomy, chemistry, biology, and related interdisciplinary areas), the variation of these numbers with time, the educational background of such lecturers, and the number of research papers they produced. Özımönu's survey deals with the period from the University Law of 1933 until 1966. Aspects of Özımönu's manipulation of his data have met with criticism from Türkeli (1971a, p.3 and 1972, p.4), however.

A number of useful studies on the research publications of Turkish scientists have been made by İnönü. He has published bibliographies of contributions by Turkish scientists to international research journals in the fields of physics (1971), mathematics (1973), astronomy (İnönü and Dizer, 1974), chemistry and related fields (1975), and has listed which contributions were made on the basis of research done inside Turkey and at which institutions, as well as the number of citations by years given to Turkish scientists in each of the above fields.

İnönü has also helped compile a list of Turkish scientists in the fields of mathematics, mechanics, astronomy, physics and chemistry who received more than nine citations in the 1961 and 1963-71 Science Citation Indexes (Birgül, Gürsey and İnönü, 1974). Other articles of İnönü's on various aspects of Turkish science include a list of the first doctoral degrees obtained by Turkish scientists (1974), statistical observations on Turkish research in physics (1976a), and a comparison of the research output of physicists in Ankara and Istanbul (1976b).
scientists contributing to international scientific journals from Turkey has been produced by Gürsey (1972).

Since the 1960 Revolution and the setting-up in 1964 of TÜBİTAK (The Scientific and Technical Research Council of Turkey) with its Science Policy Unit, there have been a number of publications dealing directly or indirectly with science development in Turkey. A fairly recent bibliography (TÜBİTAK, 1976b) lists 871 books, papers and memoranda related to science policy; however, the number is considerably boosted by the inclusion of duplicated lists and some rather peripheral topics.

The TÜBİTAK Science Policy Unit has compiled directories of research organizations and units in universities (1974b) and in the public sector (1976a), with addresses, numbers of personnel, annual budgets and library facilities. In 1966 and 1970, the Unit published the results of surveys it had made in 1965 and 1967 respectively of research workers in Turkey in universities and the public and private sectors. Information was collected concerning age, educational background, field and number of publications (TÜBİTAK, 1966 and 1970). Unfortunately, since the number of respondents was neither total (54% and 37% respectively) nor representative thereof, the results of these surveys must be treated with some caution.

The activities of TÜBİTAK are chronicled in its series of annual reports (TÜBİTAK, 1965- ). TÜBİTAK has also held a series of Science Congresses at various times since 1967. The papers delivered to the Scientist Training Group have been published since 1969 (1969, 1973, 1974a, 1975, 1977). Most of the papers presenting original work have been published in more complete form elsewhere, however.

The Science Policy Unit of TÜBİTAK was particularly active in the late 1960's and early 1970's, after which many of its members moved to other posts. In addition to the surveys of research personnel mentioned above, members of the Unit
produced a three-volume report on scientific research and technology in relation to economic development as part of the OECD Pilot Teams' Project (OECD, 1968a). At the Pilot Teams' Project Evaluation Conference, the report was praised for its brave attempt to propose a far-reaching science policy for Turkey, although the fact that it rested on insufficient statistical data was also pointed out (OECD, 1968b).

In 1971 the Unit organized a seminar in Istanbul devoted to issues in research and development planning and management (Türkeli, 1971b). A number of foreign experts, including Derek Price and Moravcsik were invited to give papers, while Celasun (1971) surveyed the problems and prospects of scientific and technological advance in Turkish development planning. In the same year, Türkeli (1971a) produced a paper giving a good historical introduction to the development of science in Turkey and pinpointing various problems related to Turkish scientific research. In 1972, the Science Policy Unit invited Dedijer (1972) to draw up a proposal for the terms of reference, organization, working procedures and plan of activities of the TÜBİTAK Committee on Science Policy.

More recently, the remaining members of the Unit have published reports on Turkish R and D expenditure for 1977 (Dizdaroğlu and Çakır, 1977), 1979 and 1980 (TÜBİTAK, 1979 and 1980) and have helped to produce the Turkish national paper submitted to the U.N. Conference on Science and Technology for Development in Vienna in August, 1979 (Doğrusöz et al., 1978).

A survey of Turkish science was included in some case studies published by Moravcsik (1973) and in a paper by Doğrusöz (1976), which outlined the past and present state of the Turkish science system, as well as some of its "crucial problems".

TÜBİTAK has sponsored a number of studies related to various aspects of research activity by Turkish scientists. Postgraduate education inside Turkey has been investigated by Varış (1972), who sent out two surveys to nine universities with chairs or departments in basic science, agriculture,
veterinary science, forestry and the different branches of engineering. She obtained the opinions of a sample of 713 post-doctorates (60%), 740 post-graduates (50%) and 564 undergraduates (12%) about the state of post-graduate education in Turkish universities. A third survey was sent to 30 officials of 25 institutions engaged in various forms of R and D in the public sector.

In another study funded by TÜBİTAK, Uysal (1974) tried to determine the degree of success of the scheme whereby students are sent abroad by the government for post-graduate training under Law No. 1416. From a sample of 278 (20%) of 1395 students still abroad and 262 (15%) of 1837 students who had returned to Turkey, he obtained information as to how well they had adjusted to life abroad, whether they had found academic standards there different from those in Turkey, and how easily they had found or were expecting to find employment on their return to Turkey.

Türkeli (1973) has compared research productivity amongst Turkish physicists trained locally and those trained abroad.

The effect of the brain drain on Turkish science has occupied one or two investigators. The most thorough study is by Öğuzkan (1971), who questioned a sample of 150 Turks with Ph.D.'s working abroad as to the reasons for their decision to live outside Turkey and the factors influencing their remaining there. Franck (1970) and Hırboglu (1972) also discussed different aspects of the Turkish brain drain.

The classic book on Turkish universities in general to 1950 is the two-volume work by Hıry (Hirsch) which contains founding laws and the text of Malche's report on the reform of Istanbul University. A general, although by now somewhat dated, review of universities in Turkey was made by Okyar (1968), while more recently Reed (1975) charted the progress of two new universities: Hacettepe and Middle East Technical University.
Turning now to works which are less explicitly concerned with the development of science in Turkey, there is the wide-ranging study by Berkes (1964) dealing with the development of secularism in the later Ottoman and early Republican era. Religious and social change in the Republican era is the subject of a study by Allen (1935, 1968). Robinson (1963) concentrates more on economic development. A comparative study of modernization in various sectors in Turkey and Japan is edited by Ward and Rustow (1964). In his thoroughly documented classic, Bernard Lewis (1961, 1968) traces the emergence of the Turkish Republic from the first signs of decline in the Ottoman Empire. Other historical accounts include those on Ottoman reform (Davison, 1963), Young Ottoman thought (Mardin, 1962) and the Young Turks (Ramsaur, 1957). The history of education in later Ottoman and early Turkish Republican times is set out in Ergin's authoritative five-volume work (Ergin, 1939-43). Surveys of the Turkish educational system in more recent times are given by Szyliowicz (1973) and Kaya (1972, with updated Turkish editions 1974, 1977). Bağgöz and Wilson (1968) have written on educational problems in Turkey between 1920 and 1940, while Kazamias (1966) has occupied himself with the relation between education and modernity. The influence of teachers upon social change in Turkey until 1940 has been charted by Akyüz (1978).

1.7.4. Relating to presuppositions in science

There are not many contemporary books which discuss the presuppositions of modern science. The reason may be, as Johnston (1977, p.6) suggests, that they have been so unquestioningly accepted. In Johnston's view, the best way to examine these underlying assumptions is to look at the writings of such natural philosophers as Copernicus, Kepler; Galileo, Bacon, Descartes, Boyle and Newton, who had to argue the merits of an, at that time, completely new basis
for knowledge about the world.

Collingwood's essay on metaphysics draws attention to presuppositions in science and how these shape which questions are asked and which answers are considered meaningful and relevant (Collingwood, 1940). A more contemporary account which identifies specific presuppositions in science is Nash's *The Nature of the Natural Sciences* (1963). A somewhat shorter discussion of assumptions in science is given by Yildirim (1971).

Johnston's proposal may have gained inspiration from Burtt's incisive analysis of the metaphysical origins of modern science (Burtt, 1924, 1932), which carefully examines the writings of most of the natural philosophers named above. Less directly, Whitehead (1925) and Russell (1949) touch on some of the presuppositions. From a more historical perspective, and from different viewpoints, Butterfield (1949, 1957), Dijksterhuis (1950, 1961), Bernal (1954), Gillispie (1960), Mason (1962), Hall (1962) and Hooykass (1972) trace the emergence of the new scientific world-view between 1300 and 1800 especially. Kuhn's account of the structure of scientific revolutions touches on different levels and types of commitment by scientists, although its main emphasis is on commitment to the current conceptual and methodological paradigm of scientists in a sub-speciality (Kuhn 1962, 1970). An earlier writer on commitment by scientists was Polanyi (1958, 1964, and 1967 and 1969).

Pertinent to the present study is the question of why modern science developed when and where it did. Which socio-cultural factors allowed the presuppositions of modern science to be more easily accepted? These questions have occupied many historians of science, who have given a variety of different answers. A fleeting survey of the different approaches is that of Fellows (1951), while anthologies in which historians of both the internalist and externalist schools argue their cases are edited by Kearney (1964), Basalla (1968) and Bullough (1970). A good overview...
of the influences affecting the emergence of modern science in different countries of Europe is provided by the collection of papers edited by Crosland (1975). In his comprehensive review of the literature of the social history of science, MacLeod (1977) portrays recent developments in the internalist-externalist debate.

The sociology of scientific knowledge has occupied a number of sociologists. Works by Barnes (1975), Bloor (1976) and Mulkay (1978a) are among the best-known in the field. A recent publication by Latour and Woolgar (1979) is a case-study on the social processes involved in the construction of scientific "facts" at the Salk Institute of Biological Studies.

1.7.5 Relating to attitudes towards the performance of experimental scientific activity

Attitudes of the Greeks towards the performance of experimental activity are discussed by Lloyd (1970), Hooykaas (1972) and Farrington (1961). Zilssel (1942) sees the attitudes of the Greeks and Romans towards manual labour as inhibiting their predilection for experimental activity. His thesis that the empiricist bent of modern science was influenced by economic and technological factors had earlier been mooted by Hessen (1931, 1971). To these two influences, Merton (1938, 1970) added a third: that of Puritanism. This latter aspect, which formed only a part of Merton's original study, has proved to be the most controversial. Among those who have taken sides in this on-going debate are Hooykaas (1956), Rabb (1962, 1965) and Hall (1963). Overviews of the controversy are given by Kemsley (1968), and by Hooykaas and Lawless (1974).

1.7.6 Appertaining to sociological factors affecting the performance of experimental scientific activity

Until the late 1960s, the only theoretical approach available to sociologists of science was functional analysis (Barnes,
The groundwork for this had been laid by Merton's classic work on the ethos of science (Merton, 1942, 1973a), in which he treated science as a social institution. Merton identified four social norms which, he claimed, underlay the social relations of science, namely universalism, communism, disinterestedness and organized scepticism. The latter he considered as both a methodological and an institutional norm. Other methodological norms were adequate and reliable empirical evidence, and logical consistency.

Parsons elaborated upon Merton's normative system by dividing the norms into three categories: technical norms binding upon the scientist, pattern variables which define the role expectations of the scientist, and norms which bind the scientist as a research worker (Parsons, 1951, pp. 335, 343 and 333).

The Mertonian schema was further developed by Barber (1952), in a work which was to become a standard text, and by Storer (1966). Other variations were later advanced by Courand and Zuckerman (1970) and by Courand and Meyer (1976). Merton himself pointed to another norm in the institution of science, originality, which, he felt, was in conflict with a further norm of humility (1957, 1973c).

The main contribution of the Mertonian school has been in the study of competition, allocation of professional rewards, and stratification in science. Merton's seminal papers in these areas have been collected together in one volume under the editorship of Norman Storer (Merton, 1973f).

An early empirical study of competition, communication and professional recognition in the scientific community is that of Hagstrom (1965). Zuckerman, one of Merton's students, has examined professional recognition (Zuckerman, 1967, 1958), as well as stratification in science (1970), in her studies of Nobel Laureates. In a much wider survey of American physicists, two other students of Merton's have also studied the reward system of science and social stratification within

A clear conclusion which arises from the above studies is that rewards in science, that is, forms of professional recognition, are given in exchange for information which is considered valuable by the scientific research community (Mulkay, 1977, p.103). This is in contrast to the conclusion to which the Mertonian theoretical framework would seem to lead, namely that scientists are rewarded in accordance with their conformity to the institutional norms. Evidence against such a conclusion is summarized by Mulkay (1977, pp.105-6).

The Mertonian ethos itself has been heavily criticized by Barnes and Dolby (1970), Mulkay (1969) and Rothman (1972). Empirical evidence which appears to run counter to it has been presented by West (1960), Blissset (1972) and Mitroff (1974a, 1974b). In addition, some of the individual norms have been brought into question in the wake of various publications: organized scepticism following Kuhn (1952, 1970) and Mulkay and Williams (1971), universalism after Crane (1967), Whitley (1970) and Beyer (1978) - although Zuckerman and Merton's (1971) paper offers somewhat conflicting evidence - and disinterestedness following Watson (1958).

Barnes and Dolby (1970, pp.12-13) and Mulkay (1976) have suggested that there is a difference between the "professed" norms of scientists, and "statistical" norms. In their view, the former are used to legitimate or denigrate certain types of behaviour, thereby acting as an ideology.

Critiques of the Mertonian ethos are summarized in Wynne (1977, pp.7-9) and Cameron and Edge (1975, pp.11-12). An extended discussion of the various objections to Merton's norms has recently been published by Stehr (1978).

Most critics of the Mertonian ethos are not against norms per se. Rather, instead of social norms they see cognitive norms as the main determinants of social control in science.
Such thinking was inspired by Kuhn's immensely influential *The Structure of Scientific Revolutions* (1952, 1970), which gave an account of how cognitive consensus is obtained in scientific specialities. Kuhn's thesis has not been without its critics (Shapere, 1964 and Toulmin, 1967), a number of whom voiced their objections in the volume of papers edited by Lakatos and Musgrave (1972). A review of these criticisms and Kuhn's rejoinders are given by Veldink (1974). Also, Ben - David (1975) has questioned whether the available sociological evidence warrants Kuhn's claim that during periods of normal science a paradigm is held in common by members of a scientific community, while Mulkay (1977, p.115) thinks there is only limited evidence for the breakdown of one paradigm and its replacement by another. Recently, Buchholz (1979) has shown that Kuhn's scheme does not deal with application-oriented new scientific disciplines.

Nevertheless, despite these misgivings, Kuhn's work has spawned a number of models of scientific development (Böhme, 1977, p.326). Gilbert (1976), for example, has proposed that instead of one fixed paradigm shared by all the members of a research community, there are related models which different members adapt according to their specific problems, a proposal approved by Mulkay (1978b).

Meanwhile, in a recent publication, Kuhn seems to have aligned himself with Merton in assuming that the social norms of science are related to its cognitive contents (Kuhn, 1977, pp. xxii). It has been claimed that sociologists and historians of science on different sides of the Atlantic favour certain specific approaches to sociology of science (Ben - David, 1978), although perhaps not merely as a result of the factors suggested by Ben - David. Despite Gaston's confident assertion that the Mertonian norms were strongly institutionalized in the British and American scientific communities he had studied (Gaston, 1978, p.185), better measures of statistical norms will have to be devised and applied over a wider variety of scientific disciplines if sociologists of science as a whole are to be convinced.
While a number of sociologists were coming to the conclusion that quality in science is rewarded only as long as it remains within the limits of the existing scientific and technical consensus (Mulkay, 1977, p.106), a quantitative tool for measuring quality had been developed in the Science Citation Index (Garfield, 1964, 1970a, 1970b). This is now used in many areas of the field of "scientometrics", the quantitative mathematical study of science and technology (Spiegel-Rösing, 1977, pp.18-19). A critical review of the literature is given by Gilbert and Woolgar (1974). Doubts about the efficacy of science citations have been expressed by Cole and Cole (1971), Porter (1977) and Edge (1979). In their study of the references given in thirty articles on theoretical high energy physics between 1968 and 1972, Moravcsik and Murugesan (1975) found that over thirty percent of the citations were redundant. An interesting test case was published recently in which the articles citing the work of a molecular spectroscopist and collected by him were analyzed with respect to their perceived function (Ruff, 1979).

Citation studies have been a means of uncovering groups of research scientists who are at work on similar problems and who actively communicate with one another - the so-called "invisible colleges" of contemporary science (Price, 1951, p.99). Invisible colleges have been the subject of investigations by Price and Beaver (1966) and by Crane (1969, 1972). Recently, attention has turned to the mapping of co-citation clusters (Small, 1977 and Mullins et al., 1977), a technique critically evaluated by Sullivan, White and Barboni (1977).

The importance of such studies in relation to the analysis of conducents for the performance of research lies in their highlighting of communication networks. It appears that research journals are less a channel of communication between scientists than a means of awarding recognition, especially in "hot" fields of research (Price, 1963, Ch.3). More informal channels of communication have been identified by Menzel (1962, 1966).
Examinations of the extent of scientific recognition given to various scientists indicate a strong correlation between it and the quality and quantity of research produced (Cole and Cole, 1957; Gaston, 1970; Blume and Sinclair, 1973).

The maintenance of high-quality standards in science by means of the referee system has occupied Ziman (1958) and Ravetz (1971). Ziman emphasizes the necessity for scientists to convince their peers of the quality of their research, leading him to the assertion that the scientific method itself is the obtaining of "a consensus of rational opinion over the widest possible field" (Ziman, 1968, p.8). Polanyi, too, has written on the maintenance of standards in science through the overlapping of sub-specialities (Polanyi, 1969, Ch.4).

Another theme of Polanyi's has been that of the tacit component in science (1958, 1964 and 1959, Chs.8-12). Ravetz has also discussed subjective factors in science in detail, and has shown the importance of the transmission of inarticulate skills (Ravetz, 1971).

The scientific role, in the widest possible sense of the word "scientific", was analyzed by Znaniecki in a work which seems to have gained in importance since it was first published (Znaniecki, 1940). More recently, Ben-David has traced the rise of the professional scientific role in the nineteenth and twentieth centuries (Ben-David, 1964 and 1971, and Ben-David and Zloczower, 1952). However, his 1971 publication was taken to task by Kuhn (1972) for portraying "the scientific role" as something which had remained unchanged since antiquity. Ben-David's approach seems to be more successful when applied to science within the past 200 years, especially in dealing with the appearance of new scientific disciplines (Ben-David, 1960b and Ben-David and Collins, 1956). In addition, Ben-David has studied the effect of academic organization upon research productivity (Ben-David, 1960a, 1958). The emergence of science as a professional institution has also been examined...
by Mendelsohn (1964), Krohn (1972), and with more specific reference to France and England, by Hahn (1975) and Cardwell (1957) respectively.

Some fruitful observations on the growth of research areas have come from Holton (1962). He considers that initially the growth of a research area is exponential, but then as the number of interesting basic ideas yet to be explored decreases, growth becomes linear and then tails off. However, before that occurs, some researchers switch to a new area or areas which are unexpected outgrowths of the old area and which seem to possess exciting new research possibilities. These new areas then attract new recruits to the field and in their turn grow exponentially, linearly and die away. Mulkay (1977, p.113) has incorporated this model into his account of the development of research networks.

In a somewhat different vein, Holton (1973, 1975) has introduced the concept of "thematic analysis" to address the question as to what it is in science which makes it a continuing enterprise when so much of its theory and practice seems to be constantly changing. He suggests that individual scientists and even groups of scientists are constrained or motivated by "themata" (for example, reductionism or holism), which he sees as more resilient than Kuhn's paradigms. Moreover, in Holton's view, thematic decisions are more an individual affair than a social one.

1.7.7 Appertaining to psychological factors affecting the performance of experimental scientific activity

In a fairly recent critical review of the psychology of science, Fisch (1977) noted that "basic concepts are diffuse and contradictory", which has prevented the comparison of results.

Early studies of the psychology of scientists were undertaken by Roe (1949, 1951a, 1951b, 1951c, 1953a), who used some of this material in her book The Making of a Scientist (1953b).
Some of Roe's articles found their way into an anthology edited by Eiduson and Beckman (1973). The same anthology also contains a paper by Eiduson (1973) on psychological aspects of career choice and development in the research scientist. Earlier, Eiduson had produced a book on the psychological world of research scientists (Eiduson, 1952).

Creativity in science has been examined by several writers. Kubie's articles still remain topical (1962a, 1962b). Stein has also written on creativity among scientists (1952), while Taylor and Barron (1953) have edited a collection of papers on the recognition and development of scientific creativity.

A summary of the characteristics of creative physical scientists is given by McClelland (1962). Barron has collated the research results of McClelland, Roe, Eiduson, and others to draw up a list of traits of productive research scientists (Barron, 1969, pp.101-2).

A slightly different approach was taken by Kaplan (1960) in noting organizational factors which affected creativity. The whole question of research scientists in organizations has been a topic of special study. An early writer was Meltzer (1955). Extensive studies by Pelz and Andrews were later recorded in their Scientists in Organizations (1966). Pelz (1967) also gave some observations on the correlation between creativity and environmental conditions.

Scientists in industrial settings are described by Marcson (1960). Kornhauser found evidence of psychological conflict among scientists in American industry due to dissonance between professional research ambitions and organizational requirements (Kornhauser, 1952). However, his findings were not supported by studies of research scientists in some areas of British industry (Ellis, 1969; Cotgrove and Box, 1970; and Barnes, 1971), which may suggest that the differences are due to the studies being undertaken in different applied science contexts (Mulkay, 1977, p.130).
A series of thirty-three articles entitled "Psychology of the Scientist" appeared in the journals *Perceptual and Motor Skills* and *Psychological Reports* between the years 1962 and 1975. Fisch (1977, p.281) has analyzed their subject matter according to various categories.

Fisch's 1977 review gives a good survey of the literature.
CHAPTER 2: CONDUCENTS FOR THE PERFORMANCE OF EXPERIMENTAL SCIENTIFIC ACTIVITY BY AN ACADEMIC RESEARCHER

The list of conducents will now be given and then each one discussed in detail. This discussion will often take place from a historical perspective, especially in the cases of those conducents I have classified as "conceptual", "attitudinal" and "methodological". This is because such conducents have become so much part of the world-view of people in the West that they may seem to be common-sense. Thus it is not easy to determine what they are merely by looking into the current scientific theories of our day. They are more easily identifiable through a study of the concepts about the world and about scientific activity which the early masters of modern science found it important to emphasize.

A few general points about the conducents should be made. First, they apply to a present-day academic researcher engaged in experimental scientific research in the physical sciences, although many of them would also apply to any person performing experimental research in a full-time capacity in a research institute or other research establishment.

Second, there is no a priori reason why another "science" could not be developed and practised with a different set of conducents, even if such a possibility seems extremely remote. However, we are dealing with science in the known world, and science as we know it seems to require a good number of the conducents here laid out. Which conducents these are will be considered after discussion of each individual conducent.

Third, some of them are obviously interrelated, but have been separated for the purpose of clearer analysis. At the same time this interrelatedness is an important aspect of the conducents in that while some of them were present at other periods of history, it was the collective appearance at a particular period of history and in particular centres of civilization of those of them which will be termed "prerequisite" which resulted in the rise of modern science.

Fourth, some of the conducents are external and some are internal to a research scientist. This suggests that the conducents may form a hierarchy. Further discussion of this point will be made at the end of the chapter.

Fifth, it should be noted that some conducents have stimulated the performance of scientific activity in some fields at some periods, but have later been modified or discarded; one example would be the mechanistic view of the sub-atomic world held by physicists before the advent of the quantum theory. This underlines the point that the conducents model is very general and may require some further modification according to the particular sub-discipline to which it is applied.
A further rider should be added at this point regarding the emergence of modern science. Historians of science have stressed that it depended on "a complicated set of conditions" (1) and "involved a great variety of factors" (2). A number of these factors have been set forth in the collections of papers edited by Bullough (3) and Basalla (4), in which both internalist and externalist positions are defended. This continuing controversy over the influences at work in the rise of modern science suggests that the list of conducents below may be less than comprehensive.

2.1 The Conducents Listed

I. Conceptual and Attitudinal Conducents
   a) A view of the natural world as real.
   b) A belief in a broad causality in the natural world; the uniformity of natural causes.
   c) A mechanistic view of the natural world: explanations should be mechanistic rather than teleological.
   d) A concept of time as moving along a linear continuum (i.e. not in cycles); the notion of progress.
   e) A conviction that the natural world can be understood and controlled.
   f) A view of science (i) as not conflicting with other deeply-held beliefs, but (ii) as yielding knowledge which is worth pursuing for its own sake or because it might be 'useful' to society.
   g) A view of experimental scientific research as an activity which is not to be despised.
   h) A commitment to one of the conceptual frameworks currently held by other scientists in the (sub-) discipline or in a potentially related sub-discipline.

II. Methodological Conducents
   a) A striving to use arguments which are logical and internally consistent.
   b) A striving for quantitative results and mathematical models.
   c) A readiness to interpret hypotheses empirically.
   d) A striving for objectivity in the performance of experiments.
   e) An openness to the possibility of alternative explanations.
f) A scepticism towards the results and hypotheses of oneself and others so as to be able (i) to gain scientific recognition, and (ii) to make judgements as to which work is significant and which is not.
g) A commitment to the use of certain instruments and to methods and techniques involving these which are currently held to be legitimate by other scientists in the (sub-) discipline or in a potentially related sub-discipline.

III. Commitment to the Norm(s) of the Scientific Community
The quality of research work which is performed and published by any research worker(s) and which lies within the limits of the existing scientific and technical consensus of the sub-discipline or of a potentially related sub-discipline is rewarded by scientific recognition in various ways:
a) Quality: experimentally and/or theoretically the work should be significantly better than previous work published in the field; it may have such features to commend it as simplicity, elegance, fruitfulness and thoroughness.
b) Lying within the limits of the existing scientific and technical consensus depends on:
   (i) the work being 'plausible', i.e. not too far from the current paradigm, including accepted methodological canons and techniques.
   (ii) attempts being made to consider other possible explanations for the evidence presented and to show that these are improbable.
   (iii) the arguments following one another logically, with no internal inconsistencies.
   (iv) the theory resting on adequate experimental evidence.

IV. Acquisition of Cognitive and Manipulative Skills Relevant to Experimental Research
a) Problem-solving skills.
b) A deep and broad knowledge of the subject.
c) Skills in the use of apparatus.
d) Research techniques.
V. Formation of a High Conception of the Role of a Performer of Research
This can take place before entering university, whilst an undergraduate, and after entering a research position. Role-conceptions may be:
(i) congruent with role-expectations.
(ii) greater than role-expectations.
(iii) less than role-expectations, in which case formal or informal sanctions may be employed.

VI. Role-Expectations (for an Academic Researcher) and the Extent of their Enforcement
Formal and informal sanctions

VII. Role-Facilities
a) Time.
b) Money for subsistence.
c) Equipment and supplies.
d) Technicians.
e) Co-workers.
f) A knowledge of foreign language(s).
g) Research literature.
h) Opportunities for information exchange.
i) Organization and freedom.
j) Cognitive and manipulative skills (see IV. above).

VIII. Psychological Characteristics
a) General role-relevant characteristics, e.g. intelligence, creativity, imagination, curiosity, independent thinking.
b) Self-confidence and self-discipline.
c) Ability to work with other scientists.
d) Motivating factors - affected by Ie; f; g; IV; V; VI; and VII above; and by a, b and c in this section.

2.2 Conducents Mentioned Generally in the Literature
Several philosophers, historians and sociologists of science have made reference to at least some of the conducents listed above. In 1925, for example, Whitehead wrote of the new scientific mentality which had
"altered the metaphysical presuppositions and the imaginative contents of our minds.\textsuperscript{(5)} In a book first published in the same year, Burtt pointed out how easy it was "to be caught in the point of view of our age and to accept unquestioningly its main presuppositions."\textsuperscript{(6)} He went on to undertake a critical study of the rise of the fundamental assumptions characteristic of modern scientific thinking. Some years later, Foster insisted that the philosophy which arose at the end of the Middle Ages and developed along the two main lines of Empiricism and Rationalism from Hobbes to Hume, and from Descartes to Leibnitz was devoted mainly to establishing the possibility of justifying the presuppositions of modern science: "What I wish admitted is simply that these pioneers of modern philosophy, writing before the modern science of nature was fully established and not grounding their conclusions on its existence, did yet ascribe to the world of nature those very characteristics which the modern science of nature must presuppose in it as the condition of its own possibility."\textsuperscript{(7)}

Nearer our own time, in a similar vein to Whitehead, Butterfield wrote that the scientific revolution had "changed the character of men's habitual mental operations."\textsuperscript{(8)}

More recently, Toulmin has shown that in a scientific investigation, certain propositions have to be taken for granted in order to state the working problems.\textsuperscript{(9)} Meanwhile, Polanyi, in his seminal series of papers on the nature of scientific activity, has taken up a similar theme. He quotes Nagel's admission: "For in point of fact, we do not know whether the unrestrictedly universal premises assumed in the explanations of the empirical sciences are indeed true; and, were the requirement adopted, most of the widely accepted explanations in current science would have to be rejected as unsatisfactory."\textsuperscript{(10)} Polanyi then remarks, "In effect, Nagel implies that we must save our belief in the truth of scientific explanations by refraining from asking what they are based upon. Scientific truth is defined, then, as that which scientists affirm and believe to be true",\textsuperscript{(11)} which indicates the extent to which presuppositions underlie scientific activity.

Polanyi has also developed the theme of a network of scientists in different disciplines and sub-disciplines knowing enough to evaluate the work of other scientists in closely neighbouring sub-disciplines. In this way, standards and values are maintained across the whole
spectrum of sub-disciplines which make up present-day academic research science. However, Wynne sees as problematic the extent to which universal values in science are isolable from the values of the scientist's wider socio-economic milieu; this, of course, is not surprising in that Wynne has in mind a socio-economic milieu in which the scientific world-view is all-pervasive.

In his study of the commitments that scientists derive from their paradigms during periods of "normal science", Kuhn discussed the different "levels" at which these commitments obtain. At the lowest level are commitments to preferred types of instruments and to the ways in which these may legitimately be used. Above this level are explicit statements of scientific law and about scientific concepts and theories. At a higher level are quasi-metaphysical commitments which can also shape methodology, such as the belief influenced by Descartes' scientific writings, that the universe was composed of microscopic corpuscles and that all natural phenomena could be explained in terms of corpuscular shape, size, motion, and interaction. Finally at a still higher level are the commitments "without which no man is a scientist". It is with this latter set of commitments that we shall be primarily concerned.

A useful list of what he terms the "assumptions underlying scientific activity" has also been given by Yıldırım.

Let us now consider the individual conducents in greater detail.

2.3-I Conceptual and Attitudinal Conducents

2.3-Ia. A view of the natural world as real

If the world is believed to be not real but merely an appearance or shadow of what is real, then it seems likely that there will be little motivation to investigate it. A potential investigator would see a greater benefit in turning his attention directly to "reality". Thus, it has been argued, Greek philosophers in the Pythagorean or Platonic tradition were not concerned to investigate matter. For them, since an object was nothing more than a realization of its form, with matter as the source of its inability to realize that form perfectly, understanding
of what is and of what happens in the actual world was achieved by intelligent comprehension of form rather than by sense experience of matter.

A similar difficulty arises with certain forms of Buddhism, in which the world is only an illusion, and in Islamic Sufism with its strongly neo-Platonic overtones. (17) More orthodox Islam seems to support the existence of a real external world. (18)

Even in the West, however, the reality of the external world has not gone unquestioned. Hume, for example, did not consider that it was possible to prove the existence of things outside oneself. For him, there was no way of knowing whether there was anything beyond the data of our senses. (19) In contrast, Berkeley claimed that things exist only in so far as they are perceived. However, so deep-rooted was the assumption that matter must exist continuously that instead of taking the logical step of concluding that it does not exist when no-one is there, he argued that God must exist to perceive the material world continuously and he presented this as a solid proof of God's existence. (20)

Later, Russell admitted that he could see no solution to the logical problem stated by Hume concerning belief in the existence of things even when they are not experienced. How then had it been accepted by scientists? Russell suggested that the belief had come about because "science started with a large amount of what Santayana calls 'animal faith'... It was this animal faith that enabled physicists to believe in a world of matter." (21) Hooykaas attributes the faith of the early modern scientists in a real external world to the influence of beliefs concerning God and creation. (22) The successes of early modern science would then justify belief in an external world to a potential scientist, whether or not he held any religious beliefs which legitimated it.

It could be argued that with the revolutions in modern physics, scientists no longer believe in matter, since the fundamental substratum of the world can be described only in mathematical terms. Nevertheless, although modern physicists may have given up their belief in matter, this does not mean that they have given up their belief in an external world. The statements of several scientists bear this out. For example, Rosenfeld, a disciple of Niels Bohr wrote..."as far as quantum
mechanics is concerned, I would say that it is impossible to understand it without assuming that there is an external world which is independent of what we think and which is the ultimate origin of all our ideas." (23) Likewise Born has commented on "man's need to believe in a real external world independent of him and permanent, and his ability to mistrust his sensations in order to maintain this belief." (24) Einstein was even more explicit: "The belief in an external world independent of the perceiving subject is the basis of all natural science." (25) If the existence of a real external world were not assumed by scientists, they could not trust their immediate perception of spatial directions and relations and they could not communicate observations to other scientists. (26)

At the same time, a rider should be added. The assumption of the existence of an external world does not necessarily mean that experimental investigations on it lead the investigator to a knowledge of objective truth about it.

The lack of distinction between a subjective and an objective world in some African philosophies has been seen as an impediment to the reception of scientific beliefs. Such a monistic world-view, it has been suggested, does not encourage its possessors to regard the natural world apart from themselves or other beings. (27)

2.3-Ib. A belief in a broad causality in the natural world; the uniformity of natural causes

In the seventeenth century, scientists abandoned any enquiry about final causes, and such questions as why God made the universe in such and such a way, and restricted themselves to the question of how the universe functions. They were now concerned only with efficient causes which they sought to relate with specific effects by means of general laws or models.

However, it was not long before causation per se was being attacked from a philosophical viewpoint by Hume. He denied that causation is a real bond between things, which can be either demonstrated a priori, or inferred from observation. The necessary connection between causes
and effects is merely something which exists in the mind, and which arises from custom. (28) However, as Macnabb points out, if the denial of causation is followed to its logical conclusions, all inferences about the unremembered past, the unobserved present, and the not yet observed future would have to be abandoned, as well as the evidence of sense, memory, testimony and the use of significant speech. (29) Thus it is not surprising that most scientists seem to have ignored Hume's critique.

More recently, Heisenberg's Uncertainty Principle (1927) has been held up as an example of non-causality in nature. However, Russell emphasizes that this principle has to do with measurement and not causation. (30) Quoting an article by Turner (31), he writes, "There is nothing whatever to show that any physical event is uncaused." Planck's view of causality was that it was "a heuristic principle, a signpost - and in my opinion, our most valuable signpost - which helps us to find our bearings in a bewildering maze of occurrences, and indicates the direction in which scientific research must advance in order to arrive at fruitful results". (32)

Macnabb's observation about the logical conclusions of the denial of causation indicate that a belief in a broad causality in the universe is prerequisite for the performance of experimental scientific activity. At the same time, it may be that for some scientists, following Planck, this is merely a heuristic device.

An important aspect of the belief in causality in nature is the underlying assumption about the uniformity of nature. That is, in conditions ABC, results XYZ will always follow if they are observed to follow on one or more occasions, provided all the conditions which are relevant remain the same. Whether or not there is a "necessary connection" in the philosophical sense is not at issue.

A scientist assumes the uniformity of nature when he attempts to obtain the same results from an experiment which he has performed previously or which another scientist has performed previously, and when he makes future predictions about phenomena. In fact, he has to assume it whenever a time lapse is involved in making observations, even during a single experiment.
As the concept of the world as orderly and consistent seems so basic to scientific endeavor, it would be as well to review what various writers and historians of science have said about the origins of this concept, especially since this study is concerned with socio-cultural influences which may inhibit the performance of experimental activity.

Lloyd points to the Milesian philosophers as differing from earlier Greek and non-Greek thinkers by their recognition that natural phenomena were regular and governed by determinable sequences of cause and effect, rather than by random or arbitrary influences. They distinguished between "natural" and "supernatural", and tried to look for a universal in nature.

The Greek idealistic philosophers presented nature as full of reason and logical necessity to which even Plato's demiurge had to submit. Thus Hall sees them as setting "at the very root of the European tradition of science the idea of an interlocking system of ideas sufficient to explain all the variety of nature". Although Whitehead did not discount the influence of the Greek philosophers, he submitted that the belief in an order in nature was vividly implanted on the European mind" by the medieval insistence on the rationality of God." He contrasted this with the conceptions of God in Asia, which were of a being "who was either too arbitrary or too impersonal for such ideas to have much effect on instinctive habits of mind". As a result, "any definite occurrence might be due to the fiat of an irrational despot, or might issue from some impersonal, inscrutable origin of things." 

Zilsel took up a similar theme when he suggested that the idea of "laws of nature" derived from two primary sources, one being the Jewish conception within Christianity of God as the Divine Legislator of the universe, and the other the practice of civil government by statute law introduced by the absolute monarchs of the sixteenth and seventeenth centuries.

The influence of neo-Platonism in the rise of modern science has been strongly argued by Burtt. In his view, the belief in an order in the universe is related to the conviction that there is an underlying mathematical harmony in nature. Burtt shows how Nicholas of Cusa became convinced that the whole universe was made of numbers.
too, became firmly persuaded that the whole natural order consisted of mathematical harmonies, and even held that the latter were the cause of the observable facts being as they were. For him, the discovery of mathematical causes was the way to truth about the real world. As justification for why there existed this mathematical order in the universe, Kepler pointed to God's creating the world in accordance with numerical harmonies. In a similar way, Galileo, although influenced by the neo-Platonic background of the mathematical and astronomical developments of his time, believed that God was a geometrician in his creative labours. Man simply had to find the mathematical relations that God had originally built into the system. It was because of its fundamentally mathematical character that nature, according to Galileo, was a simple, orderly system in which everything was thoroughly regular and necessary.

Burtt also sees other scientists up to and including Newton resting their belief in intelligent order and regular harmony in the natural world upon the divine creation of the universe. In fact, Newton went even further in assuming that the order, beauty and harmony of the universe were to be eternally preserved by the continued exertion of the divine will, even to the extent of correcting any irregularities. (33)

Newton's Second and Third Rules of Reasoning show his belief in the uniformity of nature: "To the same natural effects we must, as far as possible, assign the same causes", (39) and "The qualities of bodies ... which are found to belong to all bodies within the reach of our experiments are to be esteemed the universal qualities of all bodies whatsoever". (40) Newton's successors were encouraged to belief in continuity in nature by Newton's successes and their own. As the mechanization of the world picture became complete, Western European man viewed the universe as relentlessly pursuing natural and necessary laws. For nearly three centuries, the assumption of order in the universe was hardly to be questioned.

There is some controversy over the part played by the Calvinistic doctrine of predestination in influencing the belief in natural law. Merton (41) and Mason (42) have posited that the Calvinist system contains a belief in unalterable law which paved the way for the belief in natural law. This has been denied by Hooykaas. He shows that predestination is not
identical with determinism, and that in any case, determinism has not been very favourable to the rise of science. Although Calvinism may have emphasized the orderliness of the universe, he argues that this did not spring from the Calvinist notion of predestination. Hooykaas sees Christian philosophers attributing so-called laws of nature not to inner necessity but to the exercise of the free will of God. He quotes St. Augustine as saying "the will of God is the necessity of things" and Charles Kingsley (1850) as describing what we call laws of nature as "merely customs of God." As his third example, Hooykaas gives Bishop Berkeley, whose emphasis on empirical research alone leading to certainty about the rules of nature "led to a strictly mathematically-descriptive empiricism".

In retrospect, it appears that the conviction that there is order in the natural world stemmed partly from the Greeks, and partly from a belief in the divine creation of the universe. This conviction has been justified by the successes of successive scientists in manipulating and controlling the natural world.

If scientists did not assume that there was an order and continuity in the natural world, there would be no basis for comparing experiments performed at different times and in different places and no basis for predicting future phenomena.

Before turning to a conducive which is somewhat related to this one, I would like to consider something put forward by Horton on the basis of his studies on African traditional thought. He shows that an actor in a traditional undifferentiated society tends to draw upon the orderly elements of his experience (in his case, the pattern of social relations) to articulate his knowledge of a newly perceived event or object. Hence he tends to speak of natural objects and processes in anthropomorphic terms. Horton suggests that in contrast, actors in differentiated societies tend to speak of newly-perceived objects in more material and even scientific terms because the orderly elements of their experience are not so much social relations as relations of objects in the physical world. If true, this contrast would highlight the extent to which those in differentiated societies are socialized into assumptions and metaphysical beliefs about order in the natural world.
2.3.Ic. A mechanistic view of the natural world

A mechanistic view of the natural world refers to a way of explaining natural phenomena by mechanisms which resemble everyday things a person can see and which he can picture, rather than by spiritual, magical processes. It is strongly related to the concepts of a broad causality and a uniformity in the natural world. The developments in modern physics mean that a mechanistic view of certain areas of nature such as the sub-atomic level is not strictly possible. However, in most other areas scientists attempt to explain phenomena by means of mechanisms or models, since these lend themselves to mathematical treatment.

One of the earliest mechanistic views of the universe was put forward by the Greek atomists Leucippus and Democritus in the fifth century B.C. They believed that everything in the universe was composed of atoms, indivisible and eternal, which were perpetually in motion. Teleological considerations did not enter their cosmology. For them, all things were predetermined. A century later, the atomic theory was revived by Epicurus. In the first century B.C., it found a champion in the Roman Lucretius, who used it to attack religion.

The theory again went out of favour until the sixteenth century A.D. In the seventeenth century, it found an important proponent in the French mathematician Pierre Gassendi.

The main philosophical influence prior to that time was Aristotle. Within his system, adopted by the Scholastics, nature was portrayed as a semi-independent entity, accomplishing the full realization of her immanent Forms by means of efficient and final causes. Furthermore, her workings followed a pattern discovered by Aristotle which seemed rational to the human mind. The result was that the natural world came to be seen as full of spirits and tendencies, and explanations of natural events were given in teleological terms. Even the writings of Copernicus are found to be studded with concepts of value and types of animism, and for this reason he has been described as closing an old epoch rather than as opening a new. (46)

One of the roots of the modern notion of a mechanistic universe has been traced back to Kepler and Galileo. (47) Influenced by neo-Platonism with
a Pythagorean element, Kepler adopted a new metaphysical view of the world, whereby mathematical hypotheses discovered in the facts themselves led to a true picture of the real world. For him the real world was a world of quantitative characteristics, while the changeable, surface qualities of the world which could not be related mathematically were on a lower level of reality.

Galileo developed this distinction even further. In his view, the real or primary qualities such as number, position and motion cannot be separated from bodies, and so they lead us to a knowledge of the true object. He believed that the reality of the universe is geometrical, and so the only ultimate characteristics of nature are those in terms of which certain mathematical knowledge becomes possible. All other qualities are secondary, and merely effects on the senses of the primary qualities. Thus whereas Kepler had seen secondary qualities as existing in the world though on a lower level of reality, Galileo saw them as merely the effect on the senses of the object. The stage was now set for Descartes.

At the same time, Galileo dispensed with teleology as an ultimate principle of causation. Medieval philosophy had stressed the principle of final causality, with the explanation of events being in the form of why rather than how. Galileo, on the other hand, believed that since the real world was composed of quantifiable material elements in their mathematical relations, explanations of changes in the real world should only be in terms of mathematical changes in these material elements. Thus, everything that happens was merely the effect of mathematical changes, that is efficient causality was now what mattered.

Galileo's mechanical concept of the world (but not his mathematical analysis thereof) was developed more systematically and in greater detail by Descartes. Indeed it was probably his desire to unify the whole of natural science in a logical framework and his presentation of a system which he felt had achieved this which made his ideas so acceptable in the mid-seventeenth century. In Descartes' system, all material beings were subject to the same natural laws, which Descartes identified with mechanical laws. These "laws of nature" had been decided upon by God when he had created the universe, at which time He had also inserted amounts of matter and motion which had remained constant ever since. Thereafter, God had not interfered at all with the self-running machine.
Descartes considered the world as made up of two realms. *Res extensa* was the world of bodies, whose essence was extension. This was a geometrical world, knowable only and fully in terms of pure mathematics, a vast machine with no dependence on thought whatsoever and able to exist without human beings. *Res cogitans* was an equally real, though less important realm of thinking substance. Not extended, it was a world of imaginings, feelings, perceptions, all of which were different forms of the thinking substance. Like Galileo, Descartes considered that the secondary qualities of bodies, such as colour and smell, were merely the effect of the motions of the bodies on the senses, and that they had no real existence outside the mind.

Whereas Galileo had been content to look for mathematical relations between phenomena, Descartes presented an entire scheme of the universe in which all phenomena could be explained in terms of universal mechanical principles. Thus, gradually, as Descartes' system came to be accepted, it replaced the traditional medieval view of a universe made up of a vertical scale of qualitatively different entities. From now on, the physical and organic world was a homogeneous mechanical system made up of extension and motion. Although it was to be criticised in its details, particularly by Newton, Descartes' scheme provided a model or paradigm for enquiry in fields as diverse as psychology and astronomy.

The mechanistic world picture was thereafter adopted and adapted by such scientist-philosophers as Gassendi, Boyle, Huygens, Newton, Leibnitz and Laplace, although not all of these men entirely dispensed with traditional non-mechanical concepts.

Several explanations have been advanced for the rapid ascendancy it gained. Amongst these are the revival of interest in the materialistic philosophy of the Greek atomists; the greater clarity of mechanical explanations as opposed to traditional conceptions; the first widespread use of the microscope, which revealed mechanical structures in nature; the experiments by Torricelli and Pascal which suggested the existence of a vacuum - contrary to the assertions of the Aristotelians; the widespread use of mechanical machinery such as clocks and pumps by the mid-seventeenth century; and the writings of Boyle and others which argued that a
However, greater than all these influences seems to be the fact that it was beginning to be successful in practice. It led to advances in physics, such as Huygen's analysis of impact; in chemistry, where Boyle exposed the weaknesses of the belief in the traditional elements and principles; and in biology, where Borelli used mechanical principles to explain the movements of animals.

In summary, then, a mechanistic view of the natural world seems to have been conducive to the development of modern science in two main ways. First, by regarding as real only matter and motion, men were able to purge nature of the mysterious and semi-divine characteristics such as "substantial forms", "sympathetic virtues" and "dispositions" which had been passed on from the Greeks by the Scholastic philosophers. Second, it directed men's attention to what was measurable and enabled them to extract from the natural world those aspects of it which were suitable for mathematical manipulation.

Although it may now be only a heuristic device closely allied to the assumption of order and a broad causality in the universe, a mechanistic view of the natural world still seems to act as a conducent to the performance of scientific activity in directing the attention of scientists to mechanisms or models, and leading on to the possibility of knowledge that is repeatable, reproducible and predictable.

It seems likely that in societies where non-mechanistic explanations of natural phenomena prevail, the reception of mechanistic explanations will be impaired. Thus Dart, in most of his interviews with children and adults in Nepal found that his respondents gave both a "folk-oriented" and a "school-oriented" (or non-teleological) explanation of a given phenomenon. Motivation to pursue mechanistic explanations would seem to be lowered by the presence of such parallel explanations, which were not seen by the Nepalis as contradictory but were regarded as equally valid.

2.3-Id. A concept of time as moving along a linear continuum; the notion of progress

Needham has argued that time is "a basic parameter of all scientific thinking". He sees it as linked to causality, to the uniformity of
nature, since observations of phenomena often have to be made at different times, and to the possibility of empiricism, since experiments often require accurate measurements of time lapses. Thus in his view, the natural sciences will not be favoured by milieux in which time is regarded as illusory or as insignificant compared with the transcendent and the eternal.

Moreover, Needham sees a belief in the reality of linear time as favouring an appreciation of causality. Even though if time-cycles were long enough, an experimenter would not be able to distinguish whether they were cyclic or not, the recurrence theories would tend to sap "the psychology of continuous cumulative never-completed natural knowledge". For the scientific revolution, which required the co-operation of so many individuals, a prevalence of cyclical time would have been severely inhibitory, Needham suggests. Hence the advantage of linear Judaeo-Christian time over Indo-Hellenic time.(53)

According to Burtt, a qualitative change in the treatment of time took place at the hands of Galileo. The Scholastic philosophers had adopted Aristotle's conception of change as the actualization of potentiality. God, the Prime Mover and yet Himself unchanging was considered as drawing upwards into spheres of higher existence any being which contained the potentiality for such. In this scheme, time was merely the measure of motion, and the present existed unmoved and continually drew into itself the future. However, when Galileo introduced the concept of the real world as a world of mathematically measurable motions in space and time, time became a fundamental category stretching out along a measurable continuum. As Burtt comments: "To such a view it is impossible to regard the temporal movement as the absorption of the future into the actual or present, for there really is nothing actual. All is becoming. We are forced to view the movement of time as passing from the past into the future, the present being merely that moving limit between the two. Time as something lived we have banished from our metaphysics. Time for modern physics becomes nothing more than an irreversible fourth dimension. Time, like a spatial dimension, can be represented by a straight line and co-ordinated with spatial facts similar represented."(54) The result was that from then on time was capable of mathematical manipulation.
A linear concept of time is normally associated with a general idea: either of decline or of progress. Of the two, the latter seems to be the more fertile for scientific activity. It is closely linked to a conviction that the natural world can be understood and controlled (conducet ie). An idea of progress implies that man has the capacity for bettering the living conditions of society. This usually comes about through greater understanding, control and manipulation of the natural world. Thus where the idea is widespread that man has the capacity for bettering the living conditions of society, support will be forthcoming for those individuals who have the ability to do so. Moreover, a general belief in progress may be expected to engender confidence in man's capacity to comprehend and control the natural world, and thereby to motivate people both to engage in and to continue in scientific activity. (55)

Another point is that science appears to be a continuous, cumulative, never-completed process. A general belief in progress will tend to reinforce this idea. Hence the emphatic claim by Nash: "The idea of progress is absolutely vital to science, and no society lacking the idea (as did the great civilizations of the East) has ever supported a flourishing science."(56)

In Europe, the general idea of progress does not seem to have originated much before 1600. There seem to have been a number of factors involved. (57)

One suggestion is that the Christian belief in a grand climax to history was fertile ground for the idea of progress, in that later, in a secularized form, it encouraged men to see that history was definitely leading to something. During the quarrel between the Ancients and the Moderns, it became clear that certain forms of scientific knowledge gained with the passage of time. Francis Bacon was vociferous in his discrediting of "the vulgar philosophy" of Aristotle and in showing that the Moderns were really the Seniors.

The idea of progress gained ground in the latter half of the seventeenth century. The glamour of Versailles and the literary glory of Louis XIV's reign appear to have led to a fresh and deeper controversy between the Ancients and the Moderns. And by the end of the century, Fontenelle had helped to instil into men's minds the idea that the sciences were still in their cradle, and were not to become mature in the short space of time that Bacon had predicted.
The Enlightenment gave fresh impetus to the idea of the possibility of progress. It was an age of faith in man's capacity not only to control the natural world but also to engineer society. Within a short time, Reason would usher in a new Kingdom of man, far superior to anything the world had ever known. The symbol of this new faith in man's power to achieve progress was the great *Encyclopédie*, which was published in twenty-two volumes between 1751 and 1777. The *Encyclopédie* had an immense influence, confirming the belief current at the time that opinion governed the world.

Meanwhile in England the idea of progress had gained inspiration from Bacon's doctrine that the results of the Fall of Man in the physical world could be reversed by the application of the methods of science. Although for a while the belief in technological progress weakened with the acceptance of Leibnitz's assertion that this is the best of all possible worlds, it became popular again amongst members of the Lunar Society in Birmingham towards the end of the eighteenth century. (58)

However, the idea of progress was given its greatest stimulus by the theory of evolution. Even before the publishing of *The Origin of Species* in 1859, the notion of progress in the natural world had been propagated by Bonnet, Lamarck and Cuvier, amongst others. Also, researches in geology had presented the mind with a picture of long ages in succession to one another. With the publication of Darwin's theory, therefore, it seemed that not only in the inanimate world but also in the animate there was a tendency to change from simpler to more complex forms with the passage of time.

At the end of his classic study on the idea of progress, Bury notes "how the history of the idea has been connected with the growth of modern science, with the growth of rationalism, and with the struggle for political and religious liberty". (59)

2.3-Ie. A conviction that the natural world can be understood and controlled

The conviction that the natural world can be understood raises the question of epistemology very keenly. At the same time, it presupposes a belief in order in the world.
Although the Pyrrhonians doubted that human reason could ever arrive at knowledge about anything, let alone about the natural world, other Greek philosophers seem to have allowed that man could know about the world because it was imbued with rational Ideas, or Forms, or a world soul.

In later ages, it was considered that since God had created man "in His image" and the natural world in an orderly way, the human mind could gain knowledge about the external world by the use of reason. Throughout the Middle Ages, however, by and large this reason was reason according to Aristotle. A more empirical rationalism had to await the coming of Kepler and Galileo. Influenced by neo-Platonism, they believed that God had created the world according to a mathematical pattern, but they differed from Plato in considering that matter had not hindered the full realization of this pattern. In further contrast to Plato, they held that although mathematical Forms are in the mind, only experience can show which of them have been imprinted on the material world. Thus it was that Kepler, in a decisive act in the history of science, gave up a two-thousand-year-old belief in the circularity of the motions of the planets because of a difference of eight minutes between observation and calculation of the orbit of the planet Mars.

For Galileo, knowledge of the natural world was possible because of his belief in its fundamentally mathematical character. Real knowledge of objects could be obtained by learning their real or primary qualities of number, position and motion. Relations between objects could then be discovered. As these relations were mathematical relations, they led to a certainty inherent in the mathematical method itself. Since the human mind was capable of mathematical deduction, it could therefore attain real knowledge of the external world: "I incline to think that Nature first made the things themselves, as she best liked, and afterwards framed the reason of man capable of conceiving (though not without great pains) some part of her secrets". Following this quotation, Nash comments: "Today we incline very strongly to Galileo's opinion, thinking to have found, in the theory of evolution by natural selection, a mechanism competent so to have 'framed the reason of man'.'

Galileo's concept of science as the pursuit of truth can be further seen in the following quotation: "... the conclusions of natural science are true and necessary, and the judgement (will) of man has nothing to do with..."
them". (62) Here, Galileo's almost absolute commitment to mathematics is readily apparent.

The dualism in Descartes' system of the universe seemed to raise enormous questions as to how something which was unextended (thinking substance) could know anything about the extended universe, which was completely independent of it. Descartes attempted to solve the dilemma by an appeal to God. He claimed that God had created men's minds with certain innate clear and distinct ideas (which were in fact mathematical ideas plus some logical propositions), and that the world of matter had been created in accordance with these ideas. Since God was perfect, He would not allow men to think that their clear and distinct ideas about the world were true if they were not. Hence all logical deductions about the natural world were valid.

Such a doctrine naturally raised the level of human reason to unprecedented heights. Now, merely by deductive reasoning men could know about the natural world. As Hall remarks: "Descartes confidently proclaimed the capacity of human intelligence to discover laws, principles, logical relationships. His was an influence exerted against the ineffable mysteriousness of the universe. He held that amidst the proliferation of detail, the mind could attain universal truths and justifiably have faith in them. This was the inspiring lesson of Descartes". (63)

Descartes' system was destined to be superseded by Newton's, which continued the trend towards the mechanization of the world picture. Newton's system was an attempt to combine empiricism with the mathematical method. For him, science was composed of laws which expressed the mathematic behaviour of nature. Such laws were clearly deducible from observations about phenomena and were verifiable by experiment and further observation. Moreover, since his laws applied to both cosmic and terrestrial phenomena, they seemed to reinforce the belief introduced earlier by Galileo and Descartes that the real universe merely consisted of mathematically measurable entities. Thus, science could enable man to attain absolutely certain truth about the processes of the natural world.

Newton's spectacular success took away any doubts that the natural world could not be understood. Doubts about the capacities of the human reason
were swept away and before long, Newton's methods were being introduced into political and social sciences. (64)

Like many of his predecessors, Newton believed in the existence of a certain order in the natural world and of man's ability to comprehend this (even when, at first, it might not appear rational). This belief was based upon theological convictions that God had created the natural world, and man in His own image. Later scientists including Faraday and Clerk-Maxwell and other scientists up to the present day have had a similar justification for obtaining knowledge about the external world. However, with the influence of the Enlightenment and the rise and fall of Deism, culminating in a completely materialistic naturalism, the problem of how intelligence could comprehend an independent world in which there was no answering or controlling intelligence became acute. Indeed, eventually the very possibility of knowledge was to be questioned again by the philosophers: "It was by no means an accident that Hume and Kant, the first pair who really banished God from metaphysical philosophy, likewise destroyed by a sceptical critique the current overweening faith in the metaphysical competence of reason. They perceived that the Newtonian world without God must be a world in which the reach and certainty of knowledge is decidedly and closely limited, if indeed the very existence of knowledge is at all possible". (65) Such an agnosticism about the external world has been echoed in more modern times by, for one, Bertrand Russell: "In metaphysics my creed is short and simple. I think that the external world may be an illusion, but if it exists, it consists of events, short, small and haphazard". (66) Such views have led Schaeffer to speculate whether modern science could ever have arisen if the early scientists had held the epistemological views common in the mid-twentieth century. (67)

Meanwhile, spurred on by the triumphs of the Newtonian paradigm and, for the most part, unaffected by the disputes of the philosophers, the practising scientists continued to believe that they could obtain real knowledge about an objective physical world. Such a belief in science as "the pursuit of truth" was reinforced by the protagonists of science, or scientism, particularly when they wanted to use science as a weapon against religion. (68) Ravetz suggests that this ideal of science as the pursuit of truth has functioned as a substitute for religion for some scientists, and also that since it can appear to be the most noble
and harmless of human activities, this conception of science has helped scientists to justify their work to themselves and also to the public who support them. (69)

A shift in the views of many scientists about the nature of scientific enquiry seems to have come about with the acceptance of the quantum theory. Before that, belief in science discovering the real world had led to a criterion of truth as "that which is agreed by scientists to be the closest approximation to a true picture of nature, or one aspect thereof". Post-quantum theory physics retreated to a view of "true" knowledge as merely the representation of physical processes by mathematical symbols. However, several well-known scientists refused to accept the quantum theory as truly scientific knowledge because it did not meaningfully approximate to their picture of nature. (70)

The displacing of Newton's system of the universe following Einstein's theory of relativity also made scientists considerably more wary about making claims for objective truth about the world.

Further doubts as to what extent science reveals the objective truth about nature have come about following the seminal work of Kuhn on the nature of scientific revolutions. Kuhn has shown that there are social influences at work in theory-choice, and he has dissociated himself from the idea that successive theories approximate more and more closely to the truth. However, he has stated his conviction that scientific development is a unidirectional and irreversible process. (71) Ravetz has also discussed the social aspects of scientific knowledge in some detail. He shows that the individual scientist can only achieve an "adequate" solution to his problems, and that there is no objective, certain or "scientific" method of setting or testing criteria of adequacy; these are not set by nature, but by the scientific community. In a mature field, such criteria will be set on the basis of successful exploration of nature, but only after knowledge has been developed and tested over generations can there be any possibility of it being certain. (72)

Nevertheless, whether or not science reveals objective truth about the natural world, scientists would not have achieved their successes, or even have bothered to try unless they believed that their labours would result in a knowledge of at least some aspect of reality. It seems that
such a belief is necessary to motivate people to engage in scientific activity. Polanyi, who anticipated Kuhn in demonstrating social aspects of science, (73) underlines this point: "All scientists must believe that science offers us an aspect of reality and may therefore manifest its truth inexhaustibly and often surprisingly in the future. Only in this belief can the scientist conceive problems, pursue inquiries, claim discoveries; this belief is the ground on which he teaches his students and exercises his authority over the public... The continued pursuit of science would break down if scientists came widely to disagree about the nature of things". (74)

Confidence in man's ability to control the natural world would seem to follow naturally from his gaining knowledge about it. However, this was not the case in antiquity or the Middle Ages. Some Greeks believed that in their dealings with nature, even the gods had to bow to the law of necessity. Thus in their view it was impiety (hubris) or audacity for men to try to compete with nature in making her products. At the most, thought Aristotle, man could help nature to realize her own designs.

In the Middle Ages, the belief in a semi-independent nature again made men wary of attempting to control it. There was almost a sense of despair over man's lack of power over his environment. At the same time, there was a great confidence in the human capacity for understanding nature. (75) This apparent paradox arose from the fact that in general, men's understanding of nature was in qualitative terms.

Hooykaas argues that man's attitude towards nature was changed through the influence of biblical teaching. In the Bible, man, as the only creature made in God's image, is allowed to have dominion over his fellow-creatures. Furthermore, since nature is distinct from God, man need have no fear about manipulating it. This concept of a de-deified nature obviously conformed fairly well to a mechanistic picture of the world, and in a day when religious sanction for beliefs was paramount, contributed to the acceptance of the mechanistic world view. (76)

Francis Bacon was one of the greatest champions of the idea that man could and should control nature. In his New Atlantis he predicted tremendous technological progress for mankind. He believed, however, that the
potentialities of nature could only be realized by conforming to its laws; thus, successful human interference with nature had to be based on a reliable knowledge of nature. This led to his famous identification of knowledge with power: "And so those twin objects, human knowledge and human power, do really meet in one; and it is from ignorance of causes that operation fails". (77) However, Bacon always saw science as directed towards the benefit of mankind.

The notion that the "New Philosophy" would lead to hitherto undreamed of technological advances spread throughout the 16th and 17th centuries. The same theme was taken up during the Enlightenment, and spurred on by the visible successes of science and technology, has continued until it has become taken for granted in our own day, at least in Western societies. Moreover, it is present in other societies where underlying ideological or religious beliefs reinforce it, for example in Israel, in Japan and in countries where Marxist beliefs are prevalent. It is in such countries that scientific activity is flourishing.

In contrast, in societies in which the underlying ideological or religious beliefs do not reinforce the belief that nature can be controlled, scientific activity and the teaching of scientific concepts in schools are in difficulties. This appears to be the case in Nepal, (78) for example, and in many parts of Africa. (79)

Recently, some radical critics of science have insisted that domination over nature is the concealed goal of science. Johnston, for instance, claims that science has been so successful in extracting from reality those features of it which are amenable to reproduction and manipulation that it has been able to impose these as universal criteria of validity for knowledge. He quotes Habermas "... the modern sciences produce knowledge which through its form (and not through the subjective intention of scientists) is technically exploitable knowledge", and Marcuse, "In this project [science], universal quantifiability is a prerequisite for the domination of nature". (80) In other words, pursuit of knowledge about the natural world by scientists leads eventually to technical control, whether the scientists like it or not. Such critics of science are usually condemnatory of science as practised in recent times because in their view it has led to selfish and irresponsible domination of nature and to the development of technology harmful to man (incidentally
suggesting that Bacon's warning that the growth of scientific knowledge should be accompanied by a growth in charity has not been heeded). If a conviction that nature can be controlled is a conducive to scientific activity, then widespread belief that the control of nature is not so beneficial after all should lead to a decline of interest in scientific activity; there is evidence to suggest that radical criticism of science has influenced such a decline in recent years. (81)

It seems, therefore, that a conviction that the natural world can be understood - at least in one of its aspects - is prerequisite for the performance of experimental scientific activity. Although many modern philosophers may have abandoned the belief that scientific activity can result in true knowledge of the natural world, scientists in their research investigations act as if it were possible to uncover at least one aspect of reality. The visible fruits of scientific activity certainly continue to support the possibility, especially those fruits resulting from the application of scientific knowledge to the control of nature. A conviction that the natural world can be controlled is a corollary of the conviction that it can be understood, but may be more of a conducive from the point of view of motivation.

2.3-If. A view of science (i) as not conflicting with other deeply-held beliefs, but (ii) as yielding knowledge which is worth pursuing for its own sake or because it might be "useful" to society

The next two conducive could be described as "attitudinal" in that they prescribe attitudes towards scientific activity.

Someone who regarded experimental scientific activity as a threat to some deeply-held belief would presumably not engage in such activity. As we saw above (p. 61), some Greeks considered any attempt to tamper with nature as an impiety, thus discouraging the performance of empirical work. In later ages, science (in some form) was seen or made to be seen as running counter to religious belief; first to orthodox Islam, towards the end of the "Golden Age" of Islamic science at the beginning of the 11th century, (82) and then to Thomist Catholicism following the trial of Galileo. (However, that Galileo himself could see no clash between his religious beliefs and his scientific activity is apparent from the fact
that he continued his scientific research until the end of his days. Later the theory of evolution was displayed as evidence for science's contradicting religious belief, although it is not clear to what extent this deterred potential scientists from going into the laboratory. Nearer our own day, radical critics of science seem to have influenced some people from taking up a scientific career by portraying science as technocratic and de-humanising (see above, p. 63). Opting out of certain areas of science has also been observed, when the area was supposed to clash with other deeply-held beliefs. For example, in the 1930's some German scientists refused to do research in areas opened up by Jewish scientists.

Science, then, needs to be regarded as not clashing with other deeply-held beliefs. Basalla sees a precondition to indigenous independent science in the overcoming of resistance to science on the basis of philosophical and religious beliefs and its replacement by a positive encouragement of scientific research.

Moreover since experimental science is such a demanding activity, the knowledge gained through it needs to be seen as worthwhile, either as a step further in the pursuit of truth (or one aspect thereof) about the natural world or as beneficial to society by means of its applications. Throughout the history of science, one or other of these motivations, or a further religious motivation, seems to have characterised the behaviour of scientists.

Most of the ancient Greek philosophers pursued knowledge mainly for its own sake. Although many ordinary people did value the practical arts, Lloyd tells us that "the view that we find in Francis Bacon, that the goal of the acquisition of knowledge is its practical benefits, is quite foreign to the ancient world". Farrington sees the reason for the science of the Greeks and Romans not going forward in its failure to become a transforming force in the conditions of life.

For Francis Bacon, the great propagandist of science, there were two motivations for the quest for knowledge, one religious, and the other humanitarian. The college in Bacon's *New Atlantis* was established "for finding out the true nature of all things, whereby God might have the more glory in the workmanship of them" whilst the practical application of knowledge was "for the comfort of men". Bacon's philosophy inspired science as an activity which organizes knowledge
for use, an activity which was to be carried on in public and of concern to the public; this aspect of science, we are told, "scarcely existed before the 17th century". (88)

The Protestant Reformation seems to have had a positive influence on the development of science. Hooykaas admits that it is difficult to establish definitive causal relationships among Reformed theology, the new science, and the social and economic development of the time; however, he submits, "At any rate ... for an age in which religious sanction was necessary for something to become socially acceptable, it made a great difference whether science was distrusted, merely tolerated or positively encouraged by the prevalent religion". (89) One of the influences of the Reformation delineated by Hooykaas is the teaching of the Reformed Churches that the intellect should be used in the duty of glorifying God for all His works. This gave science as an activity a religious legitimation. Another influence was the emphasis on the general priesthood of all believers, which encouraged people not to take religious teaching on the authority of priests but to compare it with the book written by God; in a parallel way, those who had the requisite gifts were encouraged to study the book of nature without depending upon the fathers of natural philosophy. Hooykaas thus sees Puritanism and the New Philosophy as having the following in common: anti-authoritarianism, optimism about human possibilities, rational empiricism, and the emphasis on experience. (90) However, there are historians who have taken the other side in this still-continuing controversy. (91)

A religious motivation for engaging in scientific activity was also proffered by Fontenelle in 1688, who suggested that "physics becomes a kind of theology when it is pursued correctly". (92) A more orthodox religious motivation seems to have characterized other scientists long past the 17th century. Ravetz gives evidence to show the continuity between Newton's fundamental natural philosophy and his theological concerns, and claims that until nearly a century ago, many scientists in England were motivated by the conviction that a study of the natural world resulted in increasing reverence for the Creator. (93)

In the mid-nineteenth century, science in Britain began to change from being an activity almost exclusive to amateurs and gentlemen. A few university appointments in science had been made in the eighteenth
century, but now they began to be offered on a more systematic basis. However, at Oxford and particularly Cambridge, where the collegiate classical tradition was still dominant, scientists were influenced by the prevailing liberal classical educational philosophy to regard scientific activity as solely a pursuit of knowledge for its own sake. Thus Wynne shows how they vehemently opposed Government support for scientific research, since it implied a pursuit of knowledge for vulgar, materialistic ends. (95) Wynne argues that in contrast, in the provinces there was more of a desire to set science on a professional footing and so the emphasis at universities like Manchester was more on a utilitarian, materialistic type of science. Eventually "pure" science was seen to lead to unexpected technical applications, and this has been the basic argument behind its social relevance ever since.

Meanwhile, in 19th century Germany, science was being stimulated by a nationalistic, romantic philosophy which the state was intent upon spreading throughout the universities. However, because of the idealistic, anti-utilitarian nature of this philosophy, the science it encouraged was science for the sake of knowledge. It was only in the institutes which sprang up alongside the universities which nurtured a more technological-utilitarian attitude towards science. (96)

In America, science before the Civil War was regarded as relevant because of its practicality. Daniels shows how scientists and their spokesmen came to resent this in the 1870's and began a campaign to sell "science for science's sake" to the public and, ultimately, to the federal government after they had realized that the yardstick of utility was too limiting for worthwhile research. (97) He sees the continued support of scientists by society as resting upon the believability of what has now come to be the standard formula: "Utility is not to be a test of scientific work, but all knowledge will ultimately prove useful".

Thus, after experimental science became a professional activity it had to justify its existence to the wider society directly or indirectly supporting it. In recent times, this has become increasingly important as the costs of doing research, especially in the physical sciences, have steadily escalated. The implication is that if it is to flourish, scientific activity must be seen as relevant to some aspect of the needs of society by society at large. The more it is seen in this way by the scientists
themselves, the greater will be their motivation for engaging in it.

The absence of this conducent has been cited as one of the main influences in the slow development of science in modern China, where Confucian thought gave importance to moral principles and human relationships at the expense of a systematic study of the natural world. Furthermore, the Chinese had a sense of cultural superiority, and science was associated with the despised foreigner and his misdeeds. In contrast, the Japanese were quite used to cultural borrowing and within a short space of time reacted positively to "Dutch learning". Also, in the later Islamic world, the natural sciences and their technological applications were not seen as contributing anything to the fundamental needs and aspirations of their civilization, with the result that research in the natural sciences never really advanced.

In LDC's today most scientific research is university-based and as such is usually irrelevant to the felt needs and aspirations of the wider society. This has been observed, for example, in Asia, Africa and the Middle East. Since resources are scarce and expectations for rapid change are extremely high, the place of the "pure" science research worker is rather ambiguous. To the wider society, and perhaps even to himself, his research may appear to be far removed from the burning issues of the day, such as economic and social development, in that visible "spin-offs" may come about only years later. Motivation both to support and to engage in scientific research activity is likely therefore to be sapped.

2.3-Ig. A view of experimental scientific research as an activity which is not to be despised

This second attitudinal conducent is concerned with attitudes towards active experimentation. Since the latter is associated with manual labour, it is attitudes towards manual labour which seem to have affected willingness to undertake experiments.

The Greeks had a somewhat ambivalent attitude towards manual labour. Manual work was highly esteemed by the pre-Socratic Greeks, but later, it was looked down upon, especially by the Spartans. Xenophon considered that a free citizen should not perform manual trades, although
husbandry together with the labour involved and warfare were acceptable. For Plato, manual labour was something that should be left to slaves. Thus to philosophers of the Platonic school, the investigation of material things was inferior to the pursuit of spiritual things; therefore, even manual work for scientific ends was considered as despicable for philosophers. For example, Plato scorned the Pythagoreans for their experiments.

Aristotle had less metaphysical prejudice against applied science than Plato, but in his ideal state, the free artisan did not occupy an honourable position. Since leisure was necessary for the development of virtue and for participation in politics, the citizen should not till the soil or engage in mechanical or mercantile trades. Aristotle seems to have had somewhat of a social prejudice against applied science; in his *Metaphysics* he identifies a science cultivated for its own sake as the only worthy occupation for a free man.

Although Archimedes made war-machines to defend the city, he did not write about them, because he regarded mechanical instruments as low and vulgar. It seems that only in the field of medicine was manual work honoured by the Greeks.

The engineers, meanwhile, ignored the jests of the philosophers and made war-machines and artificial toys. A water-wheel was invented in the 1st century B.C., but was not widely used for many centuries, probably because of the ready availability of slave labour. Zilsel sees three reasons for slave labour inhibiting the emergence of modern science. One is that slave labour seems cheap enough to make the introduction of machines seem superfluous. Another is that slaves usually do not have the skills necessary for handling complex devices. Another reason is that slavery breeds a social contempt for manual work among the educated. Thus, "ancient intellectual development could not overcome the barrier between tongue and hand". (105)

Farrington, too, considers that the division between citizen and slave was at the root of the conception of science put forward by Plato and Aristotle. Although there were advances in mathematics and logic, "the separation of science from the fertilizing and controlling contact with techniques dealt it a crippling blow from which throughout the whole
period of antiquity and the Middle Ages it failed to recover". (106)

During the early Middle Ages, increasing admiration for the Greek writings revived the idea that manual operations were beneath the dignity of the scholar. However, the Benedictines were exceptional in combining intellectual activity with manual work. (107) During the Renaissance, there was a more general co-operation between head and hand. The emancipation of the burghers, who were often craftsmen themselves, resulted in a higher esteem for manual work, as well as for commerce and industry. In the 16th century, there was increasing co-operation between scholars and artisans with scientific interests. Paracelsus, for example, was one of the first scholars to take the side of the experimenting alchemists, who were regarded by the scholastic philosophers as trying to do something which should not and could not be done and which in any case was debasing for academics.

There is some evidence to suggest that the Reformation was influential in removing the stigma hitherto associated with manual labour, and hence with experimental work. (108) The wide dissemination of the Bible encouraged the belief that any occupation was honourable, provided it was done to the glory of God. Thus, manual work was given a religious sanction. In the typical burgher societies of Nürnberg, Antwerp, London and Amsterdam, a social emancipation of the artisan class developed alongside a religious emancipation.

Francis Bacon campaigned openly against the notion that a learned man should not stoop to enquiring into mechanical matters and performing experiments. He even advocated curriculum reform in the schools, so that more time might be given to scientific demonstrations and experiments. Such proposals were taken up by several of the Puritans, including John Wilkins who was influential in the formation of the Royal Society. It has been argued that men with strongly Protestant leanings had a major share in the founding and early development of the Royal Society, and it is significant that Sprat, the Society's chronicler, spoke of the "union of Men's hands and Reasons" represented by "the tradesman, the merchant and the scholar" who were all allowed to become members of the Society. (109)

It is also significant that in the 18th and 19th centuries, when for most
of that period, science in England was an activity practised only by gentleman amateurs, there does not seem to have been an identification in the minds of the "gentlemen" of experimental work with something which was beneath them.

A disdain for things practical seems to have survived until quite recently in many countries, and this has been cited by various observers as a negative factor in the development of science in those countries. In the last century when Louis Agassiz visited Brazil, he noted that as long as Brazilian "students of nature think it unbecoming a gentleman to handle his own specimens, to carry his own geological hammer, to make his own scientific preparation, he will remain a mere dilettante in investigation..." (110) In Africa, Burkhardt has observed a leftover from colonial days when the "master" used to sit behind a desk and give his orders while the natives did the manual work: science is less respectable than history, languages or law, and "true scholarship" means book work. (111) In India, according to Dessau, science graduates often prefer administrative posts to more technical ones, while vocational training is thought of as inferior. (112) In China, Oldham noted the Chinese communists' attempts to overcome the traditional disdain for things practical which seems to have stemmed from the Confucian emphasis on classical education. (113)

2.3-1h. A commitment to one of the conceptual frameworks held by other scientists in the (sub-)discipline or in a potentially related sub-discipline

At first sight, a commitment to a conceptual framework held by other scientists would appear to be the very antithesis of the mythical "scientific outlook". However, the work of Kuhn and his followers has shown that scientific progress normally arises out of commitment to what Kuhn loosely describes as a "paradigm", and that only when anomalies to the current paradigm abound are scientists shaken in their commitment and look around for an alternative. (114)

Unfortunately, Kuhn's use of the word paradigm in his original essay was notoriously elastic; Masterman identified twenty-one different ways in which it had been used, and divided them into three categories: metaphysical, sociological and construct or artefact paradigms. (115)
In response, Kuhn explained that what he had in mind was a "disciplinary matrix" made up of constituents which "form a whole and function together", and which is shared by a particular community of scientists in a sub-discipline. One constituent of this matrix was "symbolic generalizations" such as $f = ma$, which may be laws of nature or definitions of some of the symbols they use. Another constituent was beliefs in particular models, including heuristic models; these models present preferred or permissible analogies and metaphors which help to determine what is acceptable as an explanation, what puzzles have yet to be explained and also the relative importance of the latter.

A third component of the disciplinary matrix is shared values such as accuracy, simplicity, self-consistency, and consistency with other theories in related fields. At different periods of time, scientists may vary in attributing importance to particular values, although judgements of accuracy tend to remain fairly stable. A fourth element in the disciplinary matrix is "exemplars" or problem-solutions which scientists encounter throughout their scientific education and which show them by example how to approach specific problems first in their discipline and then in their sub-discipline. Learning to imitate these exemplars socializes a student into seeing a variety of situations in a similar light and as subjects for the same symbolic generalizations. He thereby assimilates "a time-tested and group-licensed way of seeing." Thus, in Kuhn's opinion, the perception itself of a scientist is conditioned by the special training he receives.

According to Kuhn's original account, once the majority of scientists practising in a particular field have opted for one paradigm in favour of one or more others, they enter a phase of "normal science", in which their main activity is "puzzle-solving". This means that, generally speaking, they are involved in solving problems which can be assumed to have solutions. During this period, other problems which lie "outside" the paradigm are not considered by the community of scientists as properly scientific or as capable of solution. Thus scientists concentrate exclusively on problems which the conceptual and instrumental tools provided by the paradigm allow them to solve, and the result is rapid development within the paradigm of the particular field. Commitment to a paradigm is, then, for Kuhn, a precondition for progress in science.
Nevertheless, there comes a day when anomalies to the paradigm begin to proliferate, and revolutionary-minded scientists look around for another paradigm to explain both the anomalies and the facts explained by the traditional paradigm. A period of crisis ensues, with scientists taking sides in support of different paradigms. Finally, swayed by considerations such as accuracy, consistency, scope and simplicity, most scientists in the community embrace one particular paradigm and a period of normal science begins again. Kuhn maintains that such "revolutions" may take place over a whole discipline or merely within a section of a sub-discipline. Moreover, they can be fairly frequent events, a claim, however, for which Mulkay considers there is little evidence. (117)

Kuhn suggests that at their first appearance at least, paradigms have a tacit nature, which enables scientists to proceed with scientific investigations even when theory is not fully formulated. Thus he maintains that while a paradigm can yield a set of rules which define what solutions to a puzzle are acceptable and how these are to be obtained, "paradigms can guide research even in the absence of rules". (118) Thus, scientists may identify a paradigm and let it guide their research without explicitly interpreting or rationalizing it, or reducing it to an agreed set of rules. In the absence of rules or of their formulation, normal science proceeds by "the direct inspection of paradigms", something for which a formulation of rules and assumptions is helpful but not essential. This process involves relating new investigations to already established scientific achievements by resemblance and by modelling.

With such reasoning, Kuhn has given enormous impetus to the notion of a social and often tacit dimension in scientific activity, and to an understanding of the social processes involved in scientific change. However, a more sophisticated model of growth in science allows for innovation by "cross-fertilization", or the application to new areas of results from one area, and by the migration of scientists into new areas not merely because of breakdown in the prevailing paradigm but also because the well of interesting problems indicated by the prevailing paradigm appears to be drying up. (119) Such a model is based upon one originally put forward by Holton. (120) He considers that a new research area grows exponentially at first, with rapid discovery of its most interesting basic ideas. As the number of interesting ideas yet to be explored decreases, growth becomes linear and eventually tails.
off. The period of linear growth may correspond to Kuhn's "normal science". However, before the end of the period of linear growth, some researchers switch to a new area or areas which are unexpected outgrowths of the old area and which seem to hold out exciting prospects for research. They are joined by new recruits to the field, and in its turn the new area grows exponentially, linearly and then becomes static. Thus according to Holton, "The growth of scientific research proceeds by the escalation of knowledge - or perhaps rather of new areas of ignorance - instead of by mere accumulation". Such a model complements rather than competes with Kuhn's, since it does not deal with the need for scientific and technical consensus.

Before assessing Kuhn's relevance to conducents for scientific activity, let us consider the main categories of research rules which Kuhn has been able to glean from a study of normal-scientific traditions. He suggests four categories, at various levels. At the highest level is "the set of commitments without which no man is a scientist", for example a commitment "to understand the world and to extend the precision and scope with which it has been ordered". Below these are "quasi-metaphysical" commitments, such as the Cartesian belief that all natural phenomena could be explained in terms of shaped matter and motion. Below these are generalizations such as scientific laws and explicit statements of theories. Finally, at a lower level still are "commitments to preferred types of instrumentation and to the ways in which accepted instruments may legitimately be employed".

It is clear that Kuhn has a wide definition of "scientist", since I am claiming that all of the above are in some way conducive and even prerequisite to the performance of experimental scientific activity, at least in modern times. Some confusion, too, arises in his scheme when at various points in the remainder of his book he describes commitments at each of the four levels as "paradigms" (see Masterman, ref.115 above).

I would argue that there are a number of conceptual and methodological commitments which are held by all scientists today and which do not change much over time. These conceptual commitments are those discussed before this section, namely Ia to Ig. There is also a changing conceptual commitment which would consist of the symbolic
generalizations and models of Kuhn's disciplinary matrix, appropriated mainly by the solving of exemplars. The "shared values" component of the disciplinary matrix I would want to consign to section III of the list of conducive, headed "Commitment to the Norms of the Scientific Community". Commitments to preferred types of instruments and to the ways in which these may be employed could also go under this heading, but I have separated out this methodological aspect as IIg.

I have said commitment to one of the conceptual frameworks held by other scientists in the sub-discipline to allow for periods when one or more frameworks are competing for acceptability. An example from chemistry would be the molecular-orbital and valence-bond theories. Defining the framework as being held by other scientists does not rule out the revolutionary pioneer who first presents the alternative framework, because in most cases he will have been previously committed to a prior framework in a potentially related sub-discipline from which he has migrated.

To summarize, then, what I mean by "conceptual framework" is a hierarchy of potentially changeable beliefs. The higher level ones embrace, perhaps, several disciplines. One example would be Newton's system. At a lower level are more local beliefs that are held by scientific communities which may be large and incorporate scientists from different disciplines, or which may be small and comprise a mere handful of scientists in a section of a sub-discipline. Depending on the state of the sub-discipline, the conceptual framework may be fairly vague or else well articulated. Without any commitment to a conceptual framework, however, a scientist will not know what problems to tackle, nor what his peers will count as admissible solutions. Such a framework is prerequisite, then, for the performance of experimental scientific activity, although commitment to it may loosen when anomalies begin to prevail.

2.3-II Methodological Conducents

The work of Polanyi, Kuhn and Ravetz, amongst others, has shown the extent to which the production of scientific knowledge is dependent upon social factors. They agree upon the informal interpersonal transmission of a body of methods associated with a particular field, with no simple way of testing the "correctness" of
a particular method. Thus they tend to go against the ideas of older philosophers of science who believed in a or the "scientific method" mainly through not observing closely enough the way in which scientists actually went about their business. Ravetz, for example, thinks, "The root of the difficulty in any discussion of method is that it involves an attempt to render explicit that which is largely tacit. For the achievement of significant new scientific knowledge is a creative activity, involving intellectual work that is both bold and subtle". (124)

Nevertheless, it is possible to discern several methodological emphases in experimental scientific activity. While they may not hold all of the time and in every case, they are generally conducive to the performance of experimental research of quality.

2.3-IIa. A striving to use arguments which are *logical and internally consistent*

A first impulse might be to use the word "rational" instead of logical. However, rationality is not easy to define with any precision. "Rational" and "scientific" are often used interchangeably. For example, Ayer defines a rational belief as one which is arrived at by the methods of contemporary science. (125) This suggests that in some cases rationality may be context or paradigm-dependent.

In his discussion of the whole question of rationality, Lukes has distinguished between universal and context-dependent criteria of rationality. (126) The two types of universal rationality criteria he identifies are (i) criteria of truth, "as correspondence to a common and independent reality", so as to be able to identify spatio-temporally located objects and to predict, and (ii) rules of logic, "the concept of negation and the laws of identity and non-contradiction", so as to be able to infer, argue and even think. He then lists some criteria as context-dependent, such as (a) criteria of truth applied to beliefs which are in principle neither directly verifiable nor directly falsifiable by empirical means, (b) criteria of meaning, and (c) criteria which specify the best way to arrive at and hold beliefs, and for deciding what counts as a "good reason" for holding a belief.

Lukes' universal criteria of rationality have been criticised by
Barnes. (127) His main criticism revolves around Lukes' assumption in type (i) that there exists a neutral or universal observation language, a critique which appears to hold some weight. With type (ii), however, Barnes agrees. In the final analysis, therefore, we are left with criteria of rationality which in effect are the rules of logic. This is also Barber's interpretation of Merton's norm of rationality. (128)

However, if the rules of logic are universal criteria of rationality, required by the use of language, then why should the use of arguments which are logical and internally consistent be thought of as peculiar to science? Barnes and Dolby, in their critique of Merton's "scientific ethos" argue that there is no reason for doing so. (129) Nevertheless, although they look "in vain for training or less formal socialization processes designed to teach the scientist to 'be rational'", it could be argued that potential scientists are taught by teachers and peers to ensure that arguments follow one another in a strictly logical order. "Does this really follow?" is a not infrequent question sprung upon the fledgling scientist. Incidentally, it is interesting to note how Barnes points out the "non-sequitur" in Lukes's argument. (130)

Whitehead considered that the European mind was socialized into the habit of definite exact thought by the long dominance of scholastic logic and theology. Galileo, he maintained, owed to Aristotle "his clear head and his analytic mind." (131)

Thus, although most people most of the time abide by the rules of logic, a recognition of the necessity for rigorously logical arguments in what is often highly esoteric subject matter seems to be a conduent for experimental scientific research.

Before turning to the next methodological conduent, we should note that all discussion about logic involves the tremendous assumption that at any given moment our minds are thinking logically. An argument by Haldane in a slightly different context suggests that for strict reductionists, the assumption is not a small one: "If my mental processes are determined wholly by the motions of atoms in my brain, I have no reason to suppose that my beliefs are true... and hence I have no reason for supposing my brain to be composed of atoms". (132)
2.3-IIb. A striving for quantitative results and mathematical models

In the formation of a mechanistic conception of the universe, Kepler, Galileo and Descartes pressed the idea that the fundamental nature of the world is mathematical (see above, p.50). By ignoring those properties of substances which were not quantifiable, they and their successors were able to concentrate on extracting from reality those aspects of it which were measurable. In this way, the world was reduced to mathematical entities which could then be subjected to mathematical handling. Thus by the very nature of the information they obtained about the world, scientists could repeat processes, predict events and manipulate the natural world for their own ends.

It is no surprise, therefore, to learn that developments in mathematics went side by side with the rise of modern science. Butterfield writes... "In dynamics and physics, the sciences give the impression that they were pressing upon the frontiers of mathematics all the time. Without the achievements of the mathematicians, the scientific revolution as we know it would have been impossible". (133) Thus we find Descartes' invention of analytical geometry and Leibnitz and Newton's invention of the calculus leading up to the great Newtonian synthesis.

It was Galileo who set the mathematical pattern of science which has continued until the present day: "Galileo showed how to extract from the bewildering variety of physical experience mathematically defined concepts, and how - through mathematical reasoning - general conclusions followed... Galileo created a pattern of science of tremendous power. Even in the mid-20th century by no means all science falls into this pattern, but it has been extended over the whole of physical science and has penetrated biology... It is obvious that for science to develop mathematical theories, its ideas must be expressed in quantitative terms". (134)

Quantitative results and mathematical models, then, have been the objective of scientists since Galileo's time. Quantification leads to greater exactness and precision, which in turn provide a more discriminating basis for making comparative descriptions, for formulating precise relationships, and for comparing rival hypotheses. (135) Moreover, quantification allows the data gathered to be treated mathematically. Hence, other things being equal, the scientist who strives the more for
quantitative results and mathematical models will stand a better chance of producing higher quality research than one who strives less.

2.3-Iic. **A readiness to interpret hypotheses empirically**

Conant describes the "new philosophy" of the 17th century as the result of the union of three streams of thought and action: speculative thinking, deductive reasoning and empirical experimentation. (135) The accent should undoubtedly be upon the word "union", as each of these activities is to be found in one form or another in previous ages.

Some of the Greek philosophers, such as the Hippocrates and Aristotle, developed a notion of doing empirical research, (137) but did not take it very far in practice. Several factors which went against the use of experiments by the Greeks have been suggested: rationalism, the deification of nature, the underestimation of art, and a disregard for manual work. (138)

The influence of the Greeks continued well into the Middle Ages. In order for scientific experimentation to gain general acceptance, it had to receive both moral and social sanction. (139) Moral sanction could only be obtained when suspicions that it was being used as a means for gaining improper knowledge about or improper power over nature were dispelled. Social sanction only followed when it could be shown that engaging in experimentation was not degrading for a philosopher or free citizen.

Crombie argues that a systematic understanding of at least the qualitative aspects of constructing theories and submitting them to experimental tests was created by the philosophers of the West in the thirteenth century, with Robert Grosseteste a prominent example. (140) At the same time, he does not discount the experimental contributions of Arab scientific writers such as Alkindi, Alhazen, al-Shiraz; and al-Farisi in optics, and by Rhazes, Avicenna and others in chemistry. Crombie documents the influence of the works of the medieval scholars on the scientists of the sixteenth and seventeenth centuries. Nevertheless, he admits that the earlier scholars did not undertake many actual experimental investigations, and suggests that this was because they were less interested in the concrete problems of the world of experience than in
the kind of knowledge natural science was, that is, in how it fitted into their metaphysics. (141)

The arguments of Crombie and his school illustrate the need for care in trying to pin-point the date when a true empiricism merged with mathematics. However, most scholars are agreed that such a synthesis is apparent from the time of Kepler onwards. "Without proper experiments, I conclude nothing," said Kepler. (142) Galileo, too, held that hypotheses had to conform to sense-experience: "In every hypothesis of reason, error may lurk unnoticed, but a discovery of sense cannot be at odds with the truth." (143) At the same time, however, he firmly believed that the world of senses could only be interpreted or explained in mathematical terms, and so experiments were mainly for obtaining more certain results and for convincing others of the validity of hypotheses.

Francis Bacon was one of the most vocal exponents of experimental science. According to Gillispie, "Bacon's emphasis on experiment did shape the style of science. So strongly did it do so that the term 'experimental science' has become practically a synonym for 'modern science', and nothing so clearly differentiates post-seventeenth century science from that of the Renaissance or of Greece as the role of experiment." (144) Bacon spoke out again and again against the rationalism of the Greeks, their neglect of experiments and their basing of theories on insufficient factual evidence. He wrote of the need to "discard these preposterous philosophies which have ... led experience captive, and triumphed over the works of God; and to approach with humility and veneration to unroll the volume of creation". (145)

Bacon's strong emphasis on empiricism found a warm reception in England particularly. The founders of the Royal Society, for example, considered themselves his followers. Boyle was a champion of empiricism, observing that the "new philosophy" was built on the two foundations of reason and experience, while Newton's fourth Rule of Reasoning suggests that his ultimate criterion was more empirical than mathematical. (145) The result was a triumph for rational empiricism over rationalism which has continued until our own day.

The word "tests" is not used in this conductent since it might give the erroneous impression that experiments can confirm or falsify a hypothesis
in an entirely clear-cut way. At one time, it used to be thought that a large number of experimental results which fitted a hypothesis might be sufficient to prove it.\(^{147}\) However, with the advent of non-Euclidean geometry and non-Newtonian physics, and a realization that inductive logic was logically impossible, it was found impossible to prove any theory. Recourse was then made by some philosophers to probabilism, whereby scientific theories were given different degrees of probability according to the available empirical evidence. However, Popper showed that under very general conditions all theories have zero probability, whatever the evidence.\(^{148}\) In the place of this scheme, Popper proposed a method of falsification, of "conjecture and refutation: of boldly proposing theories; of trying our best to show that these are erroneous; and of accepting them tentatively if our critical efforts are unsuccessful".\(^{149}\)

Popper's "logic of scientific discovery" was challenged in a famous debate in which Kuhn pointed out that in practice, clearly falsifying experiments are very seldom observed.\(^{150}\) First, said Kuhn, experiments may be challenged as to their relevancy or accuracy. Second, all theories can be modified by a series of ad hoc adjustments so as to "fit" the results of the experiment. Third, a theory is not usually sufficiently articulated logically nor the terms relating it to nature sufficiently defined to be able to say confidently whether a particular observation falsifies the theory or not. Kuhn saw the most fundamental difference between his views and Popper's as the assumption by the latter that recourse to a neutral observation language to discriminate between two theories is possible.

For Kuhn, because the terms used in the statements of theories are intimately bound to the theories themselves, proponents of two different theories may even use the same words in different ways, thus aggravating the difficulty of one scientist persuading the other of the superiority of his theory. Furthermore, although both parties will in general subscribe to the same set of values for theories, such as accuracy of quantitative prediction, internal consistency, consistency with related fields, scope, simplicity and fruitfulness of new research findings, they may disagree as to the relative weights to give to particular values. Thus one party may consider that a certain experiment supports their theory
because of its greater accuracy. The other party may see another experiment as supporting their theory because it appears to extend its scope. A good example is Einstein's general theory of relativity, which, until quite recently, had very little empirical evidence to support it, showing that its acceptance depended on other criteria. However, this example proves to be the exception rather than the rule, and Kuhn admits that generally the most persuasive arguments in favour of a new paradigm are not only that it can solve problems which the old one could not, but that it leads to strikingly better quantitative precision, and to the prediction - and subsequent experimental validation - of phenomena which were formerly unanticipated.

2.3-IId. A striving for objectivity in the performance of experiments

The notion of objectivity in science may have arisen with a mechanistic view of the world. In section 1c above (p.50), we noted how Galileo's ascription of reality to the quantifiable aspects of objects, namely number, position and motion, was the beginning of a process in which man came to be seen as wandering about in a vast machine which went inexorably on its way according to fixed laws. Such a view was reinforced by the Cartesian dualism and by the Newtonian system of the universe. Extracting from the world features of it which were measurable enabled these to be subjected to mathematical analysis, and also enabled the same phenomena to be observed under the same quantitative conditions, that is, permitted reproducibility. Reproducibility was presumably also facilitated by the development and increasingly wide-spread use of measuring devices such as clocks, and also by the adoption of standards in measurement.

Nevertheless, Conant has observed that in the seventeenth and eighteenth centuries in particular "violent polemics rather than reasoned opinions flowed most easily from the pen". He maintains that it was only gradually, with the formation of the scientific societies and the gradual professionalization of science, that the idea of a scientific investigator being thoroughly impartial arose. It may also be that parallel to the professionalization of science and a greater differentiation within the scientific community has arisen a concept of what should count as adequate evidence.

Some writers have also commented on the presence of a powerful ideology
of science, a point I have already touched on in considering science as "the pursuit of truth" (p.45). Ravetz, for example, considers that for nearly a century prior to the First World War, the practitioners of academic science justified its existence both to themselves and to the public by emphasizing the twin themes of the search for truth and diffuse social benefit. (154) Boguslaw writes of "the mythology of science" which "states that scientists are impartial, dedicated, rigorously honest seekers of the truth". (155) Taylor points to the enormous influence of Mach's *Die Mekanik* (1883) in propagating a completely erroneous belief about science, and about scientists as "passionless observers, unbiased by emotion, intellectually cold". (155) Mitroff lists a number of descriptions of scientists which show that what he calls "The Storybook Image of Science" is still being propagated by some writers about science. (157)

The myth of complete objectivity in science was shaken to a considerable extent by Einstein's theory of relativity, which emphasized the role of the observer. Polanyi, himself a former physical chemist, has amassed an enormous array of material to show that scientific knowledge is not impersonal. "I start", he says "by rejecting the idea of scientific detachment." (158) He considers that this "false ideal" is probably harmless in the exact sciences because it is disregarded by scientists, but that it exerts "a destructive influence in biology, psychology and sociology". In apparent vindication of these views, it is interesting to find Konod, the Nobel prize-winning biologist, seemingly still passionately believing in objectivity - so much so that he makes it "the conditio sine qua non of true knowledge" because "science" is "founded upon the postulate of objectivity". (159)

Until fairly recently, sociologists of science believed what scientists and writers about science told them about science. The immensely influential early writings of Merton on the norms of science stressed the impersonal character of science and the objectivity of scientific knowledge. (160) Merton later came to see the importance of a scientist's commitment to his ideas and of sociological ambivalence. (161) Also to a large extent, his normative scheme came to be heavily criticized, while empirical evidence regarding the actual behaviour of scientists was put forward by Mitroff to show the existence of counter-norms such as emotional commitment. (163) Mitroff even argued that these could have
positive functions in science. Watson's account of the discovery of the structure of DNA has also emphasized the part which personal commitment and dedication to ideas play in scientific activity. (164)

Nevertheless, although scientists are not and perhaps should not be too objective in holding to their hypotheses, once they begin attempting to convince their peers, they must present their case according to criteria which are considered "adequate" by their audience. If the author of a research paper makes his claim in too rhetorical a style, or if there is any suggestion that there is an ulterior motive involved, it will lose an immediate claim to credibility. His readers will suspect that his work rests on inadequate experimental evidence or that there is fraud in the argument. (165) "Adequacy" is obviously something which varies from field to field, but experimental work which appears to eliminate personal factors as much as possible - allowing the opportunity for the results to be duplicated elsewhere - will be far more convincing than work which does not.

2.3-IIe. An openness to the possibility of alternative explanations

In the discussion of conducent I1h (pp.70 ff.) I pointed out that Kuhn saw commitment to a conceptual framework as necessary for guiding research into fruitful channels. Also, in the previous section, I referred to Mitroff's study of the Apollo moon scientists. Mitroff discovered that the scientists he interviewed were mostly extremely committed to their hypotheses, and one of them even claimed that this had a positive function in enabling the scientists to continue their research in spite of many difficulties and discouragements. (166)

However, at the same time, scientists have to be aware of the possibility of their hypotheses being wrong. The resulting tension was well described by another of the scientists Mitroff interviewed: "It's all right for a scientist to be rather strongly biased while he's pursuing an idea; he should not be indifferent to the various alternatives he's trying to decide between, but he has to be objective enough to discard an alternative that runs into difficulty. This means he has to be able to switch back and forth between biased and impartial." (167) Thus, even though a scientist may be extremely committed to a particular hypothesis, at the back of his mind must lie the realization that in the past some of the most apparently immovable of scientific theories have
been swept aside. Clinging to one conceptual framework when most of the members of the same sub-discipline have transferred their allegiance to another will usually be in conducive to scientific advance.

Towards the beginning of the modern scientific era, Francis Bacon campaigned loudly against the medieval tendency to rely upon authorities. He described the scholastics thus: "their wits being shut up in the cells of a few authors (chiefly Aristotle their dictator) as their persons were shut up in the cells of monasteries and colleges." (168) This subservience to authorities was, he felt, perpetuated by the methods of learning in the schools, academies and colleges of his day. "The studies of men in these places are confined and as it were imprisoned in the writings of certain authors, from whom if any man dissent he is straightway arraigned as a turbulent person and an innovator," he wrote. (169)

In contrast, the Dissenting Academies of the seventeenth and eighteenth centuries fostered more of a spirit of speculation, inquiry and discussion, which seems to have been prompted by the general wave of religious unrest of the age. (170) In another religious tradition, Islam, the ideal of learning until this century has been purely mechanical memorization of the text and "it is likely that it did largely handicap original independent investigation and scientific productivity". (171) Memorization of an authoritative text usually does not lead to an awareness of alternative thought systems.

Horton observes that the key difference between traditional African thinking and "the scientific outlook" is that "in traditional cultures there is no developed awareness of alternatives to the established body of theoretical tenets; whereas in scientifically oriented cultures, such an awareness is highly developed". (172) Societies in which there is an awareness of alternative belief systems have been described by Popper as "open", while those in which there is not such an awareness have been described as "closed". (173)

Support for Horton's view comes from the results of a project involving the interviewing of 6,000 men from six developing countries. Inkeles et al. claim to have found empirical evidence for "a set of personal qualities which reliably cohere as a syndrome and which identify a type of man who may validly be described as fitting a reasonable theoretical
conception of the modern man". (174) Two elements of this syndrome are "an openness to new experience", including "new ways of doing things", and "the assertion of increasing independence from the authority of traditional figures like parents and priests", while, significantly, a third element is "a belief in the efficacy of science and medicine, and a general abandonment of passivity and fatalism in the face of life's difficulties". An awareness of alternative belief systems may readily be subsumed under "an openness to new experience".

Other studies of science in LDC's have drawn attention to authoritarian tendencies in the systems of learning and suggest that these tendencies act against the development of high quality scientific activity in those countries. Thus authoritarian tendencies have been noted in India, (175) Africa, (176) the Middle East (177) and Latin America, (178) where they result in rote-memorization of educational texts.

2.3-IIf. A scepticism towards the results and hypotheses of oneself and others so as to be able (i) to gain scientific recognition, and (ii) to make judgements as to which work is significant and which is not

A scepticism towards one's own results and hypotheses is a corollary of an openness to alternative explanations.

In antiquity, a tradition of criticism and debate was one of the main contributions of the Milesian philosophers. (179) They saw the need to assess the arguments in favour of different theories and to detect the weak points in each one. Later, scepticism amongst Greek thinkers developed within two distinct schools: the Academic sceptics, who believed that no knowledge was possible, and the Pyrrhonian sceptics, who held that there was insufficient evidence to decide whether any knowledge was possible. (180)

In the Middle Ages, religious scepticism found a stimulus first in the works of the Muslim philosopher Averroes, and then in the flood of translations of the pagan philosophers of antiquity. Many factors such as the invention of printing, the voyages of exploration which debunked various long-standing beliefs, the Reformation, which challenged the traditional authority of the Church, and the spread of the Copernican
system then contributed to a general shaking of the foundations. The New Philosophy soon began to call all in doubt. Two different sceptical strands may be identified with it, following the 17th century. One was the empirical method, which in Baumer's view spread a habit of doubt which runs in a line to David Hume's agnosticism and to the agnostic positivism of Comte in the 19th century. Characteristic of this method was an emphasis on the discovery of new knowledge by means of sense perception and experiment, a disparagement of ancient authorities, an emphasis on the tentativeness of knowledge, and a suspicion of "metaphysics".

A second strand is associated with the Cartesian insistence on systematic doubt and the value of reason. This theme was taken up by the French philosophers, who translated the results of the seventeenth century scientific movement into a new sceptical world-view. A new meaning was attached to the word "reason"; instead of something that could only be acquired by long and intensive training, it became simply "common-sense".

Kant gave doubt and criticism an enhanced status when he declared that the royal road to reason lay pre-eminently through them: "Reason must in all its undertakings subject itself to criticism; should it limit freedom of criticism by any prohibitions, it must harm itself, drawing upon itself a damaging suspicion. Nothing is so important through its usefulness, nothing so sacred, that it may be exempted from this searching examination, which knows no respect for persons. Reason depends on this freedom for its very existence". During the nineteenth century a host of writers emphasised that no belief should be accepted unless it had first been subjected to unrestricted doubt.

Under the influence of such writers and especially Ernst Mach, the belief arose that scientists are super-objective beings who do not accept any hypothesis until it has been well attested, and who are ready to drop it as soon as anomalous evidence is produced.

Thus, in the early 1940's, Merton was to make "organised scepticism" a methodological norm as well as one of the four institutional norms of his "scientific ethos". He described it as "The suspension of judgement until 'the facts are at hand' and the detached scrutiny of beliefs in terms of empirical and logical criteria". As we saw above
Merton's "ethos" has been severely criticised. In particular, "organised scepticism" has been attacked from the point of view that fact-finding involves prior commitment to a paradigm or to a more articulated hypothesis, and that scientists do not look at anomalies with "detached scrutiny" but try as far as possible to fit them into their existing conceptual framework, even if this requires ad hoc modifications to it.

A more realistic account of the way scientists act in a sceptical manner has been given by Barnes. He maintains that scientists have to accept work from outside their own sub-speciality largely on trust because they are not qualified to assess its quality. As for work within their sub-speciality, they only check a small fraction of it for logistic reasons. Barnes suggests that the critical faculties of scientists are aroused when they come across (a) work anomalous to the current paradigm, (b) results produced by a recently developed technique, and (c) experiments which seem technically inadequate or unreliable due to dependence upon measurements near a technical threshold. Also, certain scientists build up reputations for competent work, and their work will usually be accepted with little or no question, while the work of other scientists will be far more suspect.

Mulkay and Williams studied the behaviour of scientists in a physics department at a Canadian university and found that none of them had criticised the work of another scientist in a public journal, although they all claimed that the journals were full of poor quality work. They infer that most scientists simply ignore work that does not appear to meet their criteria of competence and relevance because in periods of normal science at least, open criticism of another scientist's work does not lead to professional recognition.

This discriminating skill or evaluative scepticism towards the results and hypotheses of others is part (ii) of conducent IIf. In periods of normal science it will operate to sort out which work is significant, and therefore worth examining more closely, and which is not. At the same time, it will serve to identify whose work is competent and trustworthy, and whose is not. Work which falls into Barnes's (b) and (c) categories above will demand a greater exercise of evaluative scepticism.
On the other hand, work anomalous to the current paradigm (Barnes's category (a)) will arouse a far deeper scepticism. In this case, public refutation may result in professional recognition, and so it is more likely to be engaged in. The further the hypothesis or results are from the current paradigm, the more sceptical the scientist is likely to be. (187)

At the same time, scientists need to be wary of accepting their own experimental results at their face value - part (i) of conducent IIIf. Ravetz has pointed out three sources of error which have appeared in the history of science and which serve as a warning to any experimenter. (188) First, there may be a concealed systematic error in the equipment itself. Second, there may be a hidden error in the theory of the equipment which undermines inferences from the readings. Third, the initial outline of an argument may contain an ambiguity or false deduction which invalidates later reasonings based upon it (cf.IIa, p.75 above).

The scientist is encouraged to be self-critical by the need to persuade his fellow-scientists of the efficacy of his hypothesis. A more immediate stimulus is the critical eye of the referee, without whose consent he cannot publish his research findings, publication of which is the prerequisite to scientific recognition and reward. Thus in his research report, the scientist tries to meet all possible objections to his hypothesis, and to his experimental results and their analysis. Ziman has well described it: "... scientists learn to communicate with one another in such tones as to further the consensible end to which they are all striving, and eventually train themselves to construct their own internal dialogues in the same language. A private psychological censor takes over from the public policeman or parent, and conforms our behaviour to social norms. But he does not keep whispering into our ear, 'Be honest, be truthful, be objective', in a chorus of pious aspiration; he says, 'Have you checked for instrumental errors? Is that series convergent? Would anyone understand that sentence? What is the present status of that old bit of theory?' and so on. In other words, a peculiar quality of the research scientist ... is that he has very high internal critical standards for arguments within the context of his discipline. He knows his consensus and he has to decide whether a proposed change is acceptable." (11)

This knowledge of his consensus is gained by constantly reviewing the latest literature, and by information exchanges with other scientists in his
sub-speciality. Thus the scientist will gain a tacit knowledge of what is considered "adequate" by his peers, a point I shall discuss in greater detail in Section III below.

Shinichi, the Japanese historian of science, has suggested that an uncritical acceptance of research done by foreigners is one reason for the former scarcity of creative research performed by Japanese scientists. (190)

Universities and research institutes in LDC's are often characterized by formal hierarchies. Junior personnel have to keep on the right side of their superiors, or risk sanctions. The resulting respect for authorities, it has been argued, curtails scepticism and a questioning attitude, and inhibits communication among scientists. (191)

2.3-IIg. A commitment to the use of certain instruments, and to methods and techniques involving these, which are currently held to be legitimate by other scientists in the sub-discipline or in a potentially related sub-discipline

In section III above (p.60), I mentioned that I had separated out the methodological aspect of Kuhn's "disciplinary matrix", namely, commitments to preferred types of instruments and to the ways in which these may be employed, as IIg. The imitation of exemplars, at least those exemplars which involve experimental work, can only be considered under this heading, since it is by that very process that commitments to instruments, and to methods and techniques involving them, are brought about.

In his excellent analysis of science as craftsman's work, Ravetz identifies the various points in experimental research when tacit craft skills are required. (192) Ravetz shows that not only are craft skills involved in the use of apparatus, but also in the interpretation of readings, and the transformation of these into a new sort of material with the help of certain mathematical tools. Each stage involves the exercise of judgements which rely partly on craft knowledge - the transmission of the experience of others by precept and imitation - and partly on explicit and formal scientific knowledge.

Such craft skills are usually transmitted during a scientist's undergraduate days, but more particularly when he is engaged in post-graduate research.
under the tutelage of a more senior scientist. Visits to other laboratories may also help him to learn about new instruments and techniques. A constant scanning of the literature related to his sub-discipline will also help him learn about other new instruments and techniques, if not how to apply them, and will also enable him to keep abreast of what the majority of his peers regard as legitimate amongst them. Conferences, workshops and other meetings will provide further opportunities for this. The wider his contacts and his reading, the more likely a scientist will be to apply new results, instruments or techniques to other sub-disciplines.

Some writers have pointed out that it is the lack of such occasions for appropriating new techniques and skills that makes the scientist in a developing country so much at a disadvantage when compared to his cousins in more developed countries.

2.3-III. Commitment to the Norm(s) of the Scientific Community

I have already alluded to Merton's "scientific ethos" (pp. 82 and 86; refs. 160, 162 and 163). In his original account written in 1942, Merton identified two technical norms - adequate, valid and reliable empirical evidence, and logical consistency - and four sets of institutional imperatives or mores - universalism, communism, disinterestedness and organised scepticism - which, in his view, comprised the ethos of modern science, the institutional goal of which was the extension of certified knowledge. Although he did not mention autonomy as a separate imperative, he saw it as underlying the other four. Merton's functionalist account was taken up by others in the same school, including Barber, who made rationality an institutional imperative, and Storer. Later, Merton added the norms of originality and humility.

The main criticisms of the Mertonian ethos are fivefold. First, no real empirical evidence has been forthcoming which shows that the norms are binding upon the behaviour of scientists in practice. Rather, it seems that the norms are merely appealed to in times of dispute, or are used by scientists to propagate an image of science to laymen in order to gain support for scientific activity, and especially for such activity which does not seem to have any immediate practical end in view. On the
other hand, empirical evidence has been accumulating which shows that scientists constantly behave in a way contrary to the professed norms of communism, disinterestedness and organised scepticism. (193)

Second, the professed ethos seems to have changed over time. (199) The period of predominantly amateur science of the 17th, 18th and 19th centuries was different from the period of professional autonomous academic science which flourished in Germany from the mid-19th century until the First World War. This, in turn, was different from the Big Science of more recent times, dependent as it is on society for support. Even academic science is now subject to funding by grant agencies, some of which have military backing. Also, a great deal of research is now undertaken in government or industrial research establishments under conditions of secrecy, and where it is nearly always mission-oriented.

Third, rather than moral values acting as the medium of consensus, scientists seem to be united by a common commitment to technical and methodological canons, or in Kuhnian terminology, to a paradigm. (200)

Fourth, it is questionable whether the Mertonian norms are peculiar to science or merely values held in the wider outside culture. However, there is some problem here in that in nearly every case where scientific activity is flourishing, it has affected the wider outside culture.

A fifth criticism concerns the functionalist thinking underlying the ethos. Such thinking is said to be insensitive to the possibility of different scientists or groups of scientists viewing the (apparently, monolithic) body of norms and values within science from different perspectives. Moreover, such an approach does not appear to offer a satisfactory explanation for innovation, intellectual resistance or controversies in science such as priority-disputes. (201)

In a recent review of criticisms of Merton's ethos of science, Stehr points out that the whole question revolves around the relationship between social and cognitive norms. (202) In fact, Stehr seems to deprecate the distinction made between the two sets of norms and concludes that Merton's original theoretical formulation is still the best available. However, Stehr does not really answer the criticisms, and it seems likely that cognitive norms influence the social behaviour of scientists rather
more than social norms affect their cognitive behaviour.

I have already discussed the two technical norms Merton identified, namely logical consistency (conduent IIa) and adequate empirical evidence (conduent IIc). As for his institutional imperatives or mores, organised scepticism seems to require severe caveats, as given above in section 2.3-IIf. Disinterestedness now appears to be rather archaic; if it exists at all, perhaps it is as an openness to the possibility of alternative explanations (conduent IIe), or as a mode of arguing in the actual research report so that the reader will not sense that he is being convinced by mere rhetoric (see above, in section 2.3-IIid, p.83 and note 165). Universalism is explicable on the basis of cognitive norms, except in so far as it refers to careers and opportunities in science being based on achievement and competence only. Communism alone seems to have a moral connotation, especially when the practice of referencing previous work is considered. However, scientists may be motivated to pass on knowledge to others by their desire for academic recognition and rewards, as Merton himself has suggested. (203)

Nevertheless, in spite of these criticisms Merton and his school have drawn attention to recognition and reward in science as a means of social control. (204) Although some scientists try to play down the importance of recognition, maintaining that the pursuit of knowledge is its own reward, (205) there exists a whole range of devices for bestowing recognition on scientists: prizes, medals, membership of scientific societies, eponymy, and the routine practice of citation. Moreover, the existence of long and bitter disputes over priority throughout the history of science points to the deep-seated desire for reward via recognition. Further evidence of the desire for recognition is the practice of some scientists in competitive fields of rushing into print before they are really satisfied with their results. (206)

What kind of research results, then, are rewarded by recognition? One characteristic of such results is their originality - either in being able to solve some long-standing puzzle, or through developing a new technique or piece of equipment that significantly improves precision, or by application of an existing technique to a new sub-discipline. Recognition may be allotted for a few "revolutionary" papers, or for a large number of precise but less original investigations over a period of
time. On the other hand, if work is too close to other work which has already been accomplished in the sub-discipline, it will not be valued. Thus we may say that originality lies along a spectrum which varies with the state of the field, but which has limiting values at either end.

At the same time, there are other criteria of scientific merit. The work must have a sufficient degree of plausibility, that is it must lie within or close to the current paradigm except during periods when a paradigm is under duress. Polanyi describes this plausibility as "the tacit component in scientific judgement". He goes on to describe a further criterion of scientific merit, namely "scientific value" which could be described as "scientific quality". This is made up of three components: its accuracy, its systematic importance — in physics, for example, this might be a wide theoretical significance — and the intrinsic interest of its subject matter. Hence "Both the criteria of plausibility and of scientific value tend to enforce conformity, while the value attached to originality encourages dissent. This internal tension is essential in guiding and motivating scientific work." For scientific recognition to accrue to any one scientist in a sub-speciality, there needs to be a consensus of opinion that he deserves it. In other words, the scientist has to convince his audience, and he will therefore by and large have to be committed to one of the conceptual frameworks currently held in the sub-discipline or in potentially related sub-disciplines (conducent Ih) and to the use of instruments, methods and techniques currently regarded as legitimate (conducent IIg). His case will sound more convincing if he has made an attempt to consider other possible explanations for the evidence presented, and to show that they are improbable. On the other hand, his audience will be unimpressed by any internal inconsistencies in his arguments. In addition to "adequate" experimental evidence for a hypothesis, his fellow scientists may find in it other attractive features such as simplicity, elegance, fruitfulness of other possible avenues of research, and thoroughness (cf. the "shared values" component of Kuhn's disciplinary matrix discussed above on p.71).

In an extended discussion of "adequacy" and "soundness" of data in
science, Ravetz notes that lack of certainty follows from the very nature of scientific enquiry. Perfection of data is impossible, and what is "acceptable" is determined by criteria developed through the social experience of the scientific (sub-)community. Moreover, criteria of adequacy do not obtain merely for experimental evidence but also for the argument derived from it. Thus even a deductive argument, especially if it is cast in a mathematical form must satisfy criteria of "rigour" to an acceptable degree, while in an inductive argument, specialized arguments often have to be used to show that a particular sample is likely to be a good representative of its population. Furthermore, the various criteria often vary with the different fields in which they are applied and even within a particular field, according to its degree of maturity. Hence the impossibility of obtaining "necessary truths" or "indisputable facts", for "the simple judgement of 'soundness' of data is a microcosm of the complex of accumulated social experience and judgements which go into scientific endeavour". (210)

In effect, Ravetz insists that criteria of adequacy have to be invoked at almost every stage of scientific activity, and that even within a sub-speciality such criteria do not remain constant over time.

That criteria of adequacy differ from one sub-speciality to another is supported by Hagstrom. (211) He shows that despite its superiority to other methods, a method of biochemical analysis was ignored by chemists because it involved the use of organisms. Also, chromatographic techniques were at first rejected by chemists because they had been discovered by a botanist. These two examples also illustrate how innovation may occur in science, despite initial rejection from scientists committed to differing paradigms.

Nevertheless, despite the differences in standards of adequacy amongst different sub-specialities, an informal system of "quality control" exists in science which by and large seems to ensure that good quality work is rewarded. (212) As the members of a sub-speciality are constantly engaged in assessing the adequacy and value of each other's work, a consensus is achieved as to reputable research workers, groups, university departments and research journals. Certain scientists are generally recognised as leaders in their field, and are then asked to referee the research papers of other scientists, to give advice about the allocation of research
grants and to nominate colleagues for appointments and even for honorary
rewards. In this way, the leaders of the field exert considerable
influence over the nature of the standards of excellence obtaining within
it. At the same time, in order to continue receiving research funds and
facilities for their own sub-speciality, the leaders have to be able to
convince other eminent men in the wider research community of the quality
of the work being undertaken within it - something which is possible
because of the existence of overlapping between different sub-specialities.
Thus the leaders of a field are continually motivated to maintain high
standards.

In their studies of American physicists, Cole and Cole found a fairly
strong correlation between the quality of a scientist's work and the
recognition he receives. They also found that scientists who produced
work of high quality tended to be highly productive. Another result of
their findings was that the highest forms of scientific recognition were
confined to a small group of highly productive scientists. (213) Moreover,
Merton has shown that as scientists become more recognised by their peers,
they gain greater credit for their research contributions than other
scientists do who have made the same discoveries independently. (214) Thus
there seems to exist a process in science whereby an élite who perform
high quality work achieve extensive recognition and then maintain their
honoured position, perhaps by being able to attract the best co-workers,
as well as funds and facilities. However, although this process might
suggest that there is some injustice involved in the recognition of high-
quality contributions, on the whole the relation between quality of work
produced and recognition awarded does not seem to be regarded as
unsatisfactory by most scientists. (215)

Originality in science does, of course, imply honesty. The public
nature of scientific communication seems to enforce this, and so
scientists are all the more shocked when a genuine hoax such as the
Piltdown Man is revealed. Nevertheless, the competitive spirit of
modern science and the frequent exchanges of information that take place
have encouraged a conscious or unconscious "stealing" of ideas. (216)

The norm that arises out of the foregoing discussion may be stated as
follows: The quality of research work which is performed and published
by any research worker(s) and which lies within the limits of the
existing scientific and technical consensus of the sub-discipline is rewarded by scientific recognition in various ways. \(^{(217)}\)

If recognition is given to scientists even when they do not produce quality research, then it seems likely that they will be discouraged from going to all the toil involved in producing research of high quality. This type of recognition may come from the local scientific community, from the wider society, or from both. Less developed countries appear to be particularly prone to giving such recognition. In India, for example, some scientists appear to obtain recognition for seniority rather than for merit. \(^{(218)}\) The comparatively small numbers of scientists in any given sub-speciality in these countries mean that few of their national colleagues have the expertise to assess work for adequacy, and so work is published in national scientific journals which is below the standard of work published in developed countries. Also, because of their understanding of the difficulties involved in performing research, local scientists who do have to evaluate their colleagues' work may be tempted to condone technical deficiencies. Added to such factors is an often rather rigid university system in which promotion is not related to the quality and quantity of research performed but to years of service with a minimum requirement of research. Thus a scientist may become a professor without ever having produced any high quality research. The wider society will accord him the status due to his title, and the local scientific community will usually do likewise, mainly because his title will allow him access to decision-making bodies through which he can wield considerable influence over the still comparatively small number of his scientific colleagues.

Basalla suggests that one of the goals to be attained during Phase 3 Science, in which science in a given country obtains its own independent tradition, is for local scientists to be rewarded by national honours for quality work. \(^{(219)}\)

2.3-IV. Acquisition of Cognitive and Manipulative Skills Relevant to Experimental Research

There is a considerable degree of overlap between this conduit and conduit IIg. The acquisition by a scientist of cognitive and manipulative skills relevant to experimental research is a result of
socialization processes, the chief of which is his formal education. This is unfortunate for developing countries, which usually have educational systems characterized by low staff to student ratios, formal teaching methods, and shortages of teachers in the sciences due to the low prestige of the teaching profession. It is not surprising therefore that the training of sophisticated manpower has been described as the bottleneck in scientific development.

Four categories may be identified under the heading of cognitive and manipulative skills: (a) problem-solving skills, (b) a deep and broad knowledge of the subject, (c) skills in the use of apparatus, and (d) research techniques. While (a) and (b) are usually acquired throughout the education process, (c) and (d) are acquired increasingly towards the latter end of it. In fact, to a greater or lesser extent, all four categories involve a never-ending acquisition process, if research is to be done which will be acknowledged as being of good quality by other scientists in the same sub-speciality.

Included under problem-solving skills are skills involving mathematical manipulations, and those which demand the slight adaptation of concrete puzzle solutions, by means of which, Kuhn claims, the science student is coached into the current "mental sets" of the discipline.

A deep knowledge of the topic means a knowledge of the current paradigms of the sub-speciality, the current problems and what is at present regarded as a solution to them. A broad knowledge means a knowledge of topics around the peripheries of the discipline, of the methods and problems of related or potentially related fields.

Apparatus may involve routine pieces of apparatus ranging from simple balances to various types of spectrometers, or radiation counters; or it may involve highly complex apparatus devised by the researcher's immediate predecessors, as is often the case in various sub-specialities of physics. Familiarity with apparatus used routinely in the sub-speciality will obviously be an advantage to any prospective research worker.

Research techniques may be techniques long-held in the discipline, or else techniques recently devised by colleagues within the same sub-
speciality, or else brought in from another sub-speciality. These latter are communicated by informal communication methods, such as visits to other laboratories, workshops, and conferences.

In section 2.3 above (p.89), I discussed how craft skills are involved in the use of apparatus, the interpretation of readings, and the transformation of readings into data by means of mathematical manipulation. The transmission of such largely tacit knowledge is usually accomplished in a scientist's secondary school and undergraduate days in practical sessions, and later during his apprenticeship to a more senior and more experienced scientist, at the end of which he receives his Ph.D. This latter period is particularly important in bringing a research worker up to the frontiers of knowledge, to a point at which he can undertake research unsupervised.

The need to acquire craft skills was seen by foreign scientists who flocked to the German centres of research excellence towards the end of the 19th century. Ben - David estimates that a majority of American, Russian and Japanese scientists at that time were trained at German universities, while English and French workers were considerably influenced by visits there. (223)

The transmission of craft skills requires an unbroken line from one who is "master" of such skills, and also those down the line who are willing to acquire the latest methods and techniques. Over time, the content of what is transmitted may vary somewhat, and even the standards of discrimination as to what is adequate. Each "link" in the chain must not only be an active researcher himself but have the ability and motivation to communicate his skills to others. Moreover, some links in the chain must be able and willing to acquire the new skills and techniques which are constantly being introduced into the sub-discipline. The acquisition of some skills nearly always demands personal contact with those familiar with them.

In developing scientific communities, the transmission of skills is normally started by a combination of sending students or junior scientists to centres of scientific excellence abroad and inviting foreign students to come and undertake research at local scientific establishments. (224) For example, this was done by the Japanese government in the second half
of the nineteenth century, and before long there was little need for foreign scientists. However, other countries have not experienced the same success.

In most LDC's, lines of transmission are easily broken. A once active researcher may give up his research because his equipment breaks down or becomes obsolete and cannot be replaced; or, he may be posted to a new establishment where research facilities are deficient or non-existent; or his motivation to undertake research may become blunted by bureaucratic difficulties or a heavy teaching load. Furthermore, the ability to acquire new skills depends upon personal contact with people in (usually) DC's who possess them. As foreign exchange is frequently a problem, visits to centres of scientific excellence abroad may be difficult to arrange. Ziman has emphasized that "science is in people's heads" and has suggested that scientists from LDC's should stay on in DC's for at least two years of post-doctoral work in order to acquire skills and techniques so thoroughly that they can transmit them to others. He has also suggested that the transmission process could be aided by renowned scientists moving overseas to set up individual centres of scientific excellence. He gives the examples of the University of Campinas in Brazil and the Korea Institute for Science and Technology in Seoul which seem to be benefitting from an arrangement whereby half of their staff come from scientific centres abroad. Indian science also seems to have gone ahead since Indian scientists who had spent many years abroad returned to their home country.

Problem-solving skills and a deep knowledge of the subject are to a large extent a function of secondary education. Observers have pointed out various deficiencies in science teaching at the secondary level in LDC's. One common feature seems to be the habit of learning by rote which is common in Asia, Africa, Latin America and the Middle East. Teachers apparently find it difficult to break the pattern since they themselves are products of the system. A concomitant of learning by rote is that teachers become preoccupied with the syllabus, or with what they teach rather than how they teach. Syllabi are frequently irrelevant to the future needs and environment of the pupils, while textbooks leave much to be desired. Practical sessions are minimal or non-existent because of the shortage of laboratories and equipment.

Nevertheless, the situation is changing. "Modern Science" projects
which emphasize practical work and application of knowledge rather than simple recall are now being undertaken in a large number of countries. (228)

The high level of basic education in Japan has been given as one reason why Japan was able to introduce western science and technology so quickly. (229)

2.3-V. **Formation of a High Conception of the Role of a Performer of Research**

Ben-David uses "role" with respect to scientists as "the pattern of behaviours, sentiments and motives conceived by people as a unit of social interaction with a distinct function of its own and considered as appropriate in given situations." (230) He goes on to argue that whenever a social activity such as science persists over time despite a change in the actors, there must exist roles to carry on the activity and also legitimation of such roles by some social group. In his view, such publicly recognized roles are necessary to ensure the transmission of the knowledge, skills and motivation associated with a particular activity.

Znaniecki sees a role as being made up of the following components: the social person, and the "social circles" of people who participate in his performance and who positively value it; a definite social status, whereby the actor is granted certain rights; and the social function which the actor has to fulfil. At the same time, a role is a dynamic system, and as different actors may give varying emphases to the individual components, roles may be performed in many different ways. In the case of a scientist, the social circles are made up of groups of people who value the cultivation of systematic knowledge and who are convinced that they need the co-operation of him and his colleagues to fulfil purposes associated with this valuable knowledge. Social status as a scientist is granted to him when he possesses qualifications regarded as appropriate by the social circles. In turn, the scientist is expected to perform the function of cultivating knowledge for the benefit of the participants of these circles. (231)

Znaniecki uses the word "scientist" in the broad sense of savant. When we consider it in the narrower sense of experimental research scientist in the basic sciences, the social circles who value his work include fellow-scientists employed (today) mainly at universities, other lecturers and university research fellows in other subjects, and the wider society.
That the wider society should be prepared to support the cultivation of knowledge which has no immediate practical benefits to the extent it does in many countries of the world is a tribute to the success of the cultivators in legitimating their activity to the wider society (and, of course, to themselves). Various types of legitimisation were considered in section 2 above (p. 63). The current legitimisation for experimental research in basic science is generally that of "spin-off" benefits sometime in the future.

However, most research workers in basic scientific fields are on the staffs of universities, where they are also expected to teach. In many parts of the world, especially in LDC's, this is the primary expectation from academic staff. The teaching role then has a legitimisation of its own. In that case, research is frequently justified by the argument that only people who are active in research can teach effectively at university level.

A significant step towards the emergence of the professional scientific role took place in Germany between 1825 and 1900. Following the Napoleonic wars, a romantic idealistic philosophy which stressed German culture and the realm of the spirit became very popular. Education was given high priority, and the universities were reformed. These reforms began with the establishment of the University of Berlin in which the faculty of philosophy (incorporating arts and sciences) was given an equivalent status to the old faculties of law, medicine and theology. Within a short time, the other universities were modelled after the example of Berlin, and new universities were set up according to a similar pattern.

The state now became responsible for the financial supervision of the universities and partly responsible for the examinations by which professional qualifications were awarded. It also had the final say in the appointing of professors to the chairs, although in practice it usually abided by the recommendations of the university senates, which were made up of all the chair professors at each university.

Freedom of academic research was provided for by the autonomy of the universities from the state. Within the university a new position of Privatdozent (private lecturer) was created to ensure freedom of research
there. The qualification for this was the Habilitation, a thesis based on an independent and original piece of research. Although the Privatdozent did not receive a salary but only fees for the lectures he was allowed to give, he had a good chance of being elected to a professorship, with its fairly lucrative salary and special honours. The institution of the Habilitation, therefore, seems to have made research an integral part of the academic role.

Nevertheless, several features of the new universities tended to go against the development of empirical natural sciences. Initially many chairs in the natural sciences were occupied by proponents of the romantic Naturphilosophie, which derided mathematics and experiment. Also, the internal organisation of the universities encouraged an oppressive hegemony by the professors. Their very autonomy and authority opened the door to conservatism and the selfish protection of vested interests.

Ben-David argues that what really facilitated the establishment of research as a career in the German universities was competition amongst them for successful researchers. Because the universities were expanding, they were open to the adoption of innovations, including the setting-up of new chairs in sub-disciplines. Thus the student who decided to go into research had a good chance of occupying a well-paying professorial chair soon after obtaining his Habilitation. The resulting demand by students for training in research led to professors concentrating their teaching efforts on training these students in preference to the mass of students who would become teachers in high schools. As research students could transfer credits to any other German-language university, laboratories and other research facilities were readily provided to discourage them from doing so.

The decentralization and competition amongst the universities led to a mobility of research workers from one to another, which in turn resulted in the setting-up of effective networks of communications and the formation of intra-disciplinary scientific communities. It was these informal communities which were the formative influences upon academic policies, ensuring that they were closely linked to the needs of the changing research front.
By the second half of the 19th century, research in German universities had been transformed into a regular career. University laboratories were now training large numbers of advanced students who worked together in one speciality over a period of time. Such a concentration of research effort in a selected problem area enabled the Germans to gain a competitive edge over other scientists in the world, such that by the end of the century, the best students from all over the world were anxious to spend time in their laboratories.

The legitimation for research, which increasingly involved heavy investment, for a long while continued to be the pursuit of pure knowledge. Within the universities, any innovation of an applied or practical nature was resisted, although outside the universities the value of professional researchers working full-time in research laboratories came to be recognized.

The German university system was imitated in many countries of the world, including Turkey. Nevertheless, the research role which developed within it stopped short of becoming a truly professional scientific role. Research in Germany was not considered as a profession, but as a voluntary, unpaid activity. The Privatdozent could do research if he was able to, but no official funds or facilities were made available to him for this. The appointment to a professorial chair was more of a reward for academic success than anything else, and the professor could perform research if and as he wished. Research done in exchange for payment was not considered to be true research at all because it was obviously not in response to a purely creative spirit.

The emergence of the fully professional scientific research career came about in the United States, mainly as a result of adoption by American universities of a modified form of the German system. Instead of the chair and research institute dominated by a single professor, the American universities opted for graduate schools within departments, in which several professors could supervise independent research groups composed largely of graduate students. This arrangement considerably facilitated the growth of sub-specialities, and inter-disciplinary research. Moreover, the egalitarian-utilitarian ethos prevailing in the wider society meant that American scientists were more open to organised, mission-oriented research. Another feature of the American system
was its extreme mobility, which contributed to the rise of the professional community within a discipline, or, more recently, a sub-discipline.

In the United States, only those who were committed to a professional career in research were expected to study their subjects to a highly specialized level, whereas in Germany this had been expected of all students in the sciences. Thus graduate schools were set up in American universities for those who already had a first degree, and who would go on to do research once they had obtained their Ph.D. qualification. In this way, the conception of the professionally qualified research worker emerged. The person who had received a Ph.D. was expected to keep up with current developments in science and to continue doing original research, while in return his employer was expected to give him the facilities, time and freedom appropriate to his status to enable him to do so.

Ben-David's account of the emergence of the scientific role has been criticised by Kuhn for not taking into consideration changes over time and place. (235) This echoes Znaniecki's comment that roles may be performed in different ways (above, p.100). A similar point has been made by Levinson, who sees role-performance as the resultant of many forces, which vary according to the individual. (236) Not only do individual role-conceptions vary, but so do role-relevant characteristics, and role-expectations.

Levinson distinguishes between a general ideology concerning the organizational world (in our case, for example, a university science faculty or department) and a role-conception appropriate to one position within it. (237) The ideology portrays and rationalizes the organizational world, its purposes (research and teaching), modes of operation (lectures, seminars, laboratory practicals, individual or group research activities), and the prevailing forms of individual and group relationships (students, research assistants, academic and research staff, administrative staff).

In Levinson's view, there is often a dominant modal role-conception which is reasonably congruent with the role-expectations for that particular position. Nevertheless, individual variation in role-conception occurs because of the differing influences at work in its formation.
Before forming the more specialized conception of academic researcher, many people gain a vague notion of what a research scientist does through reading about famous scientists either at home or at school. Such notions may be reinforced or modified by visits to science museums, by watching television programmes, or by other childhood experiences. An ideal of, for example, science for science's sake may be inculcated thereby. Much will depend on the values held by the individual, and on his personality characteristics as to which aspects of scientific activity remain in his mind.

As an undergraduate, a person will learn more about the practice of science through his formal and informal reading, and through lectures, seminars and laboratory practicals. He may also come into contact with reference groups such as research assistants, lecturers and professors. Once he enters a post-graduate research position, his conception of the role of a research scientist will become clearer, mainly through his apprenticeship training, but also through formal or informal contacts with reference groups such as other research teams in the same department or faculty, or in other universities or industrial laboratories. During the period immediately preceding or following the acquisition of his Ph.D., a research scientist will probably learn about the formal research requirements for an academic (if such formal requirements exist). Once in an academic position, his role conception will depend on these formal requirements and on the informal role expectations of his peers, either in the same university or at different research institutions.

The role-conception of an academic researcher will vary along a scale bounded at one end by an understanding of the role performance of a much-admired scientist, and at the other by the formal expectations of his role. If the latter are weakly enforced, the lower boundary may even drop below these. His conception will be in a dynamic relationship with his role facilities and with reference groups he reads about or meets at conferences, workshops or other laboratories. Role-conceptions may, therefore, be congruent with, greater than, or less than role-expectations, in which case formal or informal sanctions may be employed.

It would appear that a role-conception which is greater than formal role-expectations will act as a conducent to the performance of high-quality experimental scientific research, in proportion to how much it differs from them.
Role-conception may be blurred because of the usually dual role of the academic. The teaching aspect may become uppermost in his mind, in the minds of his colleagues, or in the minds of people outside the university.

In many LDC's, there are few opportunities for young people to learn about science and what scientists do. For example, in Mexico it appears that there is little concept of the researcher-role amongst secondary school children. After a study of over 7,000 pupils from both private and state secondary schools, de Gómez Gil wrote: "In Mexico, a kind of 'scientific illiteracy' exists; the mass media (radio, T.V., cinema, newspapers) have not helped to fight this ignorance... It would not be fair to say that the politico-economic system is completely responsible for this 'scientific illiteracy': the scientific community itself must take part of the blame. The scientist keeps himself aloof from the public. His academic contacts are predominantly with his own students, and he offers very little to less specialized groups, such as secondary school pupils - the possible future scientists." (238)

2.3-VI. Role-Expectations (for an Academic Researcher) and the Extent of their Enforcement

Role-expectations concerning research for faculty staff members in American universities and colleges tend to be high. Lack of research publications may even result in loss of tenure, which has led to the well-known "publish or perish" epigram. In British universities, research expectations are informal rather than formal, although no less strong for that. In countries following the German university model, minimum research requirements are spelled out in university laws and statutes. However, because such requirements have to apply to all fields, they are usually very low. Informal expectations then play a strong part in influencing role performance.

In scientific establishments in developing countries, these informal role-expectations will vary according to the role-facilities available and according to the academic tradition of the individual establishment. Individual chair or department heads may then have higher expectations than others. In scientific establishments in developed countries, expectations will tend to be higher because of the better role facilities, longer-standing academic tradition and greater competition.
Sanctions for not performing according to role expectations are of two kinds, formal and informal. In the event of an academic not producing research for publication, he may be dismissed from his job (in America, for example), or warned, or brought before an investigating committee. He may be kept from promotion, or given a job not involving research. However, formal sanctions may be weakly enforced.

More informal sanctions in science are of two kinds: non-publication for poor work, and lack of social recognition. The latter includes honorary awards given by other scientists, invitations to attend conferences and to join committees, and access to funds for research. (239) Since such social recognition is dependent upon research publications, the role of the referee is extremely important. Ziman sees the referee as "the lynchpin about which the whole business of Science is pivoted", with their task as that of enforcing the standards held by a consensus of scientists in the sub-discipline. (240) Ravetz agrees. He regards the assessment of a research report by the referee of a recognized journal as the one point in the system of quality control in science where formal procedures operate: "The penalties involved in this procedure at a private affair between the referee, the editor and the author; and no punitive action is taken against a scientist who submits one, or even many bad papers. But the penalty is none the less real for being discreet. Time and resources have been invested in the investigation of a problem, and with the rejection of the paper, no property has been created. Work has been wasted, and there will be an embarrassing gap in the time-sequence of the scientist's publications". (241)

Role-performance is a product of a complex of factors including role-conception, motivation and the extent of role-facilities. Thus role-performance may be higher than, congruent with, or lower than that expected from a given role-conception. Moreover, role-conception may be higher than, congruent with, or lower than formal or informal role-expectations. If we take the case of a research scientist in a university in an LDC, we may assume that the informal role-expectations will be somewhat lower than those in more developed countries and somewhat higher than formal role-expectations. The higher the informal role expectations, the greater the chance of role-performance being at least in conformity with them. This is because they will tend to be less unambiguous, facilitating the formation of clearer role conceptions. Also, informal
sanctions are likely to be stronger.

Academics are usually expected to do both research and teaching. Thus they may experience role conflict. In LDC's, where there is often a strong social pressure to expand universities, an academic may find a large amount of his time taken up by teaching. In some cases, his teaching role may be the primary role-expectation. For instance, in the late 1960's Derwish reported that in Iraq, universities were regarded as centres of teaching, with some academic staff receiving up to 40% increases in pay through lecturing overtime. (242) Furthermore, he observed that "It is still widely believed that research and teaching conflict with one another."

In contrast, in more developed countries, the research role of the academic - especially in the natural sciences - is paramount. Those who have left research for easier things are looked down upon contemptuously, while those who have taught without doing any research are to be pitied, an attitude which can be traced back to the German research schools of the 19th century. (243)

High research role-expectations, then, are conducive to experimental scientific activity provided that they are accompanied by strong sanctions.

2.3-VII. Role Facilities

The provision of role facilities may not necessarily stimulate the performance of quality experimental research. However, if the cognitive and manipulative skills necessary to use them are available, as well as the motivation to do so, they will generally be conducive to research.

Lack of role facilities is perhaps the most obvious inhibiting influence upon research in LDC's. The provision or otherwise of role facilities is a resultant of a number of factors in the wider socio-economic and political milieu. (244) One of the most important of these is the general state of the economy. Indeed, Frame has found a correlation between scientific output and the gross economic size of a country; only when a certain economic threshold has been reached is there any significant relation between scientific output and per capita GNP. (245)
The economy of a country affects its research scientists both directly and indirectly in several ways. If there is a balance of payments deficit — as is the case with most non-oil-producing LDC's — there will be difficulties in obtaining foreign currency for the purchase of supplies, equipment and scientific literature. Travel to conferences abroad may also be curtailed. Where the import of equipment is permitted, long and time-consuming import procedures will often be involved. Problems in the economy will also affect the amount of money available for research, while a rampant inflation may encourage an academic researcher to find supplementary sources of income at the expense of performing research. Because of the dramatic rise in the cost of crude oil since 1973, most LDC's have had to borrow large amounts of foreign currency to pay their oil bills, while the constant increase in fuel prices has contributed to high inflation rates.

The infrastructure of a country also affects its scientists. Electricity and water supplies may be irregular or even cut off completely for long periods of time. The maintenance of such facilities is also a function of the general economic state of the country. Problems of foreign exchange, for example, may lead to electricity cuts because of the lack of fuel or spare parts for generators. Communications, too, are often poor, which does not allow for rapid and efficient information exchange by post or telephone. High birth-rates tend to exacerbate the situation. Burgeoning populations put pressure on the educational system as well, which may result in heavier teaching loads for academics.

Research scientists in LDC's are also affected by the general state of the educational system. The teaching and research they are able to do depends to a great extent on the quality of instruction throughout the system up to undergraduate level. Also, in some countries, universities are to some extent under the supervision of the Ministry of Education; in that case, it is possible that personal and political factors will enter into the decision-making process, resulting in lowered morale. Research scientists in LDC's are usually on the staff of universities, and the extent of university financial support will depend on government decisions over the Budget. Personal and political influences can then enter into financial allocations at both inter-university and interfaculty level.

Turning now to a consideration of specific role facilities, in any given
institution or wider social setting, the extent of their provision will reflect role expectations, the support given by the society to research, the general state of the educational system, and the general state of the economy.

2.3-VIIa. Time and b. Money for subsistence

In the days of amateur science, its practitioners were supported by wealthy benefactors, or they had private means, or another job which left time for research, such as religious duties, or the practice of medicine. Nowadays, academic researchers are usually expected to do teaching and/or administration, in addition to research. A study of British university chemists disclosed that most of the staff of all grades spent 30% of their time supervising research. (246) In LDC's, where a university degree generally has high prestige, the universities which exist are under constant pressure to admit more students, while the government is under pressure to open more universities. The result is staff shortages and low staff-student ratios. Thus time which might have been spent on research has to be spent on additional teaching.

Also, because of the shortages of staff, academics are tempted by high financial reward to give lectures at other educational institutions. They are further encouraged to do so because their social status in such countries is high although their salaries are not; in order to conform to the expectations of society, they are under pressure to obtain status-symbols such as houses, cars and other consumer goods. Also, like other professional people in LDC's, scientists usually have to support members of their extended families. For example, Rahman reports that most scientists in India have to support four to six dependents on a salary which is below that of many civil servants. (247)

2.3-VIIc. Equipment and supplies

Included in this category are routine pieces of apparatus, materials with which to build new apparatus (in physics, for example), constantly needed supplies such as chemicals, and data-processing equipment such as computers.

Frame has emphasized that scientific research in LDC's is unlikely to be
able to compare favourably with that in DC's because of the sheer
costliness of most research equipment. Gone are the days when great
discoveries could be made with relatively simple equipment (except perhaps
in agronomy), and the highly sophisticated research equipment which is
required is usually very expensive since it is not manufactured in large
quantities. In fact, in many cases, equipment has to be specially
fashioned for individual research projects. He quotes estimates of
$31,000 for the cost of a single biomedical research paper and $113,800
for the cost of a single research paper in the agricultural sciences in
the United States, and he speculates that research costs usually probably
lie somewhere between these two limits. (248)

Since most of the equipment and supplies needed for research in LDC's
have to be imported, (249) the question is not simply one of cost, but
of cost in foreign exchange, which is frequently in short supply.
Moreover, what foreign exchange transactions are permitted are usually
accompanied by bureaucratic formalities which can cause many delays and
much frustration.

Once equipment has been purchased, problems may arise if it breaks down.
Lack of spare parts can keep it unusable for months or even years. On
the other hand, the absence of a small quantity of a chemical which has
to be imported can hold up a research project for months, or else deter
the research scientist involved from branching out in a new direction.

In contrast, scientists in developed countries can obtain supplies, spare
parts and new pieces of equipment within a few days or weeks. Scientists
from LDC's who are trained abroad with such facilities can easily become
discouraged when they return to their home countries.

2.3-VIId. Technicians

As research equipment becomes more sophisticated, it requires more expertise
to repair it. However, vocational schools in LDC's usually do not
attract able students because such schools tend to have low status, (250)
and they do not offer a training adequate to deal with complicated
apparatus. Also, technicians employed by universities tend to receive
lower salaries than technicians employed in industry or self-employed
technicians. For these reasons, good laboratory technicians in LDC's
are hard to come by, and once they have been trained, they are constantly tempted to move into financially more rewarding jobs elsewhere. (251)

2.3-VIIe. Co-workers

Thirty-three research workers put their names on the research paper reporting the discovery of the Omega-Minus particle in February, 1964. (252)

The era of Big Science began with the Manhattan Project during the Second World War, and has continued in many fields ever since. As research has grown more and more complex, research scientists have found it profitable to work in teams in which there is often a division of labour. Some members of a team, in physics for example, may concentrate on the technical aspects of the apparatus, some on the electronic devices associated with it and some on data-processing using computers. If the capital costs of the apparatus are high, non-stop shift-work may be required to utilise it effectively - necessitating the taking-on of even more personnel.

The more usual pattern in other sub-specialities is for one to three research assistants to work with an experienced scientist. In this way the senior scientist can have several research projects running at once, or else get his assistants to work together on a common problem. The incidence of multiple authorship in chemistry, for example, has increased considerably over the past forty years. (253)

Co-workers benefit a senior scientist both by undertaking some of the more routine tasks for him, and by stimulating him intellectually. In turn, the co-workers benefit by his experience. The knowledge and skills he transmits are partly explicit and partly tacit - a mixture of principle, precept and example. A period of intense interpersonal communication of this kind is necessary if a "school" is to be successfully set up in a given sub-speciality or in a newly-entered research area. (254)

In LDC's it is often impossible to keep a group of scientists together long enough for them to form such a school. Some may be attracted abroad or to newly-opened universities inside the country, while others may be posted elsewhere because of the personal or political antagonism of their superiors. Another problem in LDC's is that there are often strict demarcations between disciplines and even sub-disciplines, which do not encourage the formation of inter-disciplinary research teams.
2.3-VIIf. A knowledge of foreign language(s)

Those scientists whose first language is English are fortunate in being able to get by without having to know a foreign language. Nevertheless in certain fields, a knowledge of German, Russian, French or Japanese is a decided advantage.

A knowledge of English is essential for most scientists, especially for those in "hot" research areas, because most internationally recognised scientific journals are in English. Such a knowledge enables researchers to follow the current literature, and to communicate informally with other scientists working on common research problems either by letters or preprints, or by word of mouth.

Scientists in LDC's where English is not the lingua franca are sometimes not aware of the importance of learning foreign languages. A paper containing minor linguistic errors will generally not be looked at favourably by a referee, who may not want to give his time to correcting it. The peculiar impersonal style of the average scientific paper accentuates the difficulty. It is one thing to be able to follow a scientific paper in a foreign language, and it is another thing to write one.

However, in some LDC's, learning one foreign language is prerequisite to attaining a lectureship position and learning a second foreign language is prerequisite to becoming a professor. (255)

Under this heading, I would also like to put the need for a scientific vocabulary in the language native to the scientists. This is a strong conduit to communication amongst local scientists and to the teaching of science in schools, even though initially the scientists engaged in research may communicate in a common foreign language without too much difficulty.

2.3-VIIg. Research literature

To the scientist engaged in experimental research, the official research literature has several functions. (256) First, it keeps him up to date in the area of science in which he is working. However, this function
seems to be losing its importance, in that because of the time-lag between submission and publication, and the sheer volume of the literature, much communication now takes place along informal channels such as distribution of preprints. (257)

Second, it enables him to brush up his knowledge of past work performed in related areas or in an area into which he is about to enter. Third, it allows him to verify the reliability of one source of information by means of a second source. Fourth, it gives him some idea of the direction in which his sub-speciality is going and the areas in which the most research seems to be being performed. Fifth, it can direct the attention of the research scientist to new topics outside his own immediate sub-speciality.

The scientist in a LDC may be at a disadvantage compared to his fellow-scientists elsewhere because journals may take a while to reach him. Moreover he may not have access to all the journals he is interested in. Also, especially if he is at a university in the provinces, journals may be unavailable because of foreign exchange problems. Even though some system may exist for obtaining photo-copies, it is not always easy to tell the merits of an article from a short abstract.

The importance of the individual primary research paper is underlined by Ziman, who sees it as the brick from which the whole edifice of consensus in science is built. (258) Hence the need for its ready availability.

2.3-VIIh. Opportunities for information exchange.

A study by Pelz and Andrews of the productivity of research scientists indicates that they benefit from vigorous interaction with other scientists. (259) This is borne out by the continuing desire of scientists to set up specialist societies and journals, and to organize a vast array of conferences, summer schools, seminars and workshops each year in scientific sub-disciplines. Such means of communication are a result of the widespread geographical distribution of scientists working in the same research areas.

However, scientists also use a great variety of less formal methods of communication. For example, a study of how psychologists exchange
information revealed approximately fifty different ways, (260) and there is no reason to believe that scientists in the natural sciences use any fewer. Although the scientific journal is still an important means of communication, the lapse of time which ensues before results appear in print has encouraged the sending-out of preprints. Another problem with research journals is the volume of the literature; each individual scientist does not have time to scan the vast number of articles appearing each month which might have some possible relevance to his work.

It appears that scientists often obtain information in unexpected ways. In a study of the communication processes of seventy-seven scientists in a prominent American academic institution, Menzel identified four unplanned ways in which they obtained scientific news. (261) One was finding something in the literature while perusing it for another topic. Another was a spontaneous contribution by a fellow scientist when informed of a colleague's current research work. A third way was the mention of something by a colleague while together for another purpose, for example, during a visit to another laboratory. A fourth way was having information passed on by a colleague who thought it might interest him.

What made these observations even more interesting was that half of the items of information communicated were already in the literature. The social nature of science is thereby emphasized once again.

Menzel also found that the scientists he interviewed frequently contacted fellow-scientists working in the same or related sub-specialities in order to obtain unpublished minor details of already published findings, information about new techniques and apparatus, and other practical details to supplement basic knowledge already at hand. (262) Similar methods of communication amongst scientists doing research on high energy physics were reported by Gaston. (263)

Communication links appear to be strongest among groups of up to two hundred researchers working in given research areas, groups which Price has termed "invisible colleges". (264) Such researchers are often the elite leaders of research teams and so act as dispensers of information to their co-workers. When these leaders have research interests in more than one research area, they may act as agents for the transfer of
Scientists in LDC's are unlikely to become members of such communication networks. Where experimental research is involved, they will be unlikely to contribute much to scientists in DC's because of the slower pace of their research, forced upon them by difficulties with supplies and equipment. Geographically distant from the main centres of scientific activity, they will be prevented from meeting other scientists because of scarcities of foreign exchange. Poor postal and telephone communications and a lack of local scientists in the same sub-discipline will increase their isolation. Also, heavy teaching loads and rigid inter-disciplinary barriers will lessen the opportunities for talking about research projects with colleagues who, under other circumstances might have been able to supply valuable items of information.

Scientists from LDC's doing research in one field of science are fortunate, however. The opening of the International Center for Theoretical Physics in Trieste in 1964 has provided the opportunity for theoretical physicists from LDC's to exchange information and ideas with other scientists.

2.3-VIII. Organization and freedom

For a scientist to undertake experimental research, he will usually require a laboratory, and to keep the laboratory functioning he will need organization at various levels. At a higher level, a good administrator will be able to guide the research undertaken in the laboratory into areas which are potentially fruitful and which will attract the necessary funding. He will also be able to select the equipment which will benefit the researchers to the maximum and yet not place an unnecessary strain upon the laboratory's budget; this will necessitate his being familiar with the latest technical developments in the field. At a lower level, there is the need for the provision of everyday supplies and a constant supply of electricity and water.

In LDC's, maintaining even routine supplies usually requires long-range planning, since most of these will have to be imported, a procedure involving a considerable lapse of time. To combat power cuts, a stand-by generator may be required, while other arrangements may have to be made to ensure that a supply of water is available when the mains supply is turned
off. Long-range planning is not made easier by budgetary allocations which vary considerably from year to year.

In a university context, heads of chairs or departments will usually play an important part in the making of planning decisions, and they can have a considerable influence over the importance given to the performance of research in their chairs or departments, as well as to the ease with which it can be accomplished. They can also influence the time available for doing research by minimising the amount of time spent by colleagues on the administration of teaching programmes.

Unfortunately, students from LDC's studying for post-graduate degrees in DC's are very seldom taught how science is organized and managed and yet they are often involved in setting up laboratories and research institutes when they return to their home countries. (289)

The degree of freedom to choose research problems and to move into new areas also appears to be important. In their studies of productive scientists, Pelz and Andrews found that the best performances arose when freedom was combined with a certain degree of co-ordination. (270) Thus there appears to be a balance between freedom and direction in scientific research. The formal hierarchies which characterize much university science in LDC's probably tend to blunt creativity.

As for mission-oriented scientific research, there is some controversy over its efficacy. Three American studies, Project Hindsight, TRACES, and the results of the Charpie Panel, attributed technological growth to mission-oriented engineering R and D, basic scientific research, and the individual inventor and small firm respectively. (271) The problem is that such studies appear to be influenced by ideology and vested interests. In order to preserve their freedom to choose their own lines of research, basic research scientists have propagated the ideology that utility is not to be the test of the worth of scientific activity, but that "spin-off" benefits will eventually result from all advances in scientific knowledge. (272) Until quite recently, such a justification for basic research was implicitly believed by scientific advisers to both British and American governments. (273) However, signs are appearing of a reduction in the autonomy of basic research scientists in DC's, due partly to the escalating costs of engaging in research. (274) The same trend will probably shortly be seen in LDC's.
However, whether in mission-oriented or in basic research, scientists in LDC's are often the victims of lack of organization and advance planning. (275)

2.3-VIIj. Cognitive and manipulative skills

These have already been considered in section 2.3 above, and so will not be discussed again here.

2.3-VIII. Psychological Characteristics

There are several difficulties involved in considering psychological characteristics of scientists. For one thing, agreement has not really been reached by psychologists as to the meaning and measure of such concepts as "creativity". At the same time, studies of the psychological characteristics of scientists have resulted in contradictory findings. (276)

The whole issue is complicated by the different types of scientists who produce good quality work. This is not surprising in view of the vast number of people involved in "research and experimental development": about 2.4 million in eighty-five countries, of whom a quarter of a million make substantial contributions to knowledge. (277) It seems that there are many different ways of being creative.

Kubie has identified four types of scientific producers: (i) the immediate producers, (ii) those whose work bears fruit slowly, (iii) those who fail to achieve spectacular positive results but who make their contributions by the definitive precision and even the brilliance of their "failures", and (iv) those highly gifted critics who do little or no work themselves but who guide the creative work of others. (278)

Mitroff was offered a somewhat different typology by one of the scientists he interviewed in his study of the Apollo moon scientists. (279) Type I scientists were predominantly theorizers who relished the bold intuitive and theoretical leaps always required in making inferences from incomplete data to a comprehensive and encompassing theory. At the other end of the spectrum were Type III scientists, who were often seen as brilliant but extremely narrow and specialized experimenters. Type II experimenters were between these two extremes, that is, scientists who were equally
capable of doing competent experimental work as well as engaging in
modest theorizing and extrapolation activities.

In spite of the individual variations among scientists, there appear to be
certain psychological characteristics which are conducive to the performance
of experimental scientific activity, but which vary with different types of
scientist. A discussion of these will now follow.

2.3-VIIIa. 

2.3-VIIIa. General role-relevant characteristics

Barron has collated the research findings of A. Roe, C.W. Taylor,
R.H. Knapp, R.B. Cattell, R.D. MacCurdy, D.C. McClelland, B. Eiduson,
J.A. Chambers and H.G. Cough to produce a list of traits of the productive
scientist. (280) These may be subsumed under the following headings:

2.3-VIIIa. (i) A superior intelligence.

2.3-VIIIa. (ii) Creativity and imagination: a liking for abstract
thinking, and a drive towards comprehensiveness and
elegance in explanation, coupled with an excited interest in the challenge
presented by contradictions, exceptions and apparent disorder (especially
ture for Mitroff's Type I scientist). Stein defines creativity as "a novel
work that is accepted as tenable or useful or satisfying by a group at
some point in time", and sees creative men as being able to "integrate
complex situations into simplified and meaningful new developments". (281)
Ziman regards imagination as one of the three qualities (besides learning
and critical sense) "which the scientific mind must possess in abundance". (282
However, perhaps because he is a theoretical physicist, he does not allow
for scientists who do careful and competent experimental work, but who lack
imagination (Mitroff's Type III scientist). Kaplan holds that creativity
can enter at any stage of the research process: when defining or recognizing
a problem, during the experimental design, and during the interpretation
of results. (283)

2.3-VIIIa. (iii) Curiosity: a special interest in the challenge involved
in pitting oneself against the unknown, so long as one's
effort can be the deciding factor. Roe has suggested that children's
curiosity is often restricted by parents and teachers, who may be less
intelligent than their wards in some cases, and that this can adversely
affect the development of thinking conducive to science. A Japanese sociologist has argued that the introduction of modern science into Japan was facilitated by the Japanese tendency to value and encourage childhood curiosity.

2.3-VIIIa. (iv) Independent thinking: a rejection of conformity pressures in thinking. Again, this would seem to apply only to Mitroff's Type I and II scientists. Stein found that the more creative individuals in his sample of industrial chemists tended not to submit to authorities.

2.3-VIIIb. Self-confidence and self-discipline

Self-confidence is probably a conducive to success in any activity. Nevertheless, high personal dominance and forcefulness of opinion (but a dislike of personally-toned controversy), together with high ego strength; and self-sufficiency enter Barron's list. Pelz and Andrew's study showed that an outstanding trait characterizing high research performers was self-reliance.

At the same time, productive scientists appear to have a high degree of self control, or control of impulse. This is evidence from their ability to "make inordinate sacrifices" in order to achieve their goals, and to be "unusually hardworking to the extent of appearing almost obsessed with their work".

2.3-VIIIc. Ability to work with other scientists

"A somewhat distant or detached attitude in interpersonal relations ... a preference for dealing with things or abstractions rather than with people" was one of the characteristics of productive scientists listed by Barron. McClelland, too, identified avoidance of interpersonal contact as a tendency of physical scientists, and considered that in general, scientists avoided and were disturbed by complex human emotions.

In spite of this, scientists in many sub-disciplines are increasingly having to work in teams. An ability to work together with other research scientists over what may be a long period of time is then conducive to productive scientific research.
In some areas of the world, social customs may not encourage scientific collaboration. This has been given as one reason why Arab scientists find it difficult to work in research teams. (291)

In an LDC, because of the small size of the scientific community, interpersonal conflicts are more likely to appear than in a DC where scientists can avoid each other more easily. Also, scientists in LDC's may use ideological weapons to attack one another, when the real cause of the dispute is professional jealousy. (292)

2.3-VIIIId. **Motivating factors**

The motivation to engage in any activity is a resultant of a complex of factors, the relative weight of which will vary with each individual. In addition to those factors associated with Ie, If, Ig, IV, V, VI and VII above, and with a, b, and c, in this section, the following may be considered as motivating scientists to engage in scientific research:

2.3-VIIIId. (i) **A desire for recognition by the international community of scientists in the sub-discipline.** In section III above (pp. 92, 96) I pointed out that there is evidence to suggest that most scientists have a deep-seated desire for recognition by their peers, but that in LDC's recognition may be given to a scientist by society or by the local scientific community even when he does not produce research conforming to the standards of merit prevailing in his sub-discipline. Hence the emphasis here is on international.

2.3-VIIIId. (ii) **An ability to recognize the relevance of experimental research activity to other deeply-held values and beliefs.**

Jones has pointed out how many universities in LDC's have used the older tradition of European university as a model, and so have tended to produce an intellectual elite which is out of touch with the local people and the national needs. (293) He goes on to say that this is a particular temptation for scientists engaged in experimental work, because to gain the approval of the international scientific community, they have to work on problems which are more opposite to the needs of developed countries. (294) The retreat into ivory towers seems to characterize the work of university scientists from Latin America (295) to the Middle East. (296)
The great aspiration of most intellectuals in LDC's is for economic development for their countries. Thus they have difficulty in squaring their basic scientific research with this great national aim. If more research could be done which was relevant to this, scientists would receive the approbation of society, as well as the feeling of contributing to a deeply-felt need. A prejudice against applied research and development seems to exist in some LDC's. In Venezuela, for example, basic research amounted to 75% of all R and D in the early 1960's, while in Mexico it was nearly 100%. This compares with a figure of 10-20% for basic research in developed countries.

On the other hand, the fault does not always lie with university scientists. In many LDC's, the industrial, agricultural, commercial, educational, medical, military and other institutions have yet to learn the value of the results of research and to make more or less reasonable demands for them on the scientific community. Realizing that what they are doing is valued by the government and by such institutions would be a powerful motivating factor for research scientists.

There is obviously a tension between this motivational factor and (i). The advantage of a desire for international recognition is that it motivates scientists to produce high quality work. The ideal would be for scientists in LDC's to perform research that was both of a high technical standard and yet relevant to local needs.

2.3-VIIIId. (iii) Factors motivating separate individuals. Kubie argues that because the potential research scientist has to spend a large amount of time in the laboratory, he often has to withdraw from athletic, social and psychosexual activities. The result is that "when research is begun, he invests in it a lifetime of pent-up cravings" and inevitably his research will be "supercharged with many irrelevant and unfulfilled emotional needs".

These will vary with each individual, and may eventually be satisfied in different ways. Some scientists may crave for scientific fame, others for power over other men - which may eventually lead them away from research and into administration. The desire to find out something first seems to be a powerful motivating factor in science.
Other motivating factors are money, the desire for status, patriotism, and the desire to work for the glory of God.

Some psychologists have attempted to correlate childhood influences with aspirations to engage in scientific activity. For example, there is some evidence to show that natural scientists are often socially isolated in their early years, and that they develop an interest in the structure of things early in life. (300)

Productive scientists have been observed to be intensely committed to scientific activity. (301) which suggests that they are very highly motivated. Also, the fact that they keep up such a commitment over long periods of time implies that they find satisfaction with the fruits of their labours. Where this commitment is absent, in LDC's for example, indicates that initial motivation is lacking or that initial motivation becomes blunted by lack of fulfilment.

Moravcsik considers that "morale is the most important ingredient in science development" since it holds the other elements together and gives it an essential dynamic quality. (302) He describes high morale as "will, personal strength, optimism, self-confidence and a positive mental attitude". In his view, a country with good facilities but low morale is likely to produce worse research than a country with poor facilities and high morale. He sees science as being particularly susceptible to the spread of low morale from one scientist to another because of the highly collective nature of scientific research.
2.4. Groupings and Degrees of Necessity Amongst the Conducents

At the beginning of this chapter, I suggested that the various conducents might form a hierarchy of different groupings. One seemingly straightforward division is into conducents internal to a scientist and conducents external to him. This is illustrated in the diagram below:

However, the division is not a clear-cut one. Ih, IIg and III for example, presuppose the existence of an external body of scientists holding to a particular conceptual framework and committed to the use of certain instruments, methods and techniques, and also presuppose VIIg and VIIh, access to research literature and opportunities for information exchange. III also presupposes the granting of external scientific recognition in return for the performance and publication of good quality research work. IVc and equipment and supplies and also VIIh. VI implies d presuppose VIIc formal or informal sanctions strong enough to affect the behaviour of the scientist. VIIic implies a need to work with other scientists, and also presupposes their existence, VIIe. Internal motivation to perform scientific research, VIIId, may be influenced by Ie, f, and g, by VIIIA, b and c and by the external VI and VII a-j.

A somewhat similar classification might be into what is sometimes called the "supply side" and the "demand side". Let us assume that a university has been set up by reason of general social demand and that facilities for doing research are provided and
and research expected. Much will depend upon the degree of autonomy of the university and upon the clauses relating to research activities in the law governing the university. However, if as is usually the case, the university has a fair degree of autonomy, the scientists performing research within its walls will have considerable independence in their choice of research topics. The world outside the university can then only affect the direction and rate of progress of research by supplying funds in return for compliance with its conditions. Thus, for example, the Science Research Council in Britain and the National Science Foundation in the United States have some power to alter the direction and flow of some research. Industry may also supply funds by demanding specific research tasks. In these cases, supply fits specific social demand. If such demand is fairly long-term, then it will probably affect the supply of science and technology skills as well as the supply of technology, of technological problem solutions and of original research with technological spin-off benefits. This classification may be represented as follows:

<table>
<thead>
<tr>
<th>Supply</th>
<th>Demand (specific, for certain research tasks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ia-g, (h)</td>
<td></td>
</tr>
<tr>
<td>IIa-f, (g)</td>
<td></td>
</tr>
<tr>
<td>(III)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IVa-d</td>
</tr>
<tr>
<td></td>
<td>VIIa-j</td>
</tr>
<tr>
<td></td>
<td>VIIIa</td>
</tr>
<tr>
<td></td>
<td>VIIIb-d</td>
</tr>
</tbody>
</table>

The importance of other scientists in the international scientific community will probably lessen, and so Ii, IIg and III will not be so conducive. V and VI will now be quite unimportant. Some of VII a-j, may continue to be provided by the university, but others will not. VIIIb and c will be affected by VIIId, the overriding factor of high motivation.

'Demand' may also be more general. For ideological reasons, the world outside the university may decide that science is a good thing and so may support both basic and applied research within the university as well as ensure that the educational system provides plenty of high quality scientific and technical skills.
Under this scheme, the following classification would be possible.

Supply

\[ \text{Ia-h} \quad \text{IIa-g} \quad \text{III} \quad \text{IVa-d} \quad \text{V} \quad \text{VI} \quad \text{VIIa-j} \quad \text{VIIIa-d} \]

Demand (general social)

However, the extent to which, for example, Ia-h are provided by the supply side and by the demand side is greatly dependent upon the individual situation, and so such a classification is not very definitive.

Moreover, the conducents model applies to academic scientists and since most universities in non-totalitarian countries have a certain degree of autonomy which to a large extent cushions them from the effects of the demand side, the division into 'demand' and 'supply' categories does not appear to be a very helpful one.

A further classification is possible according to the conducents' degree of necessity. Some conducents are prerequisite for the performance of science as we know it, others are merely stimulative. The diagram below is an attempt to classify conducents according to their degrees of necessity:

<table>
<thead>
<tr>
<th>Degree of necessity</th>
<th>Internal conducents</th>
<th>External conducents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>Ia,b,c,(d),e,(f);(IVc,d); VIIIa, c,(f),(j).</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>VIIa, d.</td>
</tr>
<tr>
<td>Class 2</td>
<td>Ig,h;IIa,b,c,f,g;IVA,b</td>
<td>VIIB,d,e,g,i</td>
</tr>
<tr>
<td>Class 3</td>
<td>IId,e;III;IVc,d;V;VIIIB,c</td>
<td>VI;VIIf,h.</td>
</tr>
</tbody>
</table>

Class I conducents are prerequisites or conducents without which the performance of experimental science as we know it is not possible. There is no a priori reason why another set of conducents could not be developed, but for the science we know and are dealing with, these conducents do seem to be required. The only exceptions may
be Id and If. It might be possible for a person to perform experiments while holding to a cyclic concept of time provided that cycles were long enough and that the person were able to measure the passage of time between two points in the cycle or that the experiments involved were not time-related or time-dependent. However, the latter case would still require an assumption that the physical world did not change over time, so as to allow for the repetition of experiments with the same results at various times. As for If, it might be possible for a person to perform experiments under duress, even though the experiments went against the performer's deeply-held beliefs. It would be difficult to envisage a situation in which a scientist were trained under such conditions or had to do experiments under such conditions for a long period of time and still produce good research, however.

Class 2 conducents are highly desirable, but it may be possible to do scientific research without them. Some, like IIh-e, for example, are not essential in some disciplines such as biology and botany. Although it may be possible to include a logical inconsistency in a research-related argument and still produce results which though incorrect could lead on to innovation, this is unlikely. IIe and IIe are less necessary. It is possible to do good work without them. IIIf would not have been in Class 2 in earlier days when there was less literature to sift through and fewer other channels for transmitting information. IIh and IIg are in Class 2 because of the cases of the revolutionary pioneers who are not committed to conceptual frameworks or to the use of certain instruments, methods and techniques employed by others. IIg is in Class 2 to allow for cases in which a scientist or potential scientist sees experimental scientific research as a despised activity, and yet he has such a high motivation to obtain the results of a piece of research that this overrides his prejudice.

It is still possible to perform scientific research in a few sub-disciplines without problem-solving skills and without a deep and broad knowledge of the subject. This would be especially true with newly emerging sub-disciplines. However, in general IVa and IVb are necessary and so are placed in Class 2. VIIb, d, e, g and i are also in Class 2 rather than Class I because of the possibility in rare cases of doing experimental scientific research without them. Thus, provision for subsistence might
be in the form of food and supplies rather than money; a technically minded scientist might be able to dispense with technicians; individual rather than team research is still possible in some disciplines such as biology and botany; a supreme innovator might do without access to research literature; and an individual researcher might be able to manage without any degree of external organization. At the same time, such possibilities seem remote in view of the fact that the conducents model refers to research scientists in an academic context. Indeed/physical sciences, where research is done almost exclusively in teams, it would be extremely difficult to conceive of a scientist performing research without any technician or ancillary staff or without readily available supplies and equipment.

Class 3 conducents are not necessary for the performance of scientific research, but their presence is usually stimulative. III provides a mechanism whereby research work of quality is rewarded. At least one other mechanism does exist, however, especially in applied scientific fields, and that is that innovation is rewarded financially, usually by means of a patent. The more that a scientist is rewarded other than by the scientific community, the less will he be motivated by a desire to gain scientific recognition. III implies an informal system of quality control by referees of scientific journals, but quality work could be ensured by peers or superiors in, for example, a military research establishment for which an academic was doing contract research.

IVc and IVd are very much dependent on the sub-discipline. For some sub-disciplines, they would be in Class I, while for others in which little apparatus is used, they would be in Class 3. V can be dispensed with if other forms of research motivation are powerful enough. VI will depend on the individual scientist and on the extent of and degree of enforcement of sanctions; they will only be conducive to those scientists whose motivation to do scientific research would not otherwise be high enough to satisfy the role expectations in their research establishments. VIIf would be in Class I for scientists in certain sub-disciplines whose native language was not a major scientific language nor one in which translations of foreign work were readily available. For a scientist in whose native language most of the research work in the sub-discipline was extant and for the revolutionary pioneer, knowledge of a foreign language might not be necessary. VIIh
would also not apply to the revolutionary pioneer and would depend on the sub-discipline. VIIIb would probably be more necessary where a scientist was performing research on his own, in which case VIIIc would not apply, and vice versa.

In short, Class I conducents are essential for science as we know it, except for Id, If, IVc, IVd and VIIf which may be overridden by other conducents in ways I have discussed or else which may not be needed in certain extraordinary circumstances similar to those I have outlined. In various situations, Class 2 and to a greater extent Class 3 conducents may not be necessary, either because of special conditions in the sub-discipline concerned, or because another conducent such as high motivation compensates for their absence.

2.5 Interrelatedness of the Conducents

Even though conducents may be classified according to degrees of necessity, scientific research is not usually forthcoming when only Class I conducents are present. According to the sub-discipline concerned and according to whether or not the scientist is a revolutionary pioneer in a new field, Class 2 and Class 3 conducents are also required. Generally speaking, a small number of 'gaps' can be compensated for by high motivation, but if the number of missing conducents becomes too large, then this will not be possible. The number of possible missing conducents varies according to sub-discipline, the type of apparatus needed, and the point in the development of the sub-discipline at which the research scientist begins his research.

At the same time, it should be noted that an increase in a conducent such as supplies and equipment (VIIc) will not of itself produce more or better research. It must be accompanied by an increase in motivation (VIIIId), and, if the necessary skills are already present, by a means to improve and control the quality of the research (such as III). If all the external conducents in Classes I to 3 can be increased, and steps taken to increase as many of the internal conducents as possible, then more, better quality scientific research should be produced by an individual scientist.

2.6 Endogenous versus Exogenous Science and the Conducents

Writers on science, technology and economic development such as Sagasti (303) draw a distinction between endogenous and exogenous or implanted, science. Such a distinction may be valid when the
wider economic and technological system is under consideration. However, it is also true to say that science as an activity arose in a particular area of the world after a particular time and that this has not been repeated spontaneously elsewhere. Scientific research is being performed in many different countries today because it has been copied from the way science is done in Western Europe and the United States. Science may have developed somewhat differently in different countries but in every case there is a point at which science was imported from another country. As an activity, therefore, science in one country does not differ from science in another. This is not to say that science and technology as institutions do not differ from country to country. Thus because the conducents model refers to science as an activity, the conducents should not be seen as different according to whether the science-technology institution is endogenous or exogenous.

2.7. The Conducents as a Hypothesis

The above analysis of conducents for experimental scientific research in a university context has identified a wide-ranging conglomerate of factors, which, I hypothesize, are conducive to such research.

I shall now attempt to ascertain which of the above is missing or deficient in the case of first pre-Republican Turkey and then Republican Turkey.
For over 1,000 years prior to the proclamation of the Republic, the Turkish people were enthusiastic warriors for the religion of Islam, and for half that time they were subject to what was virtually an Islamic theocracy. Indeed, so completely did they identify themselves with Islam that the word 'Turk' almost went out of use. (1) In view of this enormous Islamic influence over every aspect of the lives of the Turks, I would first like to take up the question of whether the religion of Islam per se is conducive or inconducive to the performance of experimental scientific research, before proceeding to a consideration of the presence or absence of conducents in pre-Republican Turkey.

3.1 The Conducents and Islam

A survey of Sarton's *Introduction to the History of Science* (2) reveals the wide-ranging extent of the scientific contributions of Muslim scientists between the eighth and twelfth centuries, contributions which moved Sarton to talk of "the miracle of Arabic science". (3) It may, therefore, seem almost audacious to hint that there might be aspects of the religion of Islam which are inconducive to scientific research. Nevertheless, after the fifteenth century, few original scientists came from an Islamic background. One scholar observes that from the beginning of the eighteenth century to the middle of the nineteenth century "not a single scientist of any repute existed in the entire Muslim world", (4) that is, by European standards.

Two main questions arise in a consideration of Islamic science: "Why did it arise?", and "Why did it decline?" The first of these may be easier to answer than the second. Sarton sees three main reasons for the Arabs' interest in science: a desire for knowledge which would assist them in government and administration, a desire to obtain some knowledge - medical and astronomical, for example - for utilitarian ends, and also a hunger for knowledge for its own sake. (5) Montgomery Watt agrees with the second of these, and adds that philosophy was studied because it was closely associated with medicine and astrology. (6) Also, the study of philosophy grew in importance when more thoughtful Muslims came into contact with people of other faiths and saw the need of apologetics. Nasr, too, sees the sudden interest taken by the Islamic community in
Greek philosophy and sciences at the beginning of the ninth century as arising out of the challenge it faced from the theologians and philosophers of the religious minorities within the Islamic world. Pines notes that nearly all the Muslim philosophers up to the end of the twelfth century were practising physicians; the study of medicine, with its obvious practical benefits, had many patrons. Astrology was probably favoured for holding out a possibility of knowing the future, while alchemy was supported for its promise of unlimited wealth. Astronomy was not only closely linked to astrology, but it was needed by orthodox Islam for fixing the hours of prayer, the direction of Mecca, and the beginning and end of the month of fasting. Winter considers that amongst the formative influences in Islamic science and mathematics were a love for the geometrical pattern and the deductive argument, a pride in instrumental and technological design, a veneration for the great masters of Greek medicine such as Hippocrates and Galen, and a selection of elements of Hindu arithmetic, trigonometry and medical lore which could be put to practical use. However, he admits that in natural history, Muslim scholars did not undertake the same careful experimental observation as Aristotle. Nevertheless, it now seems generally agreed that Islamic science was not merely a vehicle for the transmission of Greek and Hindu science, but was "a distinct science, practising its own characteristic methods and building up its own body of knowledge".

At the same time, there is some doubt as to how orthodox the great Muslim scientists really were. In his famous lecture on science and Islam, Renan claimed that most of the best "Islamic" scientists came from a non-Islamic or heretical Islamic background. More recently, Ritter and Grunebaum have reaffirmed this thesis. Certainly, it is clear that men like al-Razi (Rhazes) were sceptics.

The second question as to why Islamic science declined is an enormously complex one, linked as it is to the problem of the decline of Muslim civilization. There seem to have been several factors involved, chief among them being the attack against philosophy by al-Ghazzālī in eastern Islam around 1100. His anti-philosophical views found wide acceptance among the orthodox in response to the excesses and violence of the Ismailian heretics, who had tried to effect a synthesis of religion and philosophy. Heresy and philosophy came to be seen by the orthodox as inextricably linked, while any deviation from orthodox belief was
suppressed. Teaching of all kinds was left to the medreses, cultural borrowing stopped, and independent thinking was no longer tolerated. The geriat began to exert its grip upon every action of the Muslim, so that everything he did had to be evaluated against it. (17)

Another factor emphasized by Saunders is the series of barbarian nomadic invasions which buffeted the Islamic world from the eleventh century onwards. Cities, schools and libraries were destroyed, and teachers were killed or scattered. At the same time, commerce was disrupted and feudalism of a kind was instigated to pay for reserve armies. Whether or not the bourgeoisie had been the patrons of secular learning, the fact remains that their decline to the level of artisans and craftsmen came about at the same time as the decline in "secular sciences". (18)

Mieli does not really tackle the problem of the decadence of Islamic science, although he hints at the Mongol invasion and the triumph of extreme orthodoxy as possible factors. (19)

Other factors mentioned by Saunders include the wide appeal of Sufi mysticism, the intensification of religious fervour - with presumably, a concomitant increased adherence to orthodox teaching - arising out of the holy wars, the break-up of cultural and linguistic unity when Arabic was replaced by Persian and Ottoman, and the prevalence of slavery, sanctioned by the Koran, which may have discouraged Muslims from trying to invent labour-saving machines. (20) With regard to the latter, it is simply not good enough to assert that mechanical gadgets were never taken seriously by Muslims because they "wanted to show that the only safe kind of complicated machine is a toy"! (21)

Anawati touches on the problem of the decline of Islamic science only briefly. In his opinion, Islam does not of itself oppose scientific research, but on the contrary stimulates it. The condition for successful scientific endeavour is for the interpretation of religious data to remain broad enough "to enable different theological and philosophical doctrines to confront each other in complete freedom". (22) However, this begs the question as to why this freedom disappeared. Could it be that orthodox Islam has a tendency not to tolerate any such freedom? If so, then "of itself" orthodox Islam would not appear to be a stimulant for scientific research.
Nasr gives an equally unsatisfying reason for the "decay" in Islamic sciences, namely that it is "directly related to a gradual loss of interest in such subjects as mathematics in the madrasahs", with no explanation for this proffered. (24)

Nasr differs from other writers in strongly defending Sufism as the real basis for an Islamic science. (25) In contrast, Qadir, for example, lays several charges at the door of mysticism: it encouraged the idea that intellectual enquiry was irrelevant, it promoted superstitions, it spread fatalism, and by its other-worldly attitude, it diverted attention from social problems. (26) Hartner also sees mysticism - especially that of al-Ghazzalî - as nourishing anti-intellectual attitudes. (27)

One of the best reviews of the factors which led to the decline of Islamic science is given by Sayîlî. (28) He agrees with other scholars in seeing the lack of reconciliation of Islam and Greek learning as one of the main influences involved. By the time the medrese had become institutionalized, the awail (or rational) sciences had already become suspect and were omitted from the curriculum. (29) Other factors mentioned by Sayîlî include the world-view of nature prevailing in Islam, which tended to undermine a belief in an orderly universe, the increasing gap between the spoken and the written (classical) Arabic language, the frequent political instability of the times, the emphasis on memorization in the educational system, and the refusal by the Islamic community to open itself to other communities, and especially Europe. (30)

Consideration of the above questions gives us a background against which to consider the individual conducents within orthodox Islam.

Some writers question whether the Muslim concept of God supports a belief in a broad causality in the natural world (conducent Ib). Sayîlî, for instance, feels that because Muslims considered that there was a continuous interference of God and of supernatural forces in nature, they hesitated to believe that fixed principles underlay natural processes. (31) The result was "a resigned doubt" as to the workings of nature. Any hint that the order of nature was independent of the will of God met with an outcry from Muslim theologians. (32) The Asharite school, the dominant school of Sunni theology, asserted that every cause was a Transcendent Cause, and any order in the world was due to the "vertical" relation of everything
with its ontological cause, rather than to any "horizontal" relation between different entities. Consequently, whatever appeared as cause and effect according to "laws of nature" was merely the "habit" of a succession of events determined by the will of God. (33) This idea was similar to that of the 14th century nominalists. (34) Nevertheless, the latter appear to have had more of an idea of the orderly workings of God, due perhaps to the impress of medieval Christian theology. (35) Islam does not seem to have presented God as a non-arbitrary, non-capricious Being in quite the same way.

This can be seen in the great debate between Averroes (Ibn-Ruṣd) and al-Ghazzālī over the question of causation. In al-Ghazzālī's view, "The connexion between what is usually believed to be a cause and what is believed to be an effect is not a necessary connexion." (36) Al-Ghazzālī's influence was widespread. His teachings became part of orthodox Islamic teaching and after him "there was no further philosopher of note in the eastern Islamic world." (37)

Although the New Testament and the Koran both teach the second coming of Jesus and the day of judgement, one observer at least has identified differing concepts of time in the two books (conducēnt Id). (38) Thus the New Testament contains accounts of historical events in a more or less chronological fashion, including the founding of the first churches. In one sense, therefore, it may be thought of as the first part of a sacred history which continued with the later expansion of Christianity. The Koran, on the other hand, is held to be external and uncreated. This sets it somewhat apart from time. Moreover, it does not describe historical events except as isolated incidents. However, the influence of the two books upon the formation of the concept of process must still be considered an open question.

A similar ambivalence to that observed in the Islamic concept of causality appears in consideration of the role of man vis-à-vis the natural world (conducēnt Ie). Is it under his control or not? In fact, are even his actions his own? This was a problem that was to occupy Muslim theologians during the 9th and 10th centuries. (39) The controversy became the more fierce because, as Watt points out, the Koran contains verses which separately stress God's omnipotence and human responsibility. (40) Watt argues that the idea that a man's life is controlled by a power beyond
himself existed in pre-Islamic Arabia, and was included in the conception of God portrayed in the Koran. (41) In particular, there are verses suggesting that misfortune is from God, (42) and that the date of death is from God. (43) Moreover, the Traditions tend to support the idea of predestination, although a few Traditions also condemn fatalistic inactivity. (44) As a result, "the standard Sunnite doctrine came to be that God by his Qadār (power) determined all happenings and events." (45)

Some writers, such as Rahbar have claimed that the idea of divine predestination is an invention of the theologians, and is not really present in the Koran. (46) Izutsu thinks that this is not an easy question to decide, and concludes, "However this may be, it is quite certain that the Koran itself raises this problem in an extremely acute form by the very fact that it puts the whole course of human life under the absolute control of the will of God." (47) On balance, therefore, the combined effect of the Koranic teachings and the Traditions seems to be to lessen any conviction that man can control the natural world (conduent 1e).

Above (p.132), we saw how philosophy became identified with heresy at about the beginning of the 12th century. Thereafter, hostile descriptions of philosophy became a normal part of the curriculum of those studying scholastic theology. (48) As Saunders notes, (49) by the 14th century, Ibn Khaldūn felt it necessary to devote a whole chapter of his Muqaddimah to refuting philosophy, (50) and was even advising his readers to avoid "the problems of physics" because they were "of no importance to us in our religious affairs or our livelihoods". (51) The non-religious sciences thus seemed to be in conflict with other deeply-held beliefs and were not regarded as yielding relevant or useful knowledge (conduent If).

The problem was that scientific research could not be legitimated to the wider Islamic society. According to Grunebaum, "No matter how important the contribution Muslim scholars were able to make to the natural sciences, and no matter how great the interest with which, at certain periods, the leading classes and the government itself followed and supported their researches, those sciences (and their technological application) had no root in the fundamental needs and aspirations of their civilization." (52) Rosenthal, too, thinks that the Islamic definition of acceptable knowledge was responsible for "intellectual stagnation and decay". (53)
Following the heyday of Islamic science, the attitude towards non-religious knowledge seems to have reverted to that held by the Umayyads; we are told that when Umar was asked what should be done to the books in the legendary library at Alexandria, he gave the following judgement: "As to the books about which you are enquiring, if there is to be found in them information which is in agreement with the Book of God (the Koran), such information is already available to us, and if there is in them materials that are contrary to the Book of God, there would be no need for them. In any event, proceed with their destruction." Ibn Khaldun notes that a similar order was given by Umar concerning a store of books and scientific papers in Persia.

The net result of the disowning of philosophy and science by orthodox Islam was that in later ages when Muslims wanted to appropriate the fruits of science and technology, they experienced psychological conflict.

According to Mardin, there also seems to have been a fear amongst certain Muslims as to the dangers of the widespread dissemination of knowledge, which in their view should only be pursued by an enlightened few: "...a most essential part of the culture of Islam was its esotericism - a conception that knowledge was dangerous when indiscriminately placed in the hands of everyone". Thus, opposition to the printing press by Ottoman ulema arose from the fear that it would increase the circulation of religious books to a dangerous extent. Mardin notes the contrast with the West where the Bible was the first book to be printed.

Another point related to conduent If is that in Islam "...research per se, as an effort to widen man's insight into the mysterious ways of the Creator, is not experienced as a means of glorifying God". Again, the contrast with the attitude of some of the fathers of modern science in the West is sharp.

Ritter goes further in claiming that in Islam, even though the world is not created evil and demons have no hand in its creation, yet it does not really have great value, in that it is merely a place to prepare us for the next life.

Turning now to methodological conduents, Nasr argues that the striving for quantitative results in the western world (conduent IIb) runs counter to the aims of Islam. He holds that Islamic science has both different objectives and different means from those of modern (western) science, since
it "seeks ultimately to attain such knowledge as will contribute toward
the spiritual perfection and deliverance of anyone capable of studying it". (62)
However, it should be borne in mind that Nasr is arguing from a strongly
Sufi position.

It is true that medieval European science, especially alchemy, had some
similarities to Nasr's idea of Islamic science. However, something(s)
made European science change, but seem to have been absent from the
Islamic world.

Nasr also hints that there is a somewhat guarded commitment to experiment
in Islam (conducent IIc). Because scientia (human knowledge) is subject
to sapientia (Divine wisdom), Islamic astronomy did not break with the
traditional medieval world view. Thus, "a certain 'limitation' in the
physical domain was accepted in order to preserve the freedom of
expansion and realization in the spiritual domain". (63) In his preface
to Nasr's book, Santillana comments upon the fact that until quite
recently, Ptolemaic astronomy together with geocentric cosmology and
philosophy has been taught in Muslim universities with a "modern system"
available as an option, but presented as a "hypothesis". (64) Santillana
confesses that he is disturbed by the parallel split between sapientia
and intellectual integrity which Nasr defends in his book. (65) More
recently, Nasr has defended the Islamic refusal to overthrow the Ptolemaic
system in much the same vein. (66)

Learning through observation was not a feature of traditional Islamic
education. Memorization was the most highly prized activity. (67) It
was believed that while repetition was taking place during the process
of memorization, God was producing knowledge in the heart of the reciter.
As a result of this dependence upon God, "systems of pedagogy could hardly
co-exist". (68) Islamic instruction revolved around the individual teacher,
who gave certificates to those students he thought had absorbed the
requisite amount of knowledge. (69)

Of course, European teaching has not always avoided mere memorization,
but from the seventeenth century onwards, there appears a fairly widespread
questioning of authorities.

The extreme Islamic emphasis on memorization would seem to dispel any
aspirations towards the testing of knowledge empirically (conducent IIc). The authoritarianism implicit in the committing to memory of revered texts and in the subservience shown towards the individual teacher as a result of both tradition and a desire to obtain his certificate, would not be conducive towards an openness to the possibility of alternative explanations (conducent IIe), nor towards a critical evaluation of knowledge gained (conducent IIf). Such a system of instruction would probably also lead to a suppression of curiosity (conducent VIIIa), while the portrayal of non-religious sciences as irrelevant and even pernicious would dampen any interest in studying the natural world (conducent VIIIId).

The Koran itself does not appear to allow for the possibility of honest doubts. (70) The one apologetic for believing it is the unique magnificence of its Suras, (71) while the punishment for unbelief is hellfire. (72) There is one verse (Sura 2/111) (73) which seems to demand evidence for belief, but it asks it of non-Muslims as to why they continue to hold to their own beliefs. (74) Is the Koranic emphasis any different from the Biblical one? The difference seems to lie in the apostles' constantly giving reasons for belief by appealing to the historical resurrection of Christ and to the fulfilment of Old Testament prophecies. Somehow, doubts are regarded less severely and are treated almost as a natural prerequisite to belief. If this is so, then Islam would appear to be more hostile towards scepticism than Biblical Christianity (conducent IIIf).

All this having been said, it is not easy to decide what the "real Islam" really is. (75) Is it, as Nasr would have us believe, that way of thinking characteristic of the Sufis? (76) If so, then there are further problems to be faced than in the more orthodox Sunni tradition. For example, the Sufis have a neo-Platonic concept of individual events, objects and signs as merely uncertain "appearances" of the Divine Principle, (77) a concept which Hooykaas claims was a barrier to the rise of modern science. (78) Furthermore, since Sufism regards nature as a book whose true meaning can only be understood by symbolic interpretation rather than by observation, (79) the place of experiment becomes questionable at best. Other difficulties with Sufism arise in connection with teleological explanation (conducent Ic) and with the notion of time as moving along a linear continuum (conducent Id). Indeed Santillana feels that Sufism in its pursuit of a science of the soul, almost blots out the science of nature. (80)
If "true" Islam is not Sufism, is it then to be regarded as the Islam which was closely defined by the Sunnite theologians and which gathered around it the institutions of the madrese and the seriat? The answer to this question may well require a great deal of further study. (81)

Meanwhile, modernist Muslims, in wanting to disown the traditional Islam of the theologians would have us believe that true Islam is the Islam of the Koran, "its repository and final authority", and the Sunnah (example) of the Prophet "insofar as it can be critically ascertained", an Islam which is presented as being entirely favourable towards modern science. (82)

However, Cragg believes that the modernists have not always been fair to the historical and original senses of the Koranic passages which they have invoked to support their case. (83)

The most that can be said, perhaps, is that Islam, as it appears in history, seems to contain within it certain tendencies which are capable of reinforcing concepts and attitudes inimic to modern science.

3.2 **The Historical Background to the Turkish Republic**. (84)

Before going on to consider aspects of the development of science in Ottoman times, it would be beneficial to pinpoint a few important dates and incidents in Ottoman history.

The Ottoman Empire reached its zenith in the reign of Süleyman the Magnificent (1520-66). In 1529, its armies were halted at the gates of Vienna, and withdrew without taking the city. Over a century and a half later, in 1683, the Ottomans made another attempt to capture Vienna, but that too was unsuccessful. From that time onwards, the Ottomans were involved in wars which ended mainly in treaties by which they ceded territory to their enemies: in 1699 to Austria, Poland and Venice, in 1718 to Austria and Venice, and in 1774 to Russia. Such setbacks were instrumental in convincing the Ottoman rulers of the need for reforms, first in the army and then in diplomacy, in the administration of the Empire and in education. (85)

The first Sultan to attempt to instigate such reforms on any serious scale was Selim III (1789-1807), although his attempts resulted in his deposition by reactionary forces. More successful in their reform efforts were Mahmud II (1808-39), and Abdülmecid (1839-61), during whose reign a series of reforming edicts were proclaimed known as the Tanzimat. (86) Although the next Sultan,
Abdülaziz (1861-76) was more reactionary, reforms in the areas of law and education were carried out by two of his Grand Vezirs.

During the 1860's, a group of liberals began to unite in their opposition to the autocratic ways of the Sultan, in a movement known as the Young Ottoman movement. However, with the accession to the throne of the even more autocratic Abdülhamid II (1876-1909), the movement came to an end. Then, in 1889, fresh opposition to Abdülhamid arose in the form of the Young Turk movement. At first those active within it were exiles living abroad, but when the movement spread to younger army officers inside Turkey, the stage was set for the institution of the constitution in 1908 and the deposition of Abdülhamid in 1909.

The reign of Abdülhamid had been that of an unmitigated tyrant, but its early years at least had seen the culmination of the legal, administrative and educational reforms begun during the Tanzimat.

From 1909 until 1918, the party of the Young Turks, known as the Committee of Union and Progress, almost continuously dominated the political scene. For the last five years of that period three men, Enver, Talât and Cemal Paşas, effectively held the reigns of power. Despite the brutal and oppressive nature of their regime, the reforming trend of the previous century was allowed to continue. A new system of provincial and municipal government was applied; the police and gendarmerie were reorganized; steps were taken toward the achievement of women's rights, and great changes were made in the educational system.

Meanwhile, the Empire had suffered several setbacks. In 1912, Tripoli had been ceded to Italy, and in the Balkan Wars of 1912-13, Bulgaria, Greece and Serbia obtained their independence. Then in 1914, the Ottomans entered the First World War on the side of Germany. By 1919, the Young Turk leaders had fled, the capital was occupied and the Allies were plotting how to divide up Thrace and Anatolia amongst themselves. However, under the brilliant leadership of Mustafa Kemal (Atatürk), the Turkish resistance forces rallied and in 1922 drove the invading Greeks into the sea. With the signing of the Treaty of Lausanne in July, 1923, the Allies agreed to recognize full Turkish sovereignty in almost all the area which makes up modern Turkey. On 29 October, 1923, Turkey was proclaimed a Republic. The Sultanate had already been abolished in November of the previous year.
After eleven years of almost continuous warfare, the Turks could now turn their attention to the task of reconstruction and to the great reforms of Kemal Atatürk.(93)

3.3 Conducents in the Pre-Republican Era

3.3.1. Early indifference to western knowledge and science

As we saw above (p.136), once orthodox Islamic theologians had taken an anti-philosophical line in the 12th century, it became increasingly difficult to justify the study of philosophy (including natural philosophy) in Muslim society. Thus, by the time of the fall of Constantinople in 1453, a century and a half after the founding of the Ottoman Empire, the teachers in the medreses were concerned only with the study of theology, rhetoric and jurisprudence.(94) As for those outside the medreses, initially there was no incentive to consider knowledge from non-Muslim sources. Since it had no relation to the Islamic religion, which embraced nearly every aspect of Ottoman life, it did not seem to have any useful function. Also, because non-Muslims were by definition inferior to Muslims, it was difficult for the latter to see how any knowledge non-Muslims might have gained could benefit Muslim civilization. This feeling of superiority encouraged the Ottomans to avoid contact with non-Muslims as much as possible.

The result of this was that the Ottomans became isolated from the tremendous intellectual and cultural movements taking place in Western Europe.(95) Their isolation was made more complete by a religious ban on the printing of books until 1727, nearly 300 years after the printing of the first book by Gutenberg.(96) This ban was effected by the ulema who feared that they would not be able to control the propagation of potentially dangerous knowledge. Moreover, the religious institution provided a number of other, less directly inhibiting influences upon the development of modern science in the Ottoman Empire. Great importance was given to rote-memorization, since it was thought that God was producing knowledge in the heart of the reciter as he repeated verses from the Koran. The Arabic script, which is rather unsuitable for the Turkish language, was tenaciously adhered to as the script of the language of heaven, which made the learning of reading and writing a long and arduous business. Also, the overwhelming belief in the will of God did not favour the explanation of phenomena in mechanistic rather than teleological terms, and it left man in a rather ambiguous position with regard to his ability to understand and control the natural world.(97)
However, a series of humiliating military defeats at the hands of the infidels forced the Ottomans to search for the secret of western military prowess. Western learning was first introduced at military and naval training schools towards the end of the 18th century, and then was gradually extended to more and more spheres of Ottoman life by reform-minded Sultans such as Selim III, Mahmud II and Abdülmecid. There was considerable opposition from various religious quarters to many of these reforms, however.

3.3.2. Legitimations for western science and technology

By the beginning of the First World War, most thinking Ottoman Turks were united in their desire to adopt western science and technology. However, their legitimation for doing so varied according to whether they were Westernizers, Islamists or Turkists.

The extreme Westernizers wanted to adopt western civilization lock, stock and barrel. They argued that such an adoption would require a change in mental attitude. They stressed the need for reason and "the scientific mind" instead of superstition and ignorance. In their view, "the oriental mentality", which resulted in scorn for other nations, apathy, fatalism and abhorrence of change, was diametrically opposed to "the western mentality". Moreover, the oriental mentality was a product of a corrupted religious institution.

The extreme Westernizers were against all religion per se. Other Westernizers, however, were more moderate. They believed that all that was required was a purging of Islam from the corruptions which had accrued to it.

The invocation of science by the Westernizers against religion and against the things of the past may have given science an anti-religious tinge in the eyes of many. The Islamists responded by trying to show that Islam was not contrary to science. Some extremists claimed that western science was born of Islam, and even that many scientific inventions were foretold in the Koran. The aim of all was to borrow science and technology as Japan had done, but to allow Islam to remain the guide in political and social matters. The Islamists were particularly concerned to show that Islam was a "rational" religion and that it was not an obstacle to progress.

As part of the drive to adopt Western science and techniques, reforms were proposed in the curriculum of the medresas.
The Turkists were a group with a somewhat different emphasis. The maxim of their principal spokesman, Ziya Gökalp (1876-1924), "To be of the Turkish nation, of the Islamic religion, and of European civilization" succinctly summarised their ideology, where European civilization consisted of the natural sciences, scientific methods and technical processes. In Gökalp's view, the acquisition of Western science by the Turks was a necessity. Not only would it lead to material progress and prosperity, but it would enable the Turks to avoid being mastered by Western civilization. Moreover, Gökalp emphasized that there was no conflict between science and Islam because, he claimed, Islam was based on reason in metaphysics. He backed up his claim by an appeal to reform Islam along rational lines. Despite the inadequacies and even contradictions in his writings, Gökalp seems to have convinced a number of influential people in Turkey that a synthesis between Western scientific thought and Muslim religious thought was possible. Although Mustafa Kemal (Atatürk) was influenced more by Westernizers than by other ideologues, many of his fellow-reformers were disciples of Gökalp. The influence of all three ideologies was therefore felt well into Republican times.

3.3.3. Education

Throughout the nineteenth century, various attempts were made to reform the system of education in the Ottoman Empire. Traditional education was obtained by attending the local mosque school, where the main activity was memorizing the Koran. The mosque schools led on to the medreses, which provided a more advanced course of religious instruction for potential ulema. On the whole, the medreses remained aloof from modernizing influences, although in 1909 one modernized medrese was established in Istanbul with physics, chemistry, astronomy, geometry and geography in the curriculum. The medreses attracted large numbers of students, partly because they offered free tuition, lodging and an allowance for food, and partly because their graduates were exempt from military service. With their traditional curricula and methods of instruction, the medreses tended to be centres of reaction and conservatism.

The state stream of education began with the iptidai (primary school), in which the content of the curriculum was strongly biased towards Islam, through the rüşdiye (senior primary school) to the idadi.
(junior secondary school) and the sultani (lise, or academic secondary school). The sultanis tended to be modelled upon the Galatasaray Lycee which had been set up in 1867 with French help. This had developed into an exclusive and influential institution for the upper classes of Turkish society. There were also military idadis, teacher-training schools and, after 1913, commercial, agricultural and technical idadis. The ethnic minorities were allowed to have their own schools. Other schools were operated by Protestant and Catholic missions. One outstanding example was Robert College, which was founded in 1869 and which attracted mainly ethnic minorities until the Republican era.

From its inception, the Galatasaray Lycee gave a prominent place in the curriculum to mathematics, physics and chemistry. The other lycees modelled after it followed suit, and were equipped with laboratories and some scientific apparatus. The idadis had to wait until the Young Turk era before science and mathematics were given prominence in the curriculum. Some were furnished with scientific equipment during that period.

A number of educational reforms were undertaken by the Young Turks, including the extension of educational opportunities to women and an increase in the number of schools. However, such reforms were hindered by first the Balkan Wars and then the First World War. Millions of men were drafted into the army, and were forced to curtail any schooling or teaching in which they had previously been involved. Thousands of women had no alternative but to work for a living. The education of the rising generation could not, therefore, receive the attention it deserved. In spite of this, the literacy rate rose from 230,000 (1% of 23 million) in 1908 to 2,800,000 (20% of 14 million) in 1918.

Enormous problems faced the Republicans as they set out to reform the educational system. In effect, there were three types of schools—the religious, the government and the foreign—which tended to produce three different types of people. Control and administration of the various schools lay with different ministries and some schools overlapped in their functions. There were no teachers in 95% of the villages, and Dr Riza Nur, the first Minister of Education under the Republic, estimated that in all, 40,000 teachers were needed to give every Turk the opportunity of at least a primary school education. Moreover, less than half the 3,316 teachers already teaching were
graduates of the Darülmuallim (Higher teacher training school).\(^{106}\)

The Republican solution was to create a unified national system of education with revised curricula and more and better educational opportunities for the people. An important means of facilitating this was the exchange of the Arabic script for the Latin script in 1928.

3.3.4. Science in pre-Republican Turkey

A change in attitude towards western knowledge and science occurred towards the end of the eighteenth and throughout the nineteenth century. It was prompted mainly by the need to strengthen the defences of the empire against growing European might, but it was also helped by the greater contacts with Europeans which led some Turks at least to a growing appreciation of the infidel way of life. Thus, between 1720 and 1838, at least forty reports on the latest European developments in various spheres were presented to the Sultan and his ministers.\(^{107}\) Several Turks who had seen Europe at close hand saw education and science as the main keys to its prosperity. Mustafa Sami, a former chief secretary of the Turkish Embassy in Paris, published an essay on Europe in 1840 in which he concluded, "From all this it is clear that such a degree of orderliness reached by the Europeans in every work and action, and the indispensability of skill and knowledge in them, are due solely to the diffusion of the sciences and the arts."\(^{108}\)

At the same time, there were some quite specific religious objections which had to be met to such things as quarantine and vaccination (which suggested opposition to the will of God), dissection of bodies and diagramatic representation. Probably to placate the ulema, non-religious knowledge was called fen or "practical skill" in contrast to ilim or "religious knowledge". The term is still used in modern Turkish for "natural sciences", as, for example, in Fen Lisesi (The Science Lycee) and Fen Fakültesi (Faculty of Science), and is even to be seen on the doors of municipal dustcarts as Fen işleri (Technical Works).

Before the Ottoman Turks could begin to undertake scientific activity, they had to have textbooks incorporating scientific knowledge in their own language. This involved the creation in the Turkish language of new terminology which would express the new scientific concepts and objects. Two men in particular Ataullah Şanizade (1769-
1826) and Hoca İshak Efendi (d.1834), were instrumental in this. Şanizade created a Turkish medical vocabulary which was used until the early years of the Republic. A man of encyclopaedic knowledge, he wrote sound books on mathematics, natural science, medicine and history. He also translated an Austrian medical textbook into Turkish, and published it with a physiological and anatomical treatise and a translation of a work explaining smallpox vaccination. Although educated as an ulema, he was accused of materialism and atheism.

Turkish terms for concepts in physics, mathematics and mechanics were coined by Hoca İshak Efendi and used until fairly recent times. He was first a teacher and then chief instructor at the school of mathematics. His four-volume *Mecmuasi Ulum-i Riyaziye* was the first Turkish book to contain some modern European mathematics and physics.

The question of Turkish chemical terminology was tackled by Kırımî Aziz, a graduate of the medical school. He campaigned for the use of Turkish terms instead of Arabic for many years, and gave a large number of suggestions in a twenty-page introduction to his book on medical chemistry published in 1869. Turkish terminology was also used to some extent in *Usulu Kimya* (Principles of Chemistry), published by Derviş Paşa in 1847. This book, together with that of Kırımî Aziz, was used as a basis for nomenclature until the Republic.

There is little record of original scientific activity before the establishment of the Darülfunun (University) at the turn of the century. A high standard of teaching was, however, achieved at the medical school, which was moved to Galatasaray in 1838. Chemistry and physics were taught by European instructors including Antonoine Calleja, a pupil of the famous Berthollet. For forty-five years from 1844, he trained a large number of chemists and doctors. His demonstrations attracted the attention of the Sultan, and his book in French on inorganic chemistry for medical students was translated into Turkish. Another teacher at the medical school was Ali Riza Bey, who had worked under Armand Gautier in his laboratory in Paris for four years.

During the nineteenth century, there were some attempts to found learned and scientific societies. An early example was the
Beşiktaş Cemiyet-i İliyesi (the Beşiktas Scientific Society), a society which was devoted to the study of mathematics, astronomy, literature and philosophy at the beginning of the century. Sanizade was a lecturer at some of its meetings. Many young men who regularly attended its meetings later rose to important positions in the government. Mardin sees the society as one of the first places where contact was made at non-government level between the Ottoman intellectual world and the Western world. (111)

In 1851, an Imperial irade authorized the setting up of the Encümen-i Diniş (Society of Knowledge), whose primary aims were the writing and translation of books for a proposed university and for the general education of the public. In a report on the society written for the Board of Education, its establishment was justified on the grounds that "the people and officials of states which try to develop the sciences are always in prosperity and civilization and it has become an unbroken tradition that such states lord it over other states." (112) The Society had a resemblance to the French Academy in having forty Turkish members as well as other foreign members. However, its activities ended in 1862 after it had produced only three books.

The Cemiyet-i İliyeye Osmaniye (Ottoman Scientific Society), founded by Münis Paşa and authorized by an imperial decree in June 1861, was rather more successful in its efforts. (113) It, too, had forty members, presided over by Sami Paşa, the First Minister of Education under Sultan Abdülmejid. According to its statutes, the aim of the Society was the writing and translation of books, the giving of general instruction and the dissemination of science in Turkey by every possible means. It had a public reading-room with foreign newspapers and a library which by 1864 contained over one thousand works. Popular courses on science were also offered, with 300-500 people attending. In addition to a few text-books, the society produced the first scientific periodical in Turkish, the Mecmuá-i Fûnûn, which introduced its readers to the language and achievements of modern science. The periodical was closed down by Sultan Abdülhamid in 1882. The efforts of the Ottoman Scientific Society were almost certainly the first systematic attempts in Ottoman Turkey to propagate and show esteem for scientific knowledge per se.
During the reign of the repressive and autocratic Abdülhamid (1876-1908), a strict censorship was imposed against Western philosophical ideas and anything which was deemed to contravene the şeriat. As a result, writers and journalists turned to science, cultural news from abroad and fiction. Several journals appeared which devoted many pages to articles on popular science.

Berkes sees a number of effects of this drive to publish articles on semi-scientific subjects. One was that reading for entertainment was established among the people; previously reading had almost always been done in a religious context. Second, the language being used was more Turkish and less Persian and Arabic, and so it was free from a religious connotation. Third, translations of French crime and adventure stories encouraged people to think more in terms of mechanistic cause and effect. Every mystery was explained in naturalistic terms. Fourth, the readers were introduced to pictures of factories, machines, harbours and bridges in the West, since the depiction of animate objects was not approved by the religious. Fifth, the achievements of scientists such as Pasteur, Helmholtz and Röntgen were described in laudatory terms, thus giving value to scientific knowledge.

However, actual acquaintance with scientific techniques and practice was only open to comparatively small numbers of Turks: those few studying in laboratories abroad, students at institutions such as the medical school, the Galatasaray Lycee and other secondary schools which possessed laboratories and scientific equipment, and students at the Darülfunun.

### 3.3.5. Science at the Darülfunun (University)

The first Darülfunun had been set up in 1863. The opening lecture - on electrical experiments in physics - was greeted with amazement by the 300 members of the audience. However, opposition from religious quarters meant that the first university did not last long. Another attempt in 1870 also ended in failure after only a year or so. After another false start in 1874, the Darülfunun did not open again until 1900.

Abdülhamid was persuaded to allow the reopening by Mehmet Said Paşa, his Grand Vezir, who explained that students who busied themselves with science and learning would not busy themselves with politics, and also that there would be no further need to send
students to Europe where they could absorb "harmful" ideas. (116)
The new Darülfünun had three faculties or departments: one of exegetics and theology, one of mathematics and natural sciences, and one of literature. During Abdülhamid's time, there were no courses on politics, sociology, philosophy or even history. Very few students were admitted. In 1903, there were 25 students studying literature, 30 studying science, and 30 studying religion. (117)
The Darülfünun had no libraries nor laboratories, and one of the first physics textbooks was an Arabic one dating back 1,000 years. (118)

The Darülfünun was reorganized during the period of the Young Turk regimes. (119) In 1908, it was moved to better quarters, and its curriculum revised to include subjects such as history, and philosophy, which had been forbidden under Abdülhamid. The number of students was increased and the fee system abolished. In 1912, Emrullah Efendi, the Minister of Education, urged that further reforms be introduced and a reform bill issued in 1912 ordered the establishment of five faculties, including one of medicine and one of science.
At the beginning of the First World War, about twenty German and Austro-Hungarian professors were invited to teach at the university, six of them in the science faculty. Libraries were set up and laboratory equipment obtained. In 1915, lectures were opened to women, with 600-700 women taking advantage of this. At about the same time, a department was set up within the university to train teachers for secondary schools and teacher-training institutes.

However, the majority of the foreign professors left at the end of the war, and in the comparatively short time they had in Istanbul, they were unable to accomplish very much of enduring value. The language barrier, the lack of co-operation between faculties, and the widely-ranging educational backgrounds of the Turkish lecturers - from medreses to European schools - made innovation difficult. The textbooks used have been estimated as being at about middle school level, while no original research papers were forthcoming. Nevertheless, laboratories were set up, including four in various branches of chemistry, and after 1917, specialists began to be trained, as opposed to merely lycée teachers. The first chemistry graduates appeared in 1920. (120)
3.3.6. **Summary of the situation with respect to the conducive factors at the foundation of the Republic.**

There may be some truth in the reason given by Ziya Gökalp for the backwardness of the Turks in science, art and philosophy, namely that a nation engaged in endless wars and living under difficult economic conditions could not spare any of its intellectual forces for such luxuries.\(^{(121)}\)

Thus it has been estimated that the Turks took part in forty-three wars between 1430 and 1941, and were at war for 61% of that period.\(^{(122)}\)

Even after 1908, Turkey was involved in four wars, including the exhausting First World War and the decimating War of Independence, which left hundreds of thousands of Turks homeless and five of the most prosperous towns in Western Anatolia burnt to the ground. It has been estimated that between 1914 and 1923, 35,000 of the country's elite lost their lives, of whom about half had a higher education.\(^{(123)}\)

Turning now to those who did survive the various wars, let us consider the group of Turks of above average intelligence who, had they been born in a scientifically developed country, could have become good research scientists. Of this group, only a small proportion—less than 3 million of the 14 million population—could read. This low figure may be attributed to the lack of importance given to non-Arabic education by the populace as a whole, the inability or unwillingness of the Ottoman Empire to provide more secular schools and the economic difficulties of a people at war, which, for many families, made education of children who could work a luxury.

Of those who could read, most of them would have been in situations of employment or circumstance which would have made the undertaking of scientific research impossible, even if they had wished to do so. This leaves the group of literates at schools and institutions of higher education.

It may be assumed that those in the religious stream of education which led to the medrese considered that secular, including scientific, knowledge was not as necessary for society as religious knowledge. In the other stream
of education, there were about 340,000 pupils in primary schools, 5,900 in middle schools and 1,250 in lycees, while 2,900 students were in institutions of higher education. These last and their 300 or so lecturers had some possibility of undertaking scientific research.

Thus many potential researchers were diverted from research at the outset by not seeing scientific knowledge as relevant knowledge (conducent I). Others were diverted at different stages of the educational ladder for the same reason, and because a primary school education was probably sufficient to obtain employment.

Of those who did go on to higher education, the majority opted for medicine, pharmacy, dentistry and law. The number of graduates by fields in the years leading up to 1924 is given below:

TABLE 3:1

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<tr>
<th>Field</th>
<th>1913</th>
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<th>1918</th>
<th>1919</th>
<th>1920</th>
<th>1921</th>
<th>1922</th>
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<tr>
<td>Medicine</td>
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<td>185</td>
<td>117</td>
<td>98</td>
<td>178</td>
<td>254</td>
<td>128</td>
<td>63</td>
<td>142</td>
<td>95</td>
<td>135</td>
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<td>7</td>
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<td>40</td>
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<td>71</td>
<td>41</td>
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<td>2</td>
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<td>14</td>
<td>33</td>
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<td>80</td>
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<td>Sciences (Fen)</td>
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<tr>
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<td>18</td>
<td>8</td>
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<td>Chemistry</td>
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<td>2</td>
<td>14</td>
<td>11</td>
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TOTAL (for university) 742 499 150 183 239 320 392 192 272 320 311

Without a detailed knowledge of the backgrounds of each of the students at the Darül İmān and at other institutions of higher education, it is not easy to ascertain the presence or absence of conceptual and methodological conducents. The very fact that they were studying at university level at all suggests that they were more Westernizers than Islamists. This would have been especially true of graduates of the Galatasaray Lycee.
and the foreign lycees.

It seems likely that in spite of the superstition which influenced life at home in many cases, the students would not have been confused by teleological explanations, but would have searched for mechanistic causes (conducents Ib and Ic). The notion of progress (Id) seems to have been widely accepted. Belief in man's ability to understand and control the natural world (Ie) probably varied with the degree of adherence to Islam. Islamists and Turkists all seemed to bend over backwards to show that science did not conflict with religious beliefs (If). With education seen largely as a means of obtaining a job in the civil service, the concept of entering a profession in which experiments needed to be done was probably an alien one (Ig). Moreover, the role of lecturer at the Darülfünon was not conceived of as a research role, except perhaps for the period when the Austro-Hungarian professors were there (conducent V).

For the most part, the presence of methodological conducents was a function of the educational system. Graduates of non-foreign schools were likely to have been taught in an authoritarian way, with memorization being put at a premium. Scepticism (IIF) was characteristic of the Westernizers; Islamists, who were more on the defensive, were probably less ready to question, with Turkists somewhere in between.

No research work was published at the Darülfünon and so there was no possibility of reward in the form of scientific recognition (III). Cognitive skills were of a low order, while only schools like Galatasaray and Robert College, founded by American Protestants, had laboratory facilities. The Darülfünon itself also had some facilities and equipment (IV and VII). Role expectations for lecturers (VII) as far as the performance of experimental research was concerned must have been low or non-existent.

What little evidence there is suggests that curiosity, creativity and independent thinking (VIII) were repressed by the authoritarian family and educational institutions. Commitments to current concepts, methods and techniques (Ih and IIg) were probably low, as the standard of textbooks was poor. However, the foreign professors may have had some influence upon this.
CHAPTER 4: THE CONDUCENTS IN REPUBLICAN TURKEY

With the proclamation of the Republic on 29th October 1923, the Turks entered a period of intensive westernization under the forceful leadership of Mustafa Kemal (Atatürk) and his colleagues. "İlim" or "science" was one of the ideological cornerstones of the new Republic. However, there were too many urgent reforms to be made before attention could be turned to the development of science as an activity in the 1930s. As necessary background to the survey in Chapter 5, this chapter will consider in some detail the development of each conducent from about 1923 until the late 1970s. Also, a full description of what science there was throughout the period will be given.

The period leading up to the beginning of the era of multi-party politics in 1946 will be considered first.

4.1 The Early Years of the Republic: 1923-1945

Prospective research scientists in the early years of the Republic can hardly fail to have been influenced by Gazi Mustafa Kemal. From 1923 until his death in 1938, Mustafa Kemal was President of the new Turkey. He was empowered to select the Prime Minister, and except for a brief period, he allowed no opposition party to the Republican People's Party he had formed. Thus he enjoyed immense power. In addition, as a brilliantly victorious general against the Greeks, he was regarded by the people as the saviour of his country. A charismatic figure, Kemal used these advantages to bring in a remarkable series of reforms which were designed to transform Turkey into a modern nation-state.

Kemal made continual reference to knowledge and science in his speeches. Before examining his attitude toward science, let us briefly consider the influences of his thinking.

4.1.1 Influences on Mustafa Kemal's thinking

According to one observer, the most powerful influence on Kemal's ideas was positivism. He is quoted as saying: "I liked Ahmet Rıza most. Auguste Comte became God in my eyes. Positivism was everything to me. I used it as the key in every thought," Later, however, Kemal said
he did not agree entirely with Riza, although he had benefited from him, Murad and Abdullah Cevdet. (3) The latter's thesis of "complete westernization" seems to have attracted him strongly, (4) while the writings of another westernizer, Tevrik Fikret, were much appreciated by him.

French writers also seem to have left their mark on Kemal's mind. At seventeen, while at the Military Training School of Monastir, he read Voltaire and Rousseau with the help of a Dominican monk. (5) Later a friend who knew French encouraged him to read Comte, Desmoulins and Montesquieu and to discuss their ideas. (6) Among the several hundred books in Kemal's personal library were some by Comte, Haeckel, Le Bon, Diderot and Durkheim. (7) Kemal's positivistic beliefs appear to be the source of many of his pronouncements about science.

4.1.2 Mustafa Kemal's pronouncements on science and on other topics relevant to the conductents

Mustafa Kemal's speeches were widely reported in the newspapers, and so they had an influence far beyond their immediate audience. They were, in effect, a vehicle for propagating the ideology of the new, secular Republic. This ideology was for "knowledge" (ilim), "science" (fen), "civilization" (medeniyet), and "logical" (mantık) ways of doing things, and opposed to "traditions" (ar' aneler) and "superstitious beliefs" (akıde ler). Thus in a remarkably short period of time, systematic western knowledge, including scientific knowledge, was elevated from its somewhat ambiguous position vis-à-vis religious knowledge in Ottoman times to official supremacy over all other forms of knowledge in the Republican era.

Perhaps Mustafa Kemal's most famous pronouncement on systematic western knowledge as the highest form of knowledge is the one which today is set into the wall of the Language, History and Geography Faculty of Ankara University overlooking one of the busiest avenues of the capital city. "Knowledge", he said in 1924, "is the truest spiritual guide (mürşit) for everything in the world, for civilization, for life and for success. To seek for any spiritual guide other than knowledge and science is naïve,
The use of the word mürisit was highly significant in that it meant the spiritual leader of an Islamic sect. Such spiritual leaders or guides were regarded by the common people as possessing a special ability to reveal divine mysteries to ordinary mortals.

The theme of knowledge and science as "truth" was repeated on other occasions. Other claims, too, were made for them. Thus, knowledge and science had guided the army to victory in the War of Independence, were the means of elevating the Turkish nation to the ranks of the civilized nations, were the necessary bases for all laws and methods of government, and were essential in effecting a cure for the social ills of the fledgling Republic. Furthermore, the latest results of science were the foundation of the new state, while science was one vehicle for bringing true peace and happiness to Turkish society. As far as religion was concerned, knowledge was the light needed to cleanse it from its errors, and the yardstick to which it had to conform.

By such pronouncements, Mustafa Kemal gave knowledge and science an almost supreme status in the new Republic. He also emphasized the need to work hard and denigrated those who did not. He firmly believed that men were the masters of their own destiny and that they could control the natural world. He stressed the need to work in a systematic logical way. He showed the need for original research rather than translation. Ancient authorities and rules, he proclaimed, had to give way to new thought-patterns because they were no longer pertinent to modern man. He linked the numbers of scientists to the progress of national development and, perhaps, widespread education.

4.1.3 Other propagators of the ideology of the Republic

The Ministers of the first governments of the Republic, for the most part, shared the positivistic ideas of Mustafa Kemal Atatürk, and were concerned to set them forth in their speeches. A contemporary observer identified three other means that were used to establish the ideas and ideals of the Republic: the school, the Press and the Türk Ocak (Turkish Hearth) Clubs, of which the school was the most important.
Chief among the propagators of the Republican ideology was İsmet Paşa (İnönü), an old friend of Kemal's who, except for a short period, was Prime Minister from 1924 until 1933. He had joined the Society of Union and Progress in 1907 and later had often met with Mustafa Kemal at his house in Istanbul. (25) His successes as a general in the War of Independence, and later at the conference table in Lausanne had made him a national hero.

Like Kemal, İsmet Paşa made great claims for science and knowledge. Thus, they were the means the Turks had used to defeat the Greeks, (26) the cure for the ills of Turkish society, (27) and the keys to national progress, (28) while their "victory" was the main aim and desire of the Republic. (29) Moreover, he stated that the Turkish nation could only become great when it made its presence felt through its scholars, scientists and specialists. (30) Hence his emphasis on increasing their numbers. (31)

İsmet Paşa also dismissed the idea that the Republican reforms were contrary to religion, (32) while he laid great stress on the need for hard work. (33) In addition to the pronouncements of the Prime Minister, there were writings and speeches by other Ministers which might have shaped the ideas of a prospective research scientist in the early years of the Republic. For example, the introduction to the Civil Code by Mahmud Esad, Minister of Justice, which was adopted in 1926, contained much anti-clerical sentiment, making reference to "obscure superstitions" and "false beliefs". "Let us not forget," it said, "that the Turkish people have resolved to accept without any reservation all the principles of modern civilization." (34) Other speakers stressed the importance of acquiring the "scientific mentality". In a speech at the official opening of the Chair of Physics and Natural Sciences at the Darülfünun, the Minister of Education, Esat, spoke of the scientific mentality causing "the present erroneous (superstitious) beliefs about natural phenomena to dry up at the roots". (35)

Similar sentiments were echoed in the Press. A professor wrote an article pointing out that the biggest different separating Turkey from Europe was the way of thinking. (36) Another writer, Sadri Etem, also wrote of the distinguishing quality of the European being his mentality, with its "logic of positive science" and its belief in "the law of cause and effect" vis-à-vis eastern fatalism. (37) The editor of a large daily newspaper
found "the greatest secret of occidental civilization" in "the method applied in Europe". (38)

At the same time, some writers were calling religion into question. The editor of the periodical Genç Düşünce (Young Thoughts) wrote an open letter to the Prophet Muhammad querying his silence in the face of open religious hypocrisy. (39) An article in Uyanış was even more explicit: "We deposed Allah with the Sultan. Our Temples are the factories." (40) Pouring scorn on obscurantists and reactionaries was also a common pastime of the revolutionary elite. A deputy for Siirt probably typified such thinking when he wrote: "There can no longer be any room left in the administration of the country for ignorant people and reactionaries. In this motherland, only knowledge, virtue and competence will reign." (41)

Meanwhile the younger generation was being coached in the ideas and ideals of the Republic in the secular schools. As early as 1921, Kemal had spoken of the need for reform in the educational system of Turkey and for the teachers to lead the new generation along "a new scientific way forward". (42) A year later, in a speech at Bursa to some teachers from Istanbul, he had made it clear that the teachers were to be the dispensers of the medicine of knowledge and science to the ailing Turkish nation: "We shall live," he said, "as a modern and civilized nation on the plane of civilization. This way of life is only possible through knowledge and science. We shall take knowledge and science from wherever they are and put them into the head of every individual in the nation. There are no restrictions or stipulations for knowledge and science. Progress is very difficult for nations which insist on holding to a whole lot of traditions and beliefs not supported by logic or evidence. Perhaps it is even impossible." (43)

Kemal made it clear that what he sought was ideological indoctrination when in 1927 he called on teachers to complete their "domination from a scientific basis" just as in the past the old teachers had "dominated from a religious basis". (44) Later, in 1933, he defined the clear aim of basic Republican policy as "the training of an indispensable, strong generation" who, amongst other things, "rely on the foundations of the positive sciences". (45)

Such challenges were eagerly taken up by the growing number of teachers
in the state schools, whom one observer has described as "Kemal's most devoted propagandists". (46)

However, Kemal did more than make speeches to propagate his reforming ideology. He took specific steps to increase its influence and to diminish the influence of opposing ideologies.

4.1.4 Measures taken to establish the ideas and ideals of the Republic

It was the religious institution which Kemal saw as the main obstacle to his programme of westernization, and he pushed through a series of measures which were designed to lower its effectiveness. These included the abolition of the Caliphate, the office of the Seyh-ül-İslâm, and the special şeriat courts (1924), the replacement of the Ministry of Religious Affairs and Pious Foundations by a Directorate-General of Pious Foundations and a Presidency for Religious Affairs directly responsible to the Prime Minister's office (1924), the suppression of religious orders, the closing of dervish meeting places, and the outlawing of the fez (1925). (47) Then followed the adoption of the international calendar and system of time (1925), the replacement of Islamic laws by laws adapted from western civil criminal and commercial law codes (1926), the removal of the article from the constitution declaring Islam to be the state religion (1928), the adoption of the international numbering system (1928), and the declaration of Sunday as a day of rest instead of Friday (1935).

Two reforms had a direct effect upon education: the closure of the separate religious schools and medreses to create a unified, national system of education (1924), and the introduction of the Latin alphabet to replace the cumbersome Arabic one (1928). The first of these meant that all schools were now responsible to the Republican Ministry of Education, which had the power to change curricula and textbooks.

The first change in school curricula came in 1924 after a committee of forty-three had met to consider which lessons did or did not conform to the principles of the Republic. Lessons or textbooks which did not were either removed from the curricula or modified accordingly. (48) Religious instruction was gradually phased out. In the primary schools, from two hours a week for 2nd - 5th formers in 1924, it dropped to one hour a week for 3rd-5th formers in 1926, and then to half an hour a week for 5th formers (3rd formers in villages) in 1930 - and then only at the
parents' request. No time for religious instruction was allotted in the 1924 lycee curriculum, and the one or two hours a week in the 1924 middle school curriculum were removed in 1930. Arabic and Farsi lessons were removed from the lycee curriculum in 1929 on the grounds of the changeover to the Latin script. (49) Significantly, a directive to teachers issued by the Ministry of Education in 1926 said: "As the opportunity arises, erroneous ideas and wrong opinions made out to be religious in nature are to be refuted." (50)

The content of religious instruction was also brought more into line with the ethos of the Republic. After a study of İslam Dini (The Religion of Islam) by Yusuf Ziya, which was the only religious textbook for middle and normal schools approved by the Ministry of Public Instruction for the year 1929-30, Allen noted eight "novel emphases in the light of Islam's recent history". These were self-reliance and hard work, thrift in time and money, progressive adaptation to new conditions, encouragement of intelligence and science, stress on the practical as opposed to the theoretical, tolerance, good health, and patriotism. (51) Moreover, Ziya maintained that Islam was "a religion based on reason... False ideas and superstitions which are rejected by reason are also repudiated by Islam." (52) A textbook on sociology by Mehmed İzzet also stressed that true religion was an affair of the conscience which had to develop "in harmony with the present-day conditions of civilization and science". (53)

Similar themes were to be found in a book of sermons issued in 1927 for use in mosques by the Presidency for Religious Affairs. (54) In one sermon included in the book, a preacher at the largest mosque in Ankara told his listeners that the Prophet Muhammed had given great importance to science, and he enjoined them to master it and not to despise it because it came from non-Muslims. (55) Another book written some years later by the Assistant President for Religious Affairs stated categorically that there was no conflict between true religion and science, and that religious truth conformed to reason. (56)

Not content with changing the presentation of Islam in school textbooks, in 1928 the new régime set up a committee to reform religious life "on scientific lines". (57) The committee, under the chairmanship of Prof. Fuad Koprülüzade, was appointed by the Faculty of Divinity at the Darülfünun, a faculty set up after the closure of the old Süleymaniye
medrese. However, only one of its recommendations, the Turkification of the call to prayer, was implemented. Nevertheless, the wide publicity given to the legitimation it gave for its task can only have reinforced the prevailing belief in educated circles that science was the final arbiter of truth. The Faculty of Divinity itself was quietly run down and closed in 1933.

Another measure taken by Kemal and his colleagues to curtail the influence of opposing ideologies and ideologues was the closure of the Darülfünun in 1932. Many of the professors had been opposed to Kemal's reforms, including the Latinization of the alphabet. After a complete reorganization, the university was re-opened in 1933 as the University of Istanbul (see below, pp.175 ff.).

The introduction of the Latin alphabet in December 1928 had two significant effects. First, it tended to cut off the Turks from their Ottoman-Islamic past. Second, it made it a great deal easier for the Turkish people to learn how to read and write. Not only was the Arabic script itself difficult to learn, but the script could not suitably represent some of the sounds of the rather different Turkish language. Thus, when the phonetic Latin script was introduced, most Turks who wanted to acquire reading and writing skills were able to do so in a few months instead of over several years. The adoption of the new script was accompanied by a concerted literacy drive with Mustafa Kemal in the forefront.

In 1930, two events occurred which showed the architects of the Republic that it had been built largely over the heads of the common people. An opposition party, the Free Republican Party, the founding of which had initially been permitted by Kemal, rapidly attracted a large number of anti-government protesters, and had to be closed down. Then a reserve officer and ex-teacher called Kubilay was beheaded at Menemen, near Izmir, when he tried to prevent a local dervish leader from publicly attacking the regime.

The first move to take the reforms to the people came the following year when the Türk Ocakları (Turkish Hearth Clubs) were closed down, and their property transferred to the Republican People's Party. The Hearth Clubs had been founded in 1912 with the aim of arousing a greater cultural awareness and unity amongst Turks, but in later years had adopted Ziya
Gökalp's view that Westernization was possible without encroaching upon certain areas of Turkish life, including religion. In February, 1932, fourteen former Hearth Clubs were opened to the public as Halkevleri (People's Houses). The Houses were described by İsmet İnönü as "the means of realizing the R.P.P.'s cultural policy of propagating knowledge, science and the fine arts". (60)

A People's House had up to nine sections, including drama, sports and library sections. The illiterate were especially catered for, with classes on reading and writing. The organizers were supposed to be Party members or government officials, who were to ensure that all the activities were in line with the nationalist-modernizing principles of the Republic. Thus, the plays and literary works sponsored by the Houses had to meet several criteria which included "promoting love of nation and country", "strengthening enthusiasm for reforms" and "focusing attention on the ugliness and ridiculousness of bad traditions". (61)

The number of Houses increased rapidly from 55 with 33,625 members (mostly civil servants) in 1933 to 379 with 100,000 members in 1940, of whom 17,000 were civil servants, 10,000 were teachers and 27,000 were farmers and agricultural workers. (62) By 1951 when they were closed down by the Democrat Party, there were 478 Houses, mostly in provincial capitals.

In 1939, the R.P.P. Council decided to extend the scheme into the villages, with the establishment of Halkodalari (People's Rooms). From 141 in 1940, the number rose to 4,322 in 1950. Similar activities to those in the Houses were undertaken. The Room Chairman was a Party member or government official, while those responsible for the activities were people such as ex-soldiers, teachers and students who had links with the world outside the villages. In this way, it was hoped that the gap between the villager and the educated would be bridged.

However, although the educative influence of the People's Houses and Rooms was probably considerable, a prospective research scientist was more likely to be found in the conventional educational system, which in the meantime had been expanding at a steady rate.
4.1.5 Expansion of and changes in the educational system

The importance given by Kemal to education was reflected in the programmes of successive governments in the early years of the Republic. Even in 1920, the then Minister of Education, Dr. Riza Nur Efendi had spoken of the various aims of the nationalist government in the sphere of education, including the re-establishing of schools and curricula along scientific (ilmi) and modern lines, the preparation of scholarly (ilmi) textbooks, and the translation into Turkish of scientific and technical works from the East and the West. The 1923 government under Fethi bey gave three of the twenty-two pages of its programme to educational matters. In his government programme of 1928, Ismet Paşa singled out primary education as a top priority, but in the programmes of 1930 and 1931 in the wake of the depression, he emphasized the need to educate a maximum number of people with the minimum of expense.

Later governments had similar ambitions. In 1939 Dr. Refik Saydam dwelt on the importance of a good primary education as well as on the necessity of meeting the needs of the country for scientific, trade and technical personnel. The 1943 government of Şükrü Saraçoğlu boasted that it had given the greatest increase in the budget to education, while in 1946, Recep Peker's government promised to concentrate on increasing the number of schools in the villages. (63)

The manifesto of the Republican People's Party, which had been founded by Kemal in 1923, and which was the only party permitted to exist for any length of time, reiterated the dedication of the new state to the propagation of secular knowledge. Article 42A stated: "The foundation stone of our educational policy is the elimination of ignorance." (64) The word used for ignorance was bilimsizlik, which literally meant "the absence of scientific knowledge".

In practice, the percentage of the total budget allocated to education between 1925 and 1940 varied between 3.6% and 6.3%. Figures for selected years are given below:

163
The total budget for 1925 was close to 184 million TL, and that for 1940 about 268 million TL.\( ^{(65)} \)

This investment in education resulted in a great increase in the number of schools, teachers and pupils. Figures for the years between 1925 and 1945 are given below.\( ^{(66)} \)

**TABLE 4.2**

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of primary schools</th>
<th>No. of teachers</th>
<th>No. of pupils</th>
</tr>
</thead>
<tbody>
<tr>
<td>1925-26</td>
<td>5,975</td>
<td>14,309</td>
<td>406,788 (92,895 girls)</td>
</tr>
<tr>
<td>1930-31</td>
<td>6,598</td>
<td>16,318</td>
<td>489,299 (174,227 )</td>
</tr>
<tr>
<td>1935-36</td>
<td>6,275</td>
<td>14,949</td>
<td>688,100 (233,974 )</td>
</tr>
<tr>
<td>1940-41</td>
<td>10,596</td>
<td>20,565</td>
<td>955,856 (294,677 )</td>
</tr>
<tr>
<td>1945-46</td>
<td>14,010</td>
<td>27,317</td>
<td>1,357,740 (491,880 )</td>
</tr>
</tbody>
</table>

**TABLE 4.3**

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of middle schools</th>
<th>No. of teachers</th>
<th>No. of pupils</th>
</tr>
</thead>
<tbody>
<tr>
<td>1925-26</td>
<td>68</td>
<td>760</td>
<td>11,622 (2,705 girls )</td>
</tr>
<tr>
<td>1930-31</td>
<td>83</td>
<td>1,068</td>
<td>27,093 (6,945 )</td>
</tr>
<tr>
<td>1935-36</td>
<td>191*</td>
<td>2,403</td>
<td>52,496 (13,942 )</td>
</tr>
<tr>
<td>1940-41</td>
<td>234</td>
<td>3,867</td>
<td>95,332 (26,235 )</td>
</tr>
<tr>
<td>1945-46</td>
<td>252</td>
<td>3,931</td>
<td>65,608 (19,534 )</td>
</tr>
</tbody>
</table>

* The number is inflated by about 70, because, in this year the middle school sections of joint lycee-middle schools began to be counted as separate schools.
The number of technical and vocational schools did not rise significantly until 1938, when Hasan Ali Yücel became Minister of Education. Such schools were financially dependent upon local agencies until the early 1930's and these agencies cut off funds during the depression. It was only in 1935 that the government accepted financial responsibility for technical and vocational schools, the number of which rose from 60 with 9,000 students in 1930 to 87 with 19,000 students in 1940.

The enormous increase in the number of primary schools from 6,700 in 1937 to 10,600 in 1940 was a result of the efforts of a far-sighted educationalist, İsmail Hakkı Tonguç. In 1935, as acting director of Primary Education in the Ministry of Education, he prepared a report for İnönü showing that rural education in Turkey was in a very sorry state. Out of 40,000 villages, only about 5,000 had schools and of these 80% had only one teacher. Armed with such statistics, Tonguç persuaded the deputies in the Grand National Assembly to pass a law whereby rural youths who had completed their military training as non-commissioned officers could become eğitmen (instructors) in their villages after a year's intensive training. By the 1945-46 academic year, over 6,200 eğitmen were teaching 210,000 students. The training courses were terminated in 1947.

More traditional teacher-training colleges were also opened, including the Gazi Middle School Teacher-Training Institute in Ankara in 1929.

In addition to the ordinary state schools, there were schools where most of the instruction was in a foreign language, either administered by Turks, such as the Galatasaray Lycee or by foreigners. In 1927-28, there were 36 French schools, 17 Italian, 8 American, 5 Bulgarian, 3 English, 2 Austrian, 1 German and 1 Yugoslav school. These schools had all been brought under.

### TABLE 4.4

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of middle schools</th>
<th>No. of lycées</th>
<th>No. of pupils</th>
</tr>
</thead>
<tbody>
<tr>
<td>1925-26</td>
<td>21</td>
<td>671</td>
<td>2,748 (825 girls)</td>
</tr>
<tr>
<td>1930-31</td>
<td>22</td>
<td>637</td>
<td>5,699 (1,366 )</td>
</tr>
<tr>
<td>1935-36</td>
<td>65</td>
<td>1,029</td>
<td>13,876 (2,999 )</td>
</tr>
<tr>
<td>1940-41</td>
<td>82</td>
<td>1,544</td>
<td>24,862 (5,981 )</td>
</tr>
<tr>
<td>1945-46</td>
<td>83</td>
<td>1,817</td>
<td>25,515 (5,104 )</td>
</tr>
</tbody>
</table>

The number of technical and vocational schools did not rise significantly until 1938, when Hasan Ali Yücel became Minister of Education. Such schools were financially dependent upon local agencies until the early 1930's and these agencies cut off funds during the depression. It was only in 1935 that the government accepted financial responsibility for technical and vocational schools, the number of which rose from 60 with 9,000 students in 1930 to 87 with 19,000 students in 1940.
the aegis of the Ministry of Education in 1924, and had more or less the same curricula as the equivalent state schools. However, most of them had foreign teachers and were better equipped than the state schools. Thus, increasingly they began to be favoured by Muslim Turks, who in Abdülhamid's day had been forbidden to attend them. For example, the number of Muslim Turks in the American schools rose from 257 out of 836 pupils in 7 schools in 1923 to 919 out of 1,257 pupils in 9 schools in 1927.\(^{(69)}\)

The overall increase in the numbers of schools and teachers in the Republic combined with the literacy drive following the alphabet reform resulted in an increase in the literacy rate from 11% of 13.6 million in 1927 to 29% of 18.8 million in 1945.\(^{(70)}\)

However, all was not well with the educational system.

4.1.6 **Shortcomings in the educational system**

Başgöz and Wilson have noted a number of problems in the Turkish educational system in the first seventeen years of the Republic.\(^{(71)}\) Many of these stemmed from lack of finance. Thus schools, teachers, books and libraries were all in short supply. Many villagers could not afford to send their children to middle schools, which were usually only found in the towns. The numbers of girls given even a primary education were very low. In general, support for non-religious schools at a local level were not forthcoming. This was especially true in provinces in eastern and southeastern Turkey, where according to the 1940 census, the percentage of village children who had never attended school was more than 90% as compared with about 40% for villagers in western Turkey.\(^{(72)}\) Furthermore, the Ministry of Education was too understaffed and occupied with day to day affairs to seek solutions to such problems until the second half of the 1930's.

One indicator, and probably a contributory cause, of malaise in the educational system, was the large number of dropouts and repeaters. For example, out of 100 students who started middle school in 1935, only 55 graduated within three years; 45 of these went on to lycée, of whom only 15 passed their final exams within three years. Figures for other years show similar attrition rates.\(^{(73)}\)
There were also dropouts among the teachers. Although many of them were in the vanguard of the Turkish Revolution and enthusiastically set off for far corners of Anatolia to propagate its ideas and ideals, some were to become disillusioned in such a way that between 1930 and 1938, 8,000 teachers left the profession. (74)

Akyüz has identified a number of factors which limited the effectiveness and morale of teachers in the early years of the Republic, especially in rural areas. (75) For one thing most teachers had nothing in common with the villagers amongst whom they had to live. Moreover, what they had to teach was almost totally irrelevant to village life. Hence the average villager could see no point in educating his children, especially since while they were at school they could not work for him in the fields or around the house. Furthermore, school buildings were often quite inadequate or even non-existent, as were books and other materials. Very few village schools had more than one teacher, who consequently had to teach up to five "classes" at the same time.

The isolation and poor living conditions were not compensated by high salaries. (76) Although both John Dewey and the German educationalist Kühne, who had been invited by Kemal to report on the educational system in 1924 and 1925 respectively, had both advocated an immediate and large increase in teachers' salaries, the government merely responded by raising salaries in relatively small increments in 1926, 1929, 1930 and 1939, none of which really kept pace with the rate of inflation. The world-wide economic crisis of the early 1930's did not permit governments to be generous.

Another factor which made the teaching profession unattractive was a practice which continues to this day. (77) Teachers could be posted from one corner of Anatolia to another at the caprice of their superiors in the Ministry of Education. This did not contribute to high morale in the profession or continuity in the schools. (78) It also probably discouraged many potential teachers from entering the teaching profession.

Those who did become teachers were often inadequately trained. The importance given to abiding by the book and to rote-memorization in the teacher-training colleges meant that teachers held similar values once they themselves started teaching. Even physics, chemistry and nature
study were taught in a theoretical way from books, with little or no practical instruction. (79)

Creative thinking and consideration of alternatives were not encouraged by the practice of a single book being used for the same lesson throughout Turkey. Thus, the lycee textbook on sociology was based entirely on Durkheim's approach, without any consideration of other schools of sociology.

Despite the shortcomings of the educational system, scientific instruction had come to occupy an important place in the various curricula.

4.1.7 Science teaching in schools

The changeover to the Latin script at the end of 1928 meant that not only were the Turks cut off from their Ottoman-Islamic past, but also that all school textbooks had to be printed in the new script. This gave the Republican regime an opportunity to revise the school curricula. Mustafa Kemal himself took a personal interest in the content of the new curricula and read through the new textbooks. (81) He also supervised the writing of a textbook called Medeni Bilgiler (Civilized Knowledge), published in 1931 under the name of Afet İnan, one of his young proteges. This book was used in a lesson entitled Yurt Bilgisi (Knowledge about Our Country), which was taught at both primary and secondary levels.

Other lessons at middle schools and lycees included Turkish Language, History, Sociology, Geography, Philosophy and Science. The amount of time allotted to science at secondary schools and teacher-training schools rose from about 10% prior to 1924 to about 20% from 1924 onwards, which reflected the importance given to science teaching by the Republican government. The percentages of the total teaching time devoted to science in secondary schools and teacher-training schools for various years are given below: (82)

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<tr>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lycee (sc.stream) + middle school</td>
<td>23.0</td>
<td>18.2</td>
<td>23.0</td>
<td>21.8</td>
<td>18.8</td>
<td>20.8</td>
<td>21.4</td>
<td></td>
</tr>
<tr>
<td>Lycee (literature stream) + middle school</td>
<td>19.0</td>
<td>16.7</td>
<td>21.3</td>
<td>20.6</td>
<td>17.0</td>
<td>19.3</td>
<td>17.7</td>
<td></td>
</tr>
<tr>
<td>Teacher training school</td>
<td>15.0</td>
<td>11.8</td>
<td>19.1</td>
<td>N.A.</td>
<td>13.4</td>
<td>N.A.</td>
<td>15.3</td>
<td></td>
</tr>
<tr>
<td>N.A. = Not available</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The need for new textbooks for science was met with the publication in 1929 of a series of handbooks on chemistry, physics, geology and botany written by a group of science teachers attached to the Ministry of Education. In 1931, physics and chemistry in middle schools were combined and a new textbook entitled Fen Bilgisi (Science Knowledge) was prepared. This was adapted from textbooks of American origin. The subject-matter was designed to show students the importance of science and technology in national development, as well as how they themselves could lead healthier lives. Topics dealt with included "How to Obtain Good Food", "How to Remain Energetic and Health", "Selecting and Taking Care of Our Clothing", "The Nature and Control of Fire", "Making Use of Air and Water Power", and "Communicating with Our Neighbours".

In 1937, in response to pressure from basic science-oriented educationalists, the science curricula were changed again. Physics and chemistry were once more taught as separate subjects, following a simple-to-complex approach. There was to be little subsequent change in school science curricula until the mid-1960's, even though textbooks were supposed to be changed every three years.

Information on scientific and related topics was further disseminated through more general books published by the government.

4.1.8 Books on science and related topics

Between 1928 and 1938, over 16,000 books were published in Turkey, with 7,445 published by government departments and offices, and 8,618 by commercial publishing houses. There was a steady increase in the number of new books appearing each year, such that 55% more books were published between 1934 and 1938 than between 1928 and 1933. The reasons for this increase given by the National Bibliography were the greater desire of the population for reading matter; more attractive formats; the influence of the People's Houses, with their libraries and publications; the greater number of publications from government departments, especially the Ministry of Education; the stimulus given by various Ministries buying up books published by commercial publishing houses; and the printing projects undertaken by the Turkish History and Language Institutes.

The 7,445 government publications are broken down in the National
Bibliography under the following subject headings. Corresponding numbers of non-government publications are in parentheses. (87)

TABLE 4.6

Social sciences, including laws and statistics: 4,401 (2,123)
Applied sciences, including medical and agricultural works: 1,275 (1,547)
"Theoretical Sciences", including mathematics: 447 (382)
History: 635 (851)
Literature: 195 (2,439)
Fine arts: 184 (197)
Philology: 154 (464)
General works: 86 (250)
Philosophy: 49 (124)
Religion: 19 (231)

Government publications on scientific subjects are well represented, while those on religion are not. The books on scientific subjects, mostly school books, included books on the following:

TABLE 4.7

Geology: 84 (26)
Physics and mechanics: 64 (33)
Chemistry: 48 (44)
Biology and anthropology: 35 (18)
Fen bilgisi (textbooks): 20 (48)
Botany: 19 (10)
Veterinary science: 10 (28)

In absolute terms, the numbers of books on scientific subjects were still very small, especially since many of them were different editions of the same textbook. Nevertheless, the fact that 23% of the books issuing from government sources were on applied or "theoretical" sciences suggests a deliberate trend.
4.1.9 The founding of research institutes (88)

The Republic inherited only two research establishments outside the Darülfünun which were to continue functioning for any length of time. One was the Kandilli Observatory near Istanbul, which had been founded in 1911; the other was a veterinary institute at Pendik, also near Istanbul, founded in 1915.

Even in 1921 during the War of Independence, another veterinary research institute had been set up at Etlik, just outside Ankara. In the years which followed, the Republican government was to give priority to animal husbandry and agriculture. Thus in 1924, an animal breeding station was opened at Bilecik, a cotton research institute in the fertile Çukurova plain, and a tea research institute on the Black Sea coast. Agricultural research institutes were built at Eskişehir and at Sakarya in 1926 and near Ankara in 1927, while an animal husbandry institute was established in Malatya in 1929.

In the 1930's and early 1940's, both general and more specialized research institutes were set up, again mainly in the spheres of agriculture and animal husbandry. Animal husbandry research institutes were built in Tekirdağ (1930), Eskişehir (1934), Ceyhan (1934), Konya (1936), Kars (1936), Tokat (1938), Antalya (1942) and Bursa (1943). Regional agricultural research institutes were set up near Istanbul (1936), Malatya (1937), Gaziantep (1938) and Samsun (1944). More specialized establishments included those concerned with research on viniculture (Manisa and Tekirdağ, 1930), plant protection (Adana and Izmir, 1931, and Ankara, 1935), cotton (Nazilli, 1934 and Manisa, 1944), citrus fruits (Antalya, 1934) hazelnuts (Giresun, 1936), olives (Izmir, 1937), figs (Aydın, 1938) and poultry (Ankara, 1930 and Aydin, 1938). The emphasis on agricultural research may have been inspired by the example of Mustafa Kemal, who had set up a model farm just outside the capital, in which he took a regular personal interest.

A Central Institute of Hygiene was also set up in Ankara in 1928, but its duties consisted more of routine testing than of research.

The most important research institute founded at that period was the Mineral Research and Exploration Institute of Turkey. This was formed in 1935 with the aim of systematically exploring and exploiting Turkey's mineral
deposits using modern geological and mining techniques. It grew rapidly from a staff of 33 and a budget of 640 thousand TL in 1935 to a staff of 255 and a budget of 3.8 million TL in 1944. By 1974, there were 3,700 geologists, engineers, technicians and administrative staff employed at the Institute, and its budget exceeded 479.5 million TL. Its duties now include geological mapping, feasibility studies and chemical analysis, besides mineral exploration work and other geological investigations.

The commitment to scientific research by governments in the early years of the Republic has to be seen against the background of the depression and the lack of trained personnel available to undertake research.

4.1.10 The training of specialist personnel abroad

In order to meet the needs of specialist personnel in various fields, the Republican government passed Law No. 1416 in April, 1929 which allowed students to obtain their education abroad, either at government expense or their own. The preamble to the law emphasized that one of its aims was that education obtained abroad should be in fields which would meet the true needs of society. (89) Students were to be carefully selected. The government is reported to have made plans to send 33 students to Europe in 1931, of whom 3 were to study physics and chemistry, 6 hydrography, 3 forestry, 4 veterinary science and 10 various types of engineering. (90) Yücel gives much higher figures; probably because he included students who were educated abroad at their own expense. Thus, he states that in the academic year 1935-36, there were 28 students abroad studying physics and chemistry, 33 studying mathematics and 14 natural history out of a total of 270 students. The Statistical Yearbook gives the total as 224 students. (91)

If the above sets of figures are true, they reflect the concern of the Republican government to train specialists in natural science and engineering, and also the desire of the people to train themselves in such fields at their own expense.

In 1943, another Law, No. 4489, was passed which permitted civil servants to take up to five years paid or unpaid leave in order to study abroad. The preamble to this law emphasized the need for advances in scholarship,
science and the arts to be followed closely where they were being made, and it admitted that this need was not being met by Law No. 1416. Several university lecturers and civil servants seem to have taken advantage of the law in order to obtain higher degrees. (92)

The number of students who had obtained Ph.D. degrees abroad in the natural sciences and related subjects began to rise fairly rapidly in the early 1930's. (93) Before 1930, there had been only four Ph.D.s in these areas, three of them in chemistry (1885 at Bern, 1917 at Munich and 1919 at Berlin) and one in mathematics (1919 at Erlangen). However, in the 1930's, Ph.D. degrees were obtained in the following subjects:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry</td>
<td>1932 (4), 1933</td>
</tr>
<tr>
<td>Physics</td>
<td>1930, 1931</td>
</tr>
<tr>
<td>Mathematics</td>
<td>1936 (3)</td>
</tr>
<tr>
<td>Astronomy</td>
<td>1934</td>
</tr>
<tr>
<td>Botany</td>
<td>1933</td>
</tr>
<tr>
<td>Zoology</td>
<td>1932, 1935, 1936</td>
</tr>
<tr>
<td>Geology</td>
<td>1932, 1933, 1938</td>
</tr>
</tbody>
</table>

Thus the number of Ph.D. degrees obtained abroad during the 1930's was 18, of which 14 were obtained at German universities and 4 at French universities.

4.1.11 Scientific instruction in the Darülfünun

The Darülfünun had experienced a reform in 1915, after which German and Austro-Hungarian professors had been invited to take up posts there. Among them were three Germans, Dr. Fritz Arndt, Dr. Hoesch and Dr. Fester, who began to teach Inorganic, Organic and Industrial Chemistry respectively. Arndt was instrumental in setting up a General Chemistry Institute in 1917, but left for his old university at Breslau, a year later, to be followed by Hoesch and Fester. (94)

Other foreigners also took up appointments in the Faculty of Science at the Darülfünun until it was reformed in 1933. These included Prof. Faillelin who taught Physical Chemistry from 1926 to 1930, Prof. Gabriel Valensi.
who taught Industrial Chemistry from 1931 to 1933, and Prof. Marcel Cau from Lille University who was Head of the Chair of Physics from 1929 to 1932. (95)

From 1923 until 1932, the Chemistry Institute was organized as a subsection of the Faculty of Science, with Chairs in Organic, Inorganic, Analytic and Industrial Chemistry, and Biochemistry. A three-year course lead to a Kinyager (Chemist) degree.

In 1924, the Faculty of Science began publishing a faculty journal, the Darülfünun Fen Fakültesi Mecmuası, which came out thereafter every three months, and which contained articles of general interest such as "Axioms of Classical Mechanics" rather than research papers.

Lecturers in the Science Faculty seem to have been concerned to educate a wider audience than merely their own students. Thus Refik (Penmen) a lecturer in electrical engineering, put out a magazine called Fen Alemi (Science World), which contained articles on science in a popular vein. Also, in 1931, three physics lecturers in the Faculty and a physics teacher at Istanbul Girls' Lycee founded the Turkish Physics Society, which put out six issues of a magazine over the next two years with some help from the Ministry of Education. The Society was not able to continue, however, and a second Physics Society was not formed until 1950. (96)

The numbers of students who graduated from the Darülfünun in various fields from 1926 until 1932 are given below: (97)

| TABLE 4.9 |
|---|---|---|---|---|---|---|---|
| Faculty/Section | 1925 | 1926 | 1927 | 1928 | 1929 | 1930 | 1931 | TOTAL for period |
| Faculty of Medicine: | | | | | | | | |
| Medicine | 75 | 52 | 65 | 56 | 82 | 47 | 74 | 451 |
| Pharmacy | 108 | 66 | 23 | 17 | 13 | 24 | 12 | 263 |
| Dentistry | 113 | 85 | 34 | 19 | 24 | 25 | 38 | 316 |
| Faculty of Law: | 59 | 52 | 152 | 70 | 89 | 127 | 121 | 670 |

continued over
### TABLE 4.9 contd.

<table>
<thead>
<tr>
<th>Faculty/Section</th>
<th>1925</th>
<th>1926</th>
<th>1927</th>
<th>1928</th>
<th>1929</th>
<th>1930</th>
<th>1931</th>
<th>TOTAL for period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty of Science:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science (Fen)</td>
<td>3</td>
<td>7</td>
<td>8</td>
<td>7</td>
<td>8</td>
<td>7</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>Physical Chemistry</td>
<td>-4</td>
<td>-2</td>
<td>-2</td>
<td>-3</td>
<td>2</td>
<td>2</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Mechanics, Electricity</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>Natural Sciences (Tabiî Ilimler)</td>
<td>3</td>
<td>6</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Mathematics</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>7</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Chemistry</td>
<td>16</td>
<td>9</td>
<td>18</td>
<td>20</td>
<td>15</td>
<td>8</td>
<td>23</td>
<td>109</td>
</tr>
</tbody>
</table>

(TOTAL for University 398 292 328 257 262 283 326 2146)

Thus in the seven years between 1925 and 1931, there were 216 graduates of the Faculty of Science, about 10% of the total number for the university. Of these 216, over half were chemists.

From the outset, the Republican government had respected the autonomy of the Darûlfûnun and had not subjected it to any reform. The government had also supported it financially, in 1923 even by increasing the professors' salaries. However, as the years went by it became increasingly apparent that the Darûlfûnun was remaining an island of obscurantism in the mainstream of the Turkish Revolution. Many of the professors actively or passively opposed some of the Kemalist reforms, including the alphabet reform. Consequently, by 1931 the R.P.P. had passed a resolution at its annual congress that the Darûlfûnun be reformed. Matters came to a head in 1932 at the First General Congress of the Turkish History Society when several professors criticized two theories strongly favoured by Mustafa Kemal concerning the origins of the Turkish people and of the Turkish language. There was a chorus of protest in the Press and Kemal himself made a critical inspection of the university.

A Swiss professor, Albert Malche, was then asked to make a report on the state of the Darûlfûnun and to offer suggestions for its improvement. In 1933, he spent four months investigating the academic records of the professors, the curricula, and the library and other facilities. Malche's report was almost uniformly negative. (98)

His main criticisms were that the lecturers were merely presenting students
with lists of facts to memorize instead of encouraging them to be creative and to study on their own, that little or no original research was being undertaken, that there were no original Turkish textbooks and no reference books in Turkish at all outside the standard texts, that the library was poor, that the students did not know a foreign language, and that in general, the content of the courses had no relation to the world outside the university. Moreover, academic appointments were based more on loyalty to various cliques rather than on academic ability.

The solution was drastic: to reappoint only those lecturers who had a recognizable academic standing. A questionnaire was sent to each lecturer enquiring about his education and specialist training, whether or not he had worked abroad, the numbers of his original publications and translations, and his knowledge of foreign languages. A committee met under the chairmanship of Malche to study the replies and to decide who should be taken on.

A large number of lecturers were not reappointed. In all, the holders of 157 posts out of a total of 193 were retired early or transferred to other posts. These included thirteen lecturers from the Faculty of Science. The academic credentials of a high proportion of the lecturers in the Darülfünun were thereby called into question.

It was not easy to find replacements for those who had been dismissed. However, just at that time, a number of German professors with Jewish backgrounds were in the process of escaping from Hitler, and were invited to take up posts at the new university. Most of them already had international reputations. The plan was for them eventually to give their lessons in Turkish and to train Turkish lecturers who would take over from them.

The establishment of the new university was authorized by Act of Parliament. In line with Kemalist policy, the university would be known as Istanbul Üniversitesi, incorporating the Western rather than the Arabic title. Appointments to the Rectorship and to professorships had to be approved by the Ministry of Education, which kept the university under fairly close scrutiny.
4.1.12 Scientific instruction and research in the new University of Istanbul

The University of Istanbul was opened on 18th August, 1933. At the opening ceremony, Dr. Reşit Galip, the Minister of Education, said: "Today we are moving one step forward along a shining road leading to a future which I am absolutely sure will be full of honours, scientific successes and glorious discoveries." He went on to say how the government had spared no expense to obtain the best personnel and equipment, to the extent of allocating nearly 1% of the national budget.

The total number of teaching staff had increased to 323 from the 193 of the last year of the Darülfünnun. These included 36 foreign professors and 15 foreign associate professors, most of whom were Germans. In the Faculty of Science, two physics institutes, General Physics and Experimental Physics, and three chemistry institutes were set up, all headed by foreigners. Prof. F. Arndt was head of the General Chemistry Institute, Prof. O. Herzog of the Industrial Chemistry Institute, and Prof. G. Valensi of the Physical Chemistry Institute. The number of students in the Faculty was 1,065.

The University expanded steadily over the next few years. By 1942, the number of teaching staff had increased to 526, of whom 39 were foreign professors. Sixteen new buildings, including Biology and Astronomy Institutes, had been erected at a cost of nearly two million lira. The number of institutes in the Faculty of Science had increased to fourteen, and the number in the Faculty of Medicine to twelve. Over one million lira's worth of apparatus and equipment had been brought from Europe, while nearly 180,000 TL had been spent on new books, including 16,000 books on scientific topics. The number of students studying in the Faculty of Science had risen to 2,864 out of 9,700 in the university as a whole. It was the largest faculty, the Faculty of Medicine being second-largest, with 2,523 students. Of the 5,186 students who had graduated by 1942, 753 of them were from the Faculty of Science. This compared with 525 science graduates between 1903 and 1933. In all, 3.7 million lira had been spent on the university.

Publications included 175 by the university and another 100 by commercial publishing-houses. 400 translations of foreign works had also been
undertaken, while several faculties had started their own journals. These included the Faculties of Science and Medicine which had already published 1,670 and 2,540 pages respectively. The *Revue de la Faculté des Sciences de l'Université d'Istanbul* published twenty-five research articles on topics in physics, for example, up to 1943, nineteen of which were written by foreigners, and two jointly by a foreigner and a Turk.

The amount of research performed was hampered by the language barrier between the German professors and their Turkish assistants, and by the comparatively short stays of some of the former. However, a small number of research groups were formed over the period. These included the one led by Prof. H. Dember, who worked on the crystal photoelectric effect (1937-1944), those established by Prof. M. Fouché, who worked on acoustic waves in various resonators (1939-1964), and those supervised by Prof. F. L. Breusch who worked on the synthesis of organic chemicals (1939-1971).

The first Ph.D. degrees to be obtained at Istanbul University were two in astronomy in 1937, two in botany in 1938 and one in geology in the same year. No Ph.D. degrees within Turkey are recorded during the 1930's for chemistry, mathematics or zoology. The lack of research was explained by a lecturer at the First Education Convention (*Şura*) in July 1939 as being due to the absence of a scientific milieu and to the poor salaries of research assistants and dozents. The latter reason was questioned by some delegates but supported by others.

4.1.13 *Scientific research and instruction in other centres*

Meanwhile, in another part of Istanbul, technical instruction was being given in the *Yüksek Mühendis Mektebi* (The Higher Civil Engineering School). This had started out in 1884 as the *Hendese-i Mülkiye* (Civil Engineering School), and then had changed its name when it had been transferred to the Ministry of Public Works in 1909. It had remained attached to the same ministry under the Republic. In 1928, chairs of roads and railways, hydraulics, construction and architecture were founded. With the reform of the Darülşifa, the Electricity and Mechanics Institute of the latter was transferred to the Engineering School in 1934, while a year later chairs of architecture and communications were established. In 1941, the name of the Engineering School was changed to the *Yüksek Mühendis Okulu* and it was placed under the jurisdiction of the Ministry of Public Education.
Chairs in aerodynamics and shipbuilding engineering were set up in 1941 and 1943.

The number of students rose from 83 in 1923 to 322 in 1930 and 609 in 1941. Between 1923 and 1941, over 530 students graduated as engineers. (105)

In 1944, a law was passed establishing Istanbul Technical University in place of the Higher Civil Engineering School. The preamble to the law explained that what differentiated a technical university from a professional school was the performance of scientific research, and that if research were not continually performed, in the long-term the standard of any such institution would decline. (105) It went on to emphasize that meeting the technical needs of the country with trained scientists and technologists was not only vital for the country, but a matter of national prestige. The university would also act as a consultative agency for the recently-begun industrial and technological development of Turkey. The wording of the preamble suggests that no research had been done in the Engineering School.

The Technical University opened in 1944 with 139 lecturers and 946 students, of whom only 9 were girls. There were six chairs: architecture and civil, mechanical, electrical, mining and chemical engineering. By June 1946, the university had been granted its autonomy.

Higher education in veterinary science and forestry was also offered to a limited number of students at the Yüksek Baytar Okulu and the Yüksek Orman Okulu respectively.

Scientific instruction and research in more basic scientific fields became available in Ankara at the Yüksek Ziraat Enstitüsü (Higher Agricultural Institute), opened in 1933, and at the Ankara Fen Fakültesi (The Science Faculty of the as yet unborn Ankara University), opened in 1943.

The Ziraat Enstitüsü was a type of agricultural university, with Faculties of Agriculture, Forestry, Veterinary Science, Agricultural Techniques and Natural Sciences. (107) German professors were appointed to all the teaching positions until the majority left Turkey in the early 1940's.

Experimental research was not neglected in the Faculty of Natural Sciences.
For example, under the leadership of Prof. H. Zahn, investigations were made into the amorphous states of metals and non-metals. In fact, the first known Ph.D. degree obtained by a Turk within Turkey, Münih Çelebi, was on "Experiments into the transition of amorphous carbon into a crystalline state". (108) Between 1939 and 1946, five research papers and reviews in physics appeared in the journal of the Institute, Ankara Yüksek Ziraat Enstitüsü Dergisi, or as occasional papers. One of the contributors to this was J. Kramer, a well-known physicist in later years, who was a guest researcher in the founding years of the Physics Department of the Institute.

The Ankara Fen Fakültesi was opened to forty-five students on November 8th, 1943. (109) The premises and laboratory equipment of Gazi Educational Institute were utilized until new buildings could be erected. Lecturers were recruited from Istanbul University and assistants from Gazi itself. Initially, there were four institutes: General Physics, Experimental Physics, Mathematics and Astronomy, and General Chemistry. In the 1944-45 academic year, biology, botany, zoology, geology and mineralogy were introduced into the curriculum.

The legitimation for founding a second science faculty was given in the preamble to the founding law passed on 17th September 1943. It said: "The realities of the latest events in the world have shown once again the necessity for the advance of nations in the area of science." (110) The minutes of the debate on the law show that Members of Parliament regarded the new faculty as a means to the industrial and technological development of Turkey. Hasan Ali Yücel, the Minister of Education, explained that the faculty was part of a projected technical university or polytechnic, within which it would pursue pure science. This plan, however, was not to materialize.

At the opening ceremony, Yücel said that the faculty had been born as a result of two things: the change over the past twenty years in the level of commitment of the country to science and technology, and the realization brought home by the mechanized weaponry of the Second World War that national defence depended on science and technology. (111)

Little or no research was accomplished in the first four years of the faculty's existence. The exceptions were the pieces of work leading to
one Ph.D. degree in mathematics and one in physical chemistry. Most lecturers concentrated on a translation project which involved translating twenty French textbooks into Turkish over a period of three years. The project brought a rebuke from scientists at Istanbul University, who claimed that lecturers at the Ankara Fen Fakültesi were neglecting research. However, when in June 1946, Ankara University was established by Law No. 4936, research assistants were forced by the law to earn their Ph.D. degree within four years or leave the faculty. This encouraged assistants to turn their hand to research fairly quickly.

The establishment of the Faculty of Science at Ankara was undertaken against a changing economic background.

4.1.14 The economic background to the period (112)

At the outset, the Republican government had to revive an economy which had been severely weakened by war and by fifty years of foreign domination under the protection of the Capitulations. In 1923, there were only 341 mechanized factories serving a population of 12.8 million. A mere 4,000 kilometres of railway line linked Istanbul with Izmir and Ankara, with no connections east of Ankara. There were fewer than 1,000 kilometres of good roads and only 8,300 kilometres of poorly-surfaced roads. Many of the minority group artisans and businessmen had been killed or had fled the country; over 350,000 others were soon to follow, when Greeks living in Turkey were exchanged for Turks living in Greece. In the villages, agricultural practices continued as they had done for centuries.

Under the Treaty of Lausanne, the Turkish government had agreed to repay 62% of the foreign debt incurred by the Ottoman regimes. This put a great strain on the economy, reducing the total budget by between 12 and 18% from 1929 until 1943. Also, in order to nationalize the industries which the Ottomans had ceded to foreign interests, the Turkish government had to pay out substantial amounts of compensation. These included forty million French francs to obtain control of the docks at Istanbul, and two million pounds sterling for the railway to Aydın. (113)

The Republican government at first attempted to encourage private industry. In 1927, a new law was passed which gave new economic enterprises very favourable conditions, including tax-exemption, and in some cases, even
government subsidies. By 1932, there were 1,473 establishments with 55,320 workers operating under the law; but by 1939, the number of establishments had dropped to 1,144. An increase in production of 140% over this period was offset by a rise of 110% in wholesale prices. Since a 1927 survey had reported the existence of 13,675 establishments employing four persons or more, it appears that "the law induced relatively little new industrial investment". (114)

Foreign capital was not easy to attract. Foreign governments and businesses were wary of extending loans to the avowedly nationalist Kemalist government. Credit was forthcoming only from the Russians in 1934, the British in 1938 and 1939, and the French and the Germans in 1939.

The solution was for the state to promote industrial and commercial projects in sections of the economy where the cause of national development seemed to be at stake. This policy of intervention by the state was termed devletçilik, or statism. A five-year plan was prepared and implemented in 1934. As a result, paper, cellulose, glass, cement, sulphur and textile factories were built, coal mines were opened and an iron and steel works constructed. However, a report published in 1949 by an American economist criticized the state enterprises for waste and inefficiency, and even for discouraging private enterprise. (115)

Meanwhile, little importance was being given to modernizing agriculture. Even in 1948 there were only 1,700 tractors in the country. Nevertheless, Robinson considers that a change in village farm practices had to await the formation of a core of literate and mechanically knowledgeable farmers. (116)

By 1945, the industrial labour force had increased to about 7% of the population from 5.6% in 1929. This was not paralleled by increasing urbanization, which remained at about the same level of 24.2% over the same period. Also, there appears to have been little growth in per capita real national income between 1929 and 1945. Several reasons have been suggested for this: the continuing tendency to disparage business and industrial activity (a hangover from Ottoman times), the conservatism of Anatolian village society, the small numbers of the educated and technically skilled, and the growth in population. (117)

The great depression of 1929 and the mobilization of thousands of men during
the Second World War also put great strains on the economy. For example, because of the dramatic fall in wheat prices in 1929-30, a villager who could buy a metre of woollen cloth for thirty pounds of wheat in 1929 had to pay eighty pounds in 1931. (118) The number of men under arms rose from 78,000 in 1932 to 800,000 in 1940, while the proportion of the budget spent on defence increased from 28% to 56%. (119)

One prominent characteristic of Turkish development in the 1930's and early 1940's was the varying importance given to the different regions of the country. Even though some industrial sites were deliberately placed in isolated areas to encourage their development, very little was done in the east and the south-east. The result was that these areas remained a wilderness, largely untouched by the modernization taking place in the west of the country. Furthermore, the enlightened elite, who had a horror of extra-city life, huddled in enclaves in Istambul, Izmir and Ankara, except when forced by the government to take their medical and other skills to less populated areas.

In short, by 1945, only slow progress had been made towards the development of an economy capable of sustaining rapid modernization and towards the formation of an industrial and technological base which would require the services of trained scientists.

Meanwhile, in 1938, the great Kemal Atatürk had died and İsmet İnönü had become President of the Republic. He was to guide the nation through the difficult war years when Turkey attempted to remain neutral.

4.1.15 The Conducents by 1945

A prospective research scientist in the early years of the Republic is likely to have been influenced by Kemalist ideology. This ideology was propagated through speeches by Kemal himself, his ministers and other officials, by the Republican People's Party members - especially via the People's Houses and People's Rooms, by teachers, and by newspapers and books. Opposing ideologies were suppressed.

The pervasiveness of Kemalist ideology in the late 1920's and the 1930's has been noted by several observers. Adnan-Adıvar described Republican Turkey as "a positivistic mausoleum" in which positivism was "the official
dogma of irreligion". Lewis writes: "The pressure of secularization in Turkey in the 1930's became very strong." Berkes claims that by 1927, science had assumed "almost a sacred position". Batu characterizes "the worst mistake made by the Republican educational system" as imparting "an undivided admiration for positive science" with the result that "in every sphere scientists and technologists were worshipped". As early as 1933, irdelp could publicly claim that the understanding of the "truth" that science is not just a luxury for a nation but a necessity "has only come to us in the Republican era", while ten years later Hasan Ali Yücel could say that in no other period than the Republican era had the Turkish nation been as "careful and successful in spreading this kind of knowledge [i.e. positive science]".

However, it is not easy to estimate the extent to which the population as a whole really shared the official enthusiasm for things scientific. With the exception of the children in the 12,000 odd village schools, most of the 14 million or so Turks in the villages in 1945 were still largely unaffected by the ideas and ideals of the Republic. In contrast, the 4½ million Turks in the towns and cities were probably more receptive to them.

Officially, science had been allotted a high status, and even religion had been pared to conform to it (conducent Ie). Yet there were still some doubts. For example, in 1928 a writer in a newspaper seemed to be voicing the unease of some when he denied that the "dissemination of the new sciences" was the reason why so few of the educated went to the mosques. Also, in 1939 a writer in Varlik (Existence) called for science to be rescued from "being used as an instrument of political and religious passions" as one precondition for "the development of scientific and philosophical life in Turkey".

A belief in cause and effect (conducent Ib), in mechanistic explanations for natural phenomena (Ic), and that the natural world can be understood and controlled (Ie) were increasingly transmitted by the schools and other ideological vehicles of the Republicans. At the same time, some teachers in rural areas experienced resistance by villagers to crop irrigation, for example, because it supposedly contravened the will of God.

The educational system was also the means of transmitting "a quite
indigenous spirit of progress" (Id) according to Frey. (129)

That manual labour was still looked down upon generally is reported by Bagöz and Wilson. (130) They state that vocational schools were despised even in Republican times because the first vocational schools, opened in the nineteenth century, had been for waifs and orphans and were thereby identified with poverty. Also, İnönü reports that when the Yüksek Mühendis Mektebi was first opened, there were very few applicants because engineering was regarded as a form of manual labour and therefore not the profession for a proper gentleman (efendi). (131)

There was certainly scepticism towards ancient traditions and beliefs (condenent IIb), but it seems to have been replaced by a Republican authoritarianism which brooked no rival (IIf). (132) Amongst scientists and scholars, criticism of the work of others often turned into a personal slanging match. (133)

Some research work was in progress under the supervision of foreign professors. This gave a few Turks the opportunity to learn the conceptual frameworks currently held by other scientists in the sub-discipline (Ih) and the instruments and techniques to which they were committed (IIg). The acquisition of cognitive and manipulative skills was made easier by the expansion of the educational system in general and by the reorganization and expansion of the Science Faculty of Istanbul University and the opening of the Ankara Science Faculty in particular (IV). On the other hand, there were the many shortcomings in the educational system mentioned above (pp.176 ff.), in addition to the fact that only about 25,000 pupils were able to study at lycée level.

The German professors, limited as they were by lack of equipment and other difficulties, may have begun to impart role-conceptions and role-expectations of academic researchers to a few students at least (V and VI).

Of the role facilities required for scientific research (VII), technicians supplies and equipment and research literature were perhaps the most lacking. As for psychological characteristics, there was little motivation to engage in research except on the part of a few research assistants.
However, a number of Turks were acquiring cognitive and manipulative skills and role-conceptions of academic researchers at universities outside Turkey.

4.2 The Republic from 1946 until 1959

4.2.1 The political and economic background to the period

The period was marked by successive eras of freedom and oppression. In 1946, after twenty-three years of almost-continuous one-party rule, the formation of an opposition party, the Democrat Party, was permitted by President İsmet İnönü. It contested the general election in the same year and won 61 seats. In 1947, martial law was lifted after being in force for seven years, trades unions were allowed to form, and the press was given greater freedom of expression and criticism. The first really free and fair election took place in 1950, when the Democrat Party swept into power under the leadership of Adnan Menderes, winning 408 out of 487 seats. It consolidated its position four years later when it won 510 out of 541 seats. However, in 1956 the growing economic crisis in the country provoked severe criticism from the Opposition, and the government replied by passing laws to curb press criticism and political gatherings by the Opposition. The government then came under increasing fire from university academics, who soon found that the government was interfering in academic appointments and dismissals.

The general election in 1957 returned the Democrats to power with a decreased majority, amidst Opposition charges of electoral malpractice. As the Democrat Party continued to lose its popular support, it resorted to increasingly repressive measures. Several writers and newspaper editors were arrested and some publications were suppressed. By 1960, the situation in the country had reached boiling-point. University students were involved in a series of anti-government demonstrations and martial law was imposed. Finally on 27th May 1960, a group of army officers seized power and arrested most of the Democrat Members of Parliament. Menderes and his Foreign and Finance Ministers were later to be tried and hanged.

One of the planks in the successful Democrat Party platform in 1950 was
their promise of greater religious freedom. A year earlier even the secularist Republicans had bowed to the pressure of religious public opinion by reintroducing religious education in state schools on a voluntary basis and opening a Faculty of Divinity at Ankara University. The first law passed by the incoming Democrats was one authorizing the call to prayer to be made in Arabic rather than in Turkish, as had been the rule since 1932. Other measures included lifting the ban on religious radio programmes, and making religious instruction in primary schools compulsory.

Over the next few years, there were increases in mosque attendance, in the numbers of religious books and magazines published, and in the numbers of Turkish pilgrims to Mecca. Piety became respectable again, and a religious revival seemed to be under way. Meanwhile, the religious attitudes of many Turks - even villagers - were undergoing a subtle transformation. Thus, Robinson remarks that by 1960, "economic incentive, material well-being, innovation, the machine, commerce and social change no longer appeared as challenges to religion".

As far as the economy was concerned, there were some severe convolutions over the period. The avowed aim of the Democrat government was for Turkey to attain the standard of living of the Western industrialized countries within a generation or two. Time and again, the Prime Minister, Mr. Menderes, spoke publicly of the brilliant and shining future which lay just around the corner, replete with material comforts and industrial might. However, in general his government attempted to do too much in too short a time, and its economic policies led Turkey to the verge of bankruptcy.

Initially, things seemed to be going well. Private investment - both Turkish and foreign - increased, new factories were opened, and industrial output rose. There was also heavy, if misguided investment in the public sector. Bumper harvests in the early 1950's enabled Turkey to become a net exporter of wheat. However, poor harvests from 1954 onwards meant that it had to import grain, and its balance of payments deficit deteriorated. In consequence, surcharges and tighter controls were imposed upon imports.

To obtain the finance needed for investment and for the importation of necessary machinery and supplies, the Menderes government adopted a policy
of borrowing from foreign creditors and not paying them back. The result was that by the summer of 1958, Turkey had amassed a foreign debt of over $1,000 million and had no foreign reserves with which to pay even the interest on its loans. There was no alternative but to agree to a stabilization programme in order to restructure its debts. This included a devaluation of the lira from about 4 TL to the dollar to 9 TL.

The surcharges and restrictions on imports from about 1953 onwards only helped to fuel an inflation which was already rising rapidly because of high consumer demand. The annual increase in the cost of living index rose from 5% in 1953 to 9% in 1954 and to 13% and over in 1955 and thereafter. In all, between 1953 and 1959, the cost of living index doubled.

Real per capita income over the period increased by a factor of four. This figure was not helped by a dramatic rise in the population, which grew from 20.9 million in 1950 to 24.1 million in 1955 and 27.8 million in 1960. Agriculture was still the mainstay of the economy, generating 42% of the national income in 1960, compared with 50% in 1938. The share generated by industry increased only slightly: from 12.6 to 13.7%. In 1960, 75% of the labour force was involved in agriculture, 10% in industry and 15% in services.

At the end of the 1950's, the appetites of most Turks for a better standard of living had been thoroughly whetted. In consequence, many villagers set off for the cities to seek their fortunes. Between 1950 and 1960, roughly 1 million villagers migrated to the cities, where most of them lived in hastily-erected squatters' houses around the perimeters. By 1960, the large cities of Turkey were growing at a rate of 10% per annum, while overall urbanization had increased to 30% from a 1945 figure of 24%.

The repercussions of the fluctuations in the economy for the average research scientist, typically an urban, middle-class Turk, may be summarized as follows. From 1953 onwards, he would have felt the effects of continually rising prices, such that by 1959 the buying power of his basic salary was about half of that in 1953. Meanwhile, accommodation costs - either rented or bought - were rising phenomenally. For example the price of land in a select residential quarter of Ankara rose tenfold in only four years. This was caused partly by the demand for housing resulting from the large-scale migration to the cities, but mainly by a lack of confidence in the Turkish lira, which encouraged investors to put their money into real estate.

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All this was occurring against a background of increasing social demand for and expectations of a high standard of living. Academics in general and professors in particular were regarded as being at the top of the social pile, and so had to face greater social expectations for a high standard of living than other professionals.

Also, from 1953 onwards, certain imported items became subject to taxes ranging from 25 to 75% according to how "essential" or "non-essential" they were considered by the government. This made it difficult to obtain certain socially prestigious consumer goods such as refrigerators, and also to import supplies and equipment needed for research. Not only did the costs of doing research increase, but also the bureaucratic formalities involved in obtaining the necessary import licences. In 1958, when foreign currency reserves had dried up, all import licensing was suspended, and then renewed only on imports vital to the economy. In most cases, supplies and equipment for research were not included in this category.

For most Turks, American aid on a massive scale brought with it some significant changes. Between 1948 and 1962, the United States furnished Turkey with $1,600 million worth of economic aid, and with $2,200 million worth of military aid. A large proportion of the economic aid was channelled into the development of a system of all-weather roads, the purchase of farm machinery, and the development of the Zonguldak coal mines. Rapid social change came in the wake of the project to establish a 21,500 kilometre network of roads and an administrative and technical apparatus to maintain them. Villagers were now able to visit the nearest town with relative ease, and all across the country the transport of produce and other goods was greatly facilitated.

American military aid provided the stimulus for a wide-ranging reorganization and modernization of the Turkish armed forces. A number of army technical schools were opened, and Turkish youths undergoing their two years of compulsory military service were trained to use the new weaponry and other machinery being supplied from across the Atlantic. Thus, hundreds of thousands of male Turkish villagers returned to their villages with a new technical expertise and with a new conception of the power and value of the machine. At the same time, hundreds of commissioned and non-commissioned officers were obtaining a more intensive technical education in the United States. (138)
Throughout the period, Turkey maintained a fairly uniform pro-Western stance. In 1948 it became part of the Organization for European Economic Co-operation, in 1949 a member of the Council of Europe, and in 1952 a full member of the North Atlantic Treaty Organization. Such links brought with them economic, scientific and technical assistance of various kinds.

4.2.2 Attitudes towards science

Towards the end of the 1950's, a committee of prominent Turkish educationalists prefaced a report with these words: "In Turkey today there are people bound to the ideas of the eighteenth century, the nineteenth century and the Republican era living at the same time, even in the same district or the same apartment house. Because they maintain differing or even sometimes opposing attitudes to life, often the best citizens regard each other with lack of confidence and sometimes even with hate."(139) Whereas in pre-Republican Turkey there had been the Westernizers, the Islamists, and the Turkists, after twenty-five years of the Republic there appeared in seeming antithesis the secularist Kemalist Turks and the Islamist Turks, with a range of Turks of varying beliefs in between and sometimes beyond.

Under the Democrats, religion again became important and the prestige of science dropped from the supreme position it had occupied under the Republican People's Party. Thus, in his speech in May 1950 outlining the new government's programme, Menderes spoke of the dangers of neglecting spiritual and moral values in the pursuit of scientific and technical development: "The dissemination of scientific and technical knowledge in a country which does not furnish its youth with moral and human values according to its national character and traditions cannot be considered as a guarantee of living as a free and independent nation."(140) Similar sentiments were expressed in his speeches outlining the government programmes of 1951 and 1954. In 1956, an editorial in the review Forum gave a warning that "Administrators seem to have lost the belief in, and the respect and love for science which was seen in the generation which brought about the Revolution."(141)

However, the various Democrat governments do not seem to have been against science, as long as religion was allowed to co-exist with it. The official Democrat newspaper, Zafer, proclaimed that "the pure form of
Islam as formulated by our Prophet has been the guide and the auxiliary of science, progress, virtue and good morals. (142) School textbooks expressed similar sentiments in presenting a modernized version of Islam. Even in the nineteen worship leaders' and preachers' schools, two-thirds of the curriculum was allotted to non-religious subjects, including science, history and foreign languages. (143)

Meanwhile, amongst the flood of books appearing on religious themes were some which tried to show that "pure" Islam had always encouraged the development of science. One example, İslam Dünyasında İlim ve İlim Görüşü, (Science and the Scientific Viewpoint in the Islamic World) was written by a physics professor at Istanbul University. (144) Other books attempted to show how Islam in general and the Koran in particular conformed to modern scientific principles. (145) Newspaper and magazine articles appeared which made claims such as those in an article by a psychology professor at Istanbul University: "Islam is more rational than other religions and has many basic beliefs which encourage science." (145)

In the early 1950's, many of the more secularist Kemalist intelligentsia became increasingly alarmed at the growing outspokenness of religiously-minded men and the recognition given to such and to religion in general by the new government. One of the targets of the reactionaries appears to have been the hitherto sacrosanct "science", as the following quotation from an article in Varlık suggests: "How can Islam be the enemy of civilization and of science? How can a 'true' religion be founded to torture its adherents and to leave them in backwardness and misery on the earth?" The article went on to say that the type of Islam proffered by these religious fanatics had no relation at all to Islam; it was merely an "opium" with which to exploit "the ignorant populace", and therefore was "the finest type of atheism". Moreover, because Atatürk had closed the door to their schemes and intrigues, these religious fanatics were merciless in their enmity towards him and towards such eye-opening "media of civilization" as the school, the cinema, the theatre, the radio and the newspaper. (147)

Another article by the same writer indicates that the reason the reactionaries saw it as their duty to oppose the Westernizers and other Kemalist elements was because they considered them to be Communists. (148) Such mutual antagonism only increased the polarization between the reactionaries and
The eyes of the latter had been opened to the domination of superstition and religion in the villages by the publication of Bizim Köy (Our Village) in 1950 by Mahmut Makal, a young village schoolteacher. Makal, who had been brought up in a village, had come to adopt an almost positivist world-view and it was through positivist spectacles that he made his penetrating observations of village life. The book became a best-seller, with over 50,000 copies sold. Makal himself was imprisoned for a short period on the charge of being a Communist, but was released after a public outcry. His descriptions of backwardness in the villages seem to have come as a revelation to the elite in the cities.

The secularists were thereby encouraged in their belief that fanatical religion was an evil to be stamped out. Not only was it a brake on progress, but it was anti-scientific. Such sentiments were expressed in reply to a questionnaire sent out in 1959 by the editors of the review Yeni Ufuklar to various well-known writers and intellectuals, asking them what they understood by the term "softalik" (religious fanaticism) and whether they regarded it as a danger to Turkey. Thus Sabahattin Eyuboğlu wrote that for the softa (religious fanatic) "The new comes from the West, and the West is infidel, and so the new must be infidel." According to Ahmet Oktay: "Underlying softalik are dogmatic judgements which cannot be reconciled with scientific thinking and an absolute faith which has no room for tolerance." Fakir Baykurt agreed: "The religious fanatic, once he believes in something, will not waver in his belief, even if you collect hundreds of pieces of evidence which show that he is in error." In Orhan Duru's view, the religious fanatic was "the archetype of ignorance, of enmity towards science, of vested interests" and, presumably because he had strayed from the 'true' Islam, of "irreligion" also. Hakkı Tonguç saw the antidote to religious fanaticism in education: "The surroundings of those being educated in the secular school are hung and illuminated with the works of science, technology and the fine arts. Liberation from the evil of the religious fanatic is only possible with knowledgeable, secular citizens." In addition to those who saw an antithesis between science and a corrupt form of Islam, there were some who saw a conflict between science and religion per se. These included a professor of sociology at Istanbul
University, who in 1952 quoted Comte's three stages approvingly; (151) a writer in Yeni Ufuklar who in July 1954 took the editors of the review Istanbul to task for suggesting that religion and modern technology could co-exist; (152) and a writer in Varlık, who in 1960 pointed to contradictions between what was taught in Nature and Religion lessons at primary school. (153)

In short, the era of multi-party politics in Turkey witnessed an increasing entrenchment behind opposing ideological barriers. However, although science was still used by some Turks as an ideological weapon against religious fanaticism, in the face of the growing political influence of religiously-minded men, many of the intelligentsia were becoming more disposed towards a form of Islam which could be accommodated with modern science and technology. At the same time, as was noted above (p.187, reference 136), by 1960 conservative Muslims in general had succumbed to the lure of material advancement and had set aside any previous opposition to technical innovation. Nearly all ideological groups were agreed on the need for science and technology to help pursue goals of national development.

4.2.3 Official support for science

Both Republican and Democrat were in favour of supporting science as an institution, especially when they saw it as contributing to the economic development of Turkey. However, in contrast to the Republicans, the Democrats were against the propagation of a "science-as-ideology" which had the aim of countering religious superstition and tradition.

An examination of the foreign classics translated into Turkish under the sponsorship of the Ministry of Education between 1940 and 1966 bears this out. (154) The translation project had been instigated in 1940 by Ministry officials during Hasan Ali Yücel's term of office, and over the next twenty-five years, 1,120 works were translated under its auspices, most of them from French, German or English.

In the first ten years of the project, 634 works were published, with a peak of 143 works in 1946. During the 1940's, many of the writings of the French Encyclopaedists were translated into Turkish. Works translated included some by Descartes, Francis Bacon, Voltaire, Rousseau, Condorcet, Fontenelle, Diderot, Fenelon and Malebranche. Comte's Le catéchisme
positiviste appeared in 1952, probably before Democrat officials had had time to learn of its existence. It was almost the last anti-clerical work to be translated by the Ministry.

Books on scientific method and practice, however, did appear under the Democrats. Poincaré's Science et méthode (published in 1951) joined his Science et hypothèse (1946) and his Le valeur de la science (1949) which were already in translation. Renan's L'avenir de la science (1951) was followed by Bouty's La vérité scientifique (1952), Goblot's Système des sciences (1954), and Le Châtelier's De la méthode dans les sciences expérimentales (1955). On a more popular level, Jeans' The Universe Around Us appeared in 1950.

The Democrats continued to open research institutes of various kinds, although the pace slackened somewhat. Between 1945 and 1960, Republicans and Democrats set up animal husbandry research institutes in Bafra (1949), Konya and Van (1950), Çanakkale (1951), Elazığ (1952), Denizli (1958) and Ankara (1959). Regional agricultural research institutes were established in Istanbul (1948), Samsun (1948) and Diyarbakir (1958). Regional soil and water research institutes were set up in Tarsus (1947), Konya and Menemen (1949) and Eskişehir (1952). Regional forest research directorates were established in Ankara (1952), and in Trabzon and Antalya (1958).

More specialized research institutes were also opened, some of which were part of the American aid package. They included a research unit attached to the Ministry of Transport to deal with the construction of railways, harbours and airports (1954), which complemented the research unit on road construction which had been opened in 1948; research centres in Ankara for soil and drainage (1954), and for soil and fertilizers (1954); a geotechnical research unit (1956), a handicrafts research laboratory (1959), and a research and testing laboratory for building materials (1958), all in Ankara; and centres for research on vegetables in Antalya (1957), on plant protection in Ankara (1957), on olives in Balikesir (1959), and on seed testing in Ankara (1959).

However, the work performed in the agricultural research stations at least consisted of either routine testing or work lacking in originality and application. Furthermore, promotion of active researchers in such
establishments often involved appointments to desk jobs away from the laboratory.

The Democrats' term of office saw the founding of four new universities, mainly with American assistance (see below, pp.205 ff.).

An Atomic Energy Commission was also set up in 1956 after an agreement had been signed with the United States over co-operation in the development and application of atomic energy for peaceful purposes. In 1959 construction began on a one megawatt reactor at Çekmece, near Istaniul. The reactor went critical for the first time in October, 1962 within what had now become the Çekmece Nuclear Research and Training Centre.

4.2.4 Literacy and numbers of publications

The literacy rate for the population as a whole saw a steady increase until about 1955, when it actually began to decline slightly. The figures for various years are as follows:(157)

<table>
<thead>
<tr>
<th>Year</th>
<th>Population over 6 years of age (millions)</th>
<th>Literacy (as percentage of population over 6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1945</td>
<td>15.7</td>
<td>29.0</td>
</tr>
<tr>
<td>1950</td>
<td>17.2</td>
<td>33.6</td>
</tr>
<tr>
<td>1955</td>
<td>19.4</td>
<td>40.9</td>
</tr>
<tr>
<td>1960</td>
<td>22.5</td>
<td>39.5</td>
</tr>
</tbody>
</table>

The 1960 population census, based on a 1% sample, revealed variations in literacy by sex, habitat (urban-rural), and by region. Thus, while 54.5% of the male population were classified as literate, only 25.2% of the female population were so classified. The disparity between male and female literacy rates was even greater by urban and rural (less than 10,000 inhabitants) habitat. (158)
TABLE 4.11

<table>
<thead>
<tr>
<th>Percentage of literates among total population residing in</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>urban centres</td>
<td>21.9</td>
<td>12.2</td>
</tr>
<tr>
<td>Percentage of literates among total population residing in rural areas</td>
<td>32.5</td>
<td>13.0</td>
</tr>
<tr>
<td></td>
<td>54.4</td>
<td>25.2</td>
</tr>
</tbody>
</table>

Since 70% of the total population in 1960 was rural, the number of literate rural females was very small.

Variation in literacy by region was also considerable. The literacy rate among the sixty-seven provinces of Turkey ranged from 73.4% in Istanbul to less than 30% in twenty-eight provinces in the east and south-east, the lowest of which was 11.5% in Hakkari.

In every age-group except one, there was a decline in the literacy rate between 1955 and 1960. The six-to-fourteen age-group showed the greatest decline: from 48.7% in 1955 to 43.3% in 1960. Such a decline in the school age-group revealed the ineffectiveness of the primary school system. The fifteen-to-twenty-four age-group showed the only increase: from 50.8% in 1955 to 53.1% in 1960.\(^{(159)}\)

One of the main reasons for this increase was the basic education programme for illiterate conscripts set up by the army in the late 1950's. All illiterates were required to undergo an eight-week course which included 30 hours of Turkish per week, 3 hours of social studies and 11 hours of arithmetic. About 60% of the annual intake, approximately 180,000 men, had to take the course at one of 16 basic education centres. At the culmination of their military training, only about 35% of the annual intake were still illiterate.\(^{(160)}\) However, this literacy drive by the army did not affect the female population, who were not required to do military service.

In 1951, the Democrats closed down the People's Houses and People's Rooms.
Between 1932 and 1947, 67,000 people are reported to have received reading and writing proficiency certificates in these establishments. The People's Houses were not to reopen until after the army had come to power in 1960.

The number of books published over the period increased steadily. The number of magazines and newspapers, however, declined during the 1950's, probably because of the rampant inflation and the unavailability of foreign exchange with which to import raw materials for newsprint. Selected figures are shown below:

**TABLE 4.12**

<table>
<thead>
<tr>
<th></th>
<th>1945</th>
<th>1950</th>
<th>1955</th>
<th>1960</th>
</tr>
</thead>
<tbody>
<tr>
<td>Books and booklets</td>
<td>2455</td>
<td>2187</td>
<td>2891</td>
<td>3548</td>
</tr>
<tr>
<td>Magazines</td>
<td>n.a.</td>
<td>452</td>
<td>135</td>
<td>190</td>
</tr>
<tr>
<td>Newspapers - daily</td>
<td>n.a.</td>
<td>123</td>
<td>31</td>
<td>66</td>
</tr>
<tr>
<td>- non-daily</td>
<td>n.a.</td>
<td>332</td>
<td>211</td>
<td>149</td>
</tr>
</tbody>
</table>

n.a. = figures not available

It is not possible to ascertain the importance given by various governments to scientific and other publications from 1939 onwards because from that date on, the National Bibliography no longer separated official and commercial publications. A breakdown by subject-field for all books and booklets is given below:

**TABLE 4.13**

<table>
<thead>
<tr>
<th></th>
<th>1945</th>
<th>1950</th>
<th>1955</th>
<th>1960</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applied sciences</td>
<td>249</td>
<td>338</td>
<td>395</td>
<td>430</td>
</tr>
<tr>
<td>'Theoretical sciences'</td>
<td>123</td>
<td>115</td>
<td>116</td>
<td>143</td>
</tr>
<tr>
<td>Religion</td>
<td>28</td>
<td>68</td>
<td>104</td>
<td>217</td>
</tr>
<tr>
<td>Literature</td>
<td>621</td>
<td>337</td>
<td>633</td>
<td>827</td>
</tr>
<tr>
<td>Social sciences</td>
<td>441</td>
<td>704</td>
<td>914</td>
<td>957</td>
</tr>
</tbody>
</table>

The number of books on religion increased seven-fold between 1945 and 1960, while the number of books on the social sciences more than doubled, and the number on applied sciences increased by more than two-thirds.
A bibliography of works on Islam published between 1923 and 1973 shows that very few of the approximately 3,030 works listed were published before 1950. (163)

Many of the novels and other literary works written during the period were the products of a new school of Turkish writers, some of whom were from a village background. These writers and poets were mostly of secularist or leftist persuasion. According to Karpat, they aimed to make the average Anatolian more aware of the world around him and of the potential within himself to change his environment. Thus in general, "Action and resourcefulness are praised, fatalism and the contemplative life deplored." (16)

Many villagers were to be given the opportunity of more formal education by changes in the educational system.

4.2.5 The Village Institutes and expansion of primary education (165)

The Village Institute project was a scheme set up in the early 1940's to provide village schools with teachers. Conceived by İsmail Hakkı Tonguç, it superseded the ekitmen scheme mentioned above (see p.165). Between 1941 and their closure in 1951, the Village Institutes produced over 17,000 teachers, who, it has been estimated, brought secular education of some kind to 15,000 villages and half a million village children. (166) A number of Institute graduates, including Mehmet Başaran, Mahmut Makal and Fakir Baykurt, went on to become famous writers or educators.

The Institutes were co-educational boarding schools set up in rural areas for graduates of village primary schools, in accordance with Law No. 3803, passed in 1940. After five years of instruction at these Institutes in both general culture and in practical matters, graduates were sent back to their villages not merely to teach in the village primary school but also to set up model fields, vineyards, gardens and workshops which would display to the other villagers the benefits of "farming in a scientific manner." (167)

The curriculum of the Institutes was made up of 22 hours of reading, writing, arithmetic, history and geography, 11 hours of agricultural subjects and 11 hours of technical instruction. Above all, the teaching was highly relevant to the rural environment. There was a strong emphasis on man's
ability to change the world around him for the better through hard work and the application of scientific principles.

Some of the teachers at the Institutes were patently positivist in outlook, and this aroused the forces of reaction to brand the Institutes as seedbeds of Communism. Hence their closure by the Democrat Party in 1951. A prominent anti-Communist, Fethi Evetoğlu, quotes an anti-religious poem by one of the Institute students which appeared in Köy Enstitüleri Dergisi, the Journal of the Village Institutes. The poem, entitled Tanrı? (God?), attacks traditional religious beliefs and calls for tomorrow's world to be based on a "rational religion" which would be "free from beliefs in invisible heavenly forces and extraphysical notions". (168)

The Village Institute scheme displayed a trend away from providing educational opportunities for an elite to providing them for the masses. Thus by the time the 21 Village Institutes were converted to Primary Teacher-Training Schools in the early 1950's, they had contributed to a large-scale expansion of the Turkish primary education system. In fact, by 1960, the numbers of schools had almost doubled and the numbers of teachers and pupils had more than doubled since 1945, as the following figures show: (169)

TABLE 4.14

<table>
<thead>
<tr>
<th>Year</th>
<th>No.of primary schools</th>
<th>No.of teachers</th>
<th>No.of pupils</th>
</tr>
</thead>
<tbody>
<tr>
<td>1945-46</td>
<td>14,010</td>
<td>27,320</td>
<td>1,357,740 (491,880 girls)</td>
</tr>
<tr>
<td>1950-51</td>
<td>17,430</td>
<td>35,870</td>
<td>1,616,630 (599,710 &quot; )</td>
</tr>
<tr>
<td>1955-56</td>
<td>18,720</td>
<td>42,170</td>
<td>1,983,670 (745,340 &quot; )</td>
</tr>
<tr>
<td>1960-61</td>
<td>24,400</td>
<td>62,530</td>
<td>2,866,500 (1,066,470 &quot; )</td>
</tr>
</tbody>
</table>

Nevertheless, in spite of the increase in the number of primary schools, the percentage of primary school-age children who were actually enrolled at school was still only about 68% by 1960; (170)

TABLE 4.15

<table>
<thead>
<tr>
<th>Year</th>
<th>1945</th>
<th>1950</th>
<th>1955</th>
<th>1960</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage enrolment:</td>
<td>50.0</td>
<td>65.5</td>
<td>65.7</td>
<td>68.2</td>
</tr>
</tbody>
</table>

Moreover, the proportion of girls rose only from 36.2% in 1945 to 37.2% in 196
The reasons for the slow increase in enrolment appear to be as follows. First, even by 1960, 45% of the villages still had no schools. Second, some villages which did have schools had no teachers to teach in them. Teaching in villages became increasingly unattractive to young people during the 1950's; the idealism which in earlier Republican days had inspired many to venture forth to the villages of Anatolia was now shaken by the closure of the Village Institutes, by the official moves to sanction religious expression and by the lack of official enforcement of the compulsory education law. This last, which was a result of the Democrats' desire not to antagonise voters, was a third reason for the low school attendance. Fourth, many peasants were still against or indifferent to their children - especially girls - obtaining a modern education.

The shortage of teachers meant that between 1950 and 1960, primary school pupil/teacher ratios remained high or experienced only a slight improvement.

TABLE 4.16

<table>
<thead>
<tr>
<th>Year</th>
<th>Primary Schools</th>
<th>Rural</th>
<th>Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td>1945-46</td>
<td>Primary Schools</td>
<td>62</td>
<td>48</td>
</tr>
<tr>
<td>1950-51</td>
<td></td>
<td>51</td>
<td>43</td>
</tr>
<tr>
<td>1955-56</td>
<td></td>
<td>52</td>
<td>44</td>
</tr>
<tr>
<td>1960-61</td>
<td></td>
<td>49</td>
<td>43</td>
</tr>
</tbody>
</table>

Thus, by the end of the 1950's it had become only marginally easier for a young person and perhaps a potential scientific research worker to obtain a primary education than had been the case at the beginning of the decade.

4.2.6 Expansion of secondary education

In general, the Democrats' policy towards education was characterized by a lack of systematic planning and a lack of adequate financial allocation. Although there was expansion at all levels, it did not keep up with the increase in population. While the number of pupils overall increased by 89%, expenditure on education increased by only 35%. (173)
Nevertheless, between 1950 and 1960, there was a numerical growth in secondary education, as may be seen from the following figures:

### TABLE 4.17

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of middle schools</th>
<th>No. of teachers</th>
<th>No. of pupils</th>
</tr>
</thead>
<tbody>
<tr>
<td>1945-46</td>
<td>252</td>
<td>3,930</td>
<td>65,610 (19,530 girls)</td>
</tr>
<tr>
<td>1950-51</td>
<td>406</td>
<td>4,530</td>
<td>68,190 (17,920 &quot; )</td>
</tr>
<tr>
<td>1955-56</td>
<td>573</td>
<td>6,380</td>
<td>133,220 (35,640 &quot; )</td>
</tr>
<tr>
<td>1960-61</td>
<td>745</td>
<td>12,080</td>
<td>291,270 (70,780 &quot; )</td>
</tr>
</tbody>
</table>

### TABLE 4.18

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of lycees</th>
<th>No. of teachers</th>
<th>No. of pupils</th>
</tr>
</thead>
<tbody>
<tr>
<td>1945-46</td>
<td>83</td>
<td>1,817</td>
<td>25,520 ( 5,100 &quot; )</td>
</tr>
<tr>
<td>1950-51</td>
<td>88</td>
<td>1,954</td>
<td>22,170 ( 4,640 &quot; )</td>
</tr>
<tr>
<td>1955-56</td>
<td>123</td>
<td>2,476</td>
<td>33,410 ( 8,170 &quot; )</td>
</tr>
<tr>
<td>1960-61</td>
<td>194</td>
<td>4,219</td>
<td>75,630 (19,620 &quot; )</td>
</tr>
</tbody>
</table>

In middle schools, the numbers of pupils increased by a factor of four, while the number of teachers increased by a factor of less than three. In lycees, the numbers of pupils increased three-fold, while the numbers of teachers increased only two-fold. This led to overcrowded classrooms and the introduction of a two-shift system in many schools. Moreover, some of the teachers were only part-time.

The proportion of girls studying at middle schools actually decreased between 1945 and 1950, from 29.8% to 24.3%. However, over the same period, the proportion of girls studying at lycees increased from 20% to 25.9%.

The numbers of minority and foreign schools changed only slightly over the period. On the other hand, there was a substantial increase in the number of Turkish private schools at all levels, especially towards the end of the 1950's.

Efforts to develop technical and vocational education were not helped by the increasing trend among middle school pupils to opt for academic subjects. The proportion of such pupils rose from 67% in 1949-50 to 83% in 1959-60.
Thus although the number of technical and vocational schools increased, the number of pupils actually decreased between 1955 and 1960: (175)

TABLE 4.19

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of technical and vocational schools (middle school level)</th>
<th>No. of pupils</th>
</tr>
</thead>
<tbody>
<tr>
<td>1945</td>
<td>38</td>
<td>10,730</td>
</tr>
<tr>
<td>1950</td>
<td>87</td>
<td>13,685</td>
</tr>
<tr>
<td>1955</td>
<td>86</td>
<td>20,502</td>
</tr>
<tr>
<td>1960</td>
<td>101</td>
<td>19,139</td>
</tr>
</tbody>
</table>

A few of these schools trained technicians who could be employed in a university research department. Such schools included general technical schools and boys' technical institutes, and an institute of chemical studies.

4.2.7 Shortcomings in primary and secondary education between 1945 and 1960 (1)

At the end of the 1950's, a number of factors were hampering the appearance at university level of young people with the aptitude and motivation to pursue scientific research. At the bottom end of the educational ladder, there were vast numbers of children who were unable to obtain even a primary school diploma. In 1959 about one third of all primary school age children were not attending school. Village children were at a particular disadvantage; 39 out of 100 were unable to attend school compared to 13 out of 100 of their cousins in the towns and cities. For village girls of school age, opportunities were even fewer: approximately 57 out of 100 did not attend school. (177)

Once in the classroom, there was a good chance that a child would repeat one or more years or else drop out altogether. Only about 1 child in 4 completed his primary education within the prescribed five years. (178)

In general, classrooms were overcrowded, books and other materials in short supply and teachers inadequately trained. In some urban schools, there were two or even three shifts because of the lack of buildings, whilst in rural schools many teachers had to teach several grades simultaneously in the same classroom. Moreover, the school year was very short: from 1st October until 23rd April in the villages, and until 31st May in the
towns and cities. The curriculum tended to be overladen with material, most of which was irrelevant to the environment and to the future needs of most of the pupils.

For those who did obtain a primary school diploma, it was not always easy to go on to secondary education. Village children had to board with relations or friends in nearby towns or cities, since middle schools were not found in villages. Only teacher-training schools and a few vocational schools offered free board and lodging. Also, until 1950, graduates of the Village Institutes in the villages had been offering a rather different type of instruction to that offered by primary school teachers in the towns, which made it difficult for rural youths to adapt to the more theoretical middle school instruction.

Thus in 1960, out of 100 middle-school age boys and girls in Turkey, only 17 were able to attend middle-school, and of these 13 were boys and only 4 were girls. Once enrolled, each pupil had only a 50% chance of completing his studies within three years. About half the pupils had to repeat at least one year or else they left school for good.

However, over 70% of those pupils who did obtain their middle-school diplomas went on to study at lycee. The result was that out of every 100 Turkish children between 16 and 18 years of age, about 5 were studying at lycee and a further 4 at lycee-level establishments such as teacher-training schools. More than 7 out of 10 lycee students graduated at the end of the statutory three years.

Nevertheless, secondary school education suffered from many of the deficiencies found in primary education. There was a shortage of more than 3,000 teachers in middle-schools and lycees, where 4,400 part-time or untrained personnel were attempting to fill the gap. The teaching profession continued to be unattractive because of low pay scales and the often arbitrary and capricious handling of transfer appointments. Buildings, furniture, books and other materials were in short supply. Also, the teaching of foreign languages left much to be desired, with poorly-trained teachers, few books and unproductive methods. On a local level, initiative tended to be stifled by the highly-centralized pattern of educational administration; all matters, including choice of textbooks, appointments of teachers and principals and allocations of funds...
were regulated by the Ministry in (often far-off) Ankara.

At all levels, examinations tested recall and not application. As the National Commission on Education wrote, "In our schools, it is seen that knowledge is taken to be an end in itself... and that in short, teaching has taken rote learning as its aim." (181)

Further criticisms of lycee graduates were made in a report prepared by a Commission of the Istanbul University Senate. According to the report, lycee graduates were lacking in general knowledge, were weak at oral and written expression, were unable to make connections or comparisons with other things they had read, lacked creativity, were unable to think for themselves, had little interest in the social problems of the country and of the world, and had a very poor knowledge of any foreign language. (182)

Thus even when the average Turkish student who had struggled to the top of the educational tree arrived at university, he was still lacking in many of the cognitive and manipulative skills required for the advanced study of modern science and technology. (183) At the same time, the training of technicians to assist in any scientific research was of a low standard; in addition, an education in a technical school was regarded as a second-rate option by many Turks. (184)

4.2.8 The place of science in the school curricula

As was mentioned above (p.168), there were very few changes in the content of the school science curricula over the period, and the amount of time allotted to science remained fairly constant.

However, during the 1950's a number of curriculum experiments were made, mainly under the influence of American educators. (185) In 1953, the Multipurpose Junior High School Experiment was launched, with an integrated science course incorporating physics, chemistry and biology. In 1954, another integrated science course was developed, at Istanbul Atatürk Girls' Lycee. A year later, a similar course was tried out at the Bahgelievler Experimental Lycee in Ankara. This project, perhaps the most successful of the science curriculum development projects in the 1950's, was financed by the Ford Foundation as part of a wider scheme to stimulate innovation in the Turkish educational system. The experimental curriculum
included both elective and compulsory courses, with a strong emphasis on laboratory work. Then in 1959, a project was undertaken to teach modern physics in six lycees in Istanbul with the aid of 162 physics teaching films and a Turkish translation of an American modern physics textbook.

Although the content of the science instruction in the ordinary lycees remained almost unchanged over the period, the curricula reaffirmed the emphasis on cultivating scientific attitudes in the pupils, both inside and outside the classroom. Thus, according to the "Principles of Secondary Education" spelled out in the 1951 Middle School Curriculum, "The school will teach methodical ways of working and will encourage students to think critically" and "The teacher ... will assist the students to gain a scientific way of seeing and thinking." One of the aims of teaching physics was "to ensure that the students obtain a rational view of the universe"; of chemistry, "to show how chemistry serves technology and today's civilization, and to awaken an interest in this science amongst students"; and of biology, "to give the students the ability to solve the problems they meet in their everyday lives from a scientific viewpoint and using the scientific method" and "to make each student into a constructive individual who aims to better his environment". (186)

However, according to qualified observers, most of the principles embodied in this document remained a dead letter. (187)

4.2.9 Education at university

There was considerable expansion of higher education in Turkey between 1945 and 1960. (188) In 1946, the hitherto independent faculties of Science, Political Science, Medicine and Language, History and Geography were incorporated into a new University of Ankara. In 1948, the Higher Agricultural Institute was raised to the status of an Agricultural Faculty, and its Natural Sciences section transferred to the Science Faculty.

In the 1950's, two universities were set up according to the pattern of the three older universities. These were Ege University at Izmir, which opened in 1955 with faculties of medicine and agriculture; a third faculty, the Science Faculty, was opened in 1961. The other university was Karadeniz Teknik (Black Sea Technical) University at Trabzon on the Black Sea coast, which was founded in 1958 but which did not open its doors to students.
until 1963. Its first faculty, of basic sciences, was joined by a faculty of construction engineering in 1966. Staff were recruited from Istanbul University and Istanbul Technical University.

A more novel type of university was set up in Erzurum, in the far eastern and backward part of Turkey, in the early 1950's. A primary aim of this university, called Atatürk University, was to stimulate regional development, and the University of Nebraska was asked to co-operate in founding it along similar lines to those of the American land-grant colleges. A number of Turkish instructors were sent to Nebraska for training, while staff from the University of Nebraska spent varying periods of time in Erzurum. In all, American technical assistance continued for more than ten years, but the remoteness of the area and the extreme climatic conditions delayed the proper functioning of the university long after it began admitting students to its faculties of agriculture and of arts and sciences in 1958.

A university which was to have a great influence upon the development of both basic and applied science in Turkey was set up in Ankara in 1956. This was the Middle East Technical University (or METU), an English-medium university with an American form of administrative structure. It was designed to serve the whole of the Middle East, and as such was able to attract substantial amounts of United Nations and other foreign aid with which to build a superb campus just outside Ankara. Its faculty of arts and sciences was opened in 1960, joining the faculties of architecture, engineering and administrative sciences which were already functioning.

From its inception, METU possessed a unique legal status which gave it several advantages over the other more traditional Turkish universities. First, it could offer its instructors much higher salaries. Second, it could allow people who had only recently completed their Ph.D.'s to lecture immediately instead of having to wait a further four years at least for their disentships, as was the statutory requirement elsewhere. This tended to give its teaching staff a young and dynamic character. Third, its administrative structure along departmental lines did away with the rigid academic hierarchies obtaining elsewhere and the concomitant inflexibility. Fourth, because it was exempt from the standard and time-consuming government accounting procedures, it was able to see its new buildings constructed in record time. Fifth, as its instruction was in
English, the staff and students had access to modern textbooks and periodicals not normally available in Turkish. Moreover, the requirement to teach in English meant that most of the staff obtained their Ph.D.'s at scientific establishments in Britain or America. There was also a large proportion of foreigners on the staff in the early years.

With the opening of 10 new faculties between 1945 and 1960, the number of Turks studying at university almost tripled. (189)

TABLE 4.20

<table>
<thead>
<tr>
<th>Year</th>
<th>No.of faculties</th>
<th>No. of university students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1945-46</td>
<td>17</td>
<td>15,270 (19.3% girls)</td>
</tr>
<tr>
<td>1950-51</td>
<td>18</td>
<td>19,870 (19.0% &quot; )</td>
</tr>
<tr>
<td>1955-56</td>
<td>21</td>
<td>29,080 (16.4% &quot; )</td>
</tr>
<tr>
<td>1960-61</td>
<td>27</td>
<td>44,460 (22.6% &quot; )</td>
</tr>
</tbody>
</table>

The numbers of students studying in the various basic science faculties more than doubled over the same period:

TABLE 4.21

<table>
<thead>
<tr>
<th>Year</th>
<th>AUSF</th>
<th>METUFAS</th>
<th>IUSF</th>
<th>EAUSF</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1945-46</td>
<td>81</td>
<td>-</td>
<td>2,180</td>
<td>-</td>
<td>2,263 (23.6% girls)</td>
</tr>
<tr>
<td>1950-51</td>
<td>247</td>
<td>-</td>
<td>1,790</td>
<td>-</td>
<td>2,036 (34.2% &quot; )</td>
</tr>
<tr>
<td>1955-56</td>
<td>575</td>
<td>-</td>
<td>2,800</td>
<td>-</td>
<td>3,375 (23.3% &quot; )</td>
</tr>
<tr>
<td>1960-61</td>
<td>2,025</td>
<td>66</td>
<td>3,125</td>
<td>36</td>
<td>5,252 (24.6% &quot; )</td>
</tr>
</tbody>
</table>

AUSF = Ankara University Science Faculty
METUFAS = Middle East Technical University Faculty of Arts and Sciences
IUSF = Istanbul University Science Faculty
EAUSF = Erzurum Atatürk University Science Faculty

The figures are slightly inflated as they include some students at METU and Atatürk University who were not studying science. On the other hand, they do not include some 60 pupils studying in the Science and Foreign Languages Department of Robert College, a private American College in Istanbul.
The numbers of students studying more applied science subjects at Istanbul Technical University increased from 907 in 1945 to 2,682 in 1960.

The percentage of girls studying in basic science faculties increased from 23.6% in 1945 to 34.2% in 1950, and then fell to 24.6% in 1960.

Overall, the proportion of students studying social science subjects increased, while the proportion studying all scientific and technical subjects remained fairly constant. (190)

**TABLE 4.22**

Percentages of students in various sectors of higher education

<table>
<thead>
<tr>
<th>Year</th>
<th>Science and Techn.</th>
<th>Health</th>
<th>Social Scs.</th>
<th>Arts</th>
<th>Agric.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1944-45</td>
<td>23.6</td>
<td>18.2</td>
<td>41.5</td>
<td>12.4</td>
<td>4.3</td>
</tr>
<tr>
<td>1949-50</td>
<td>21.1</td>
<td>18.3</td>
<td>43.5</td>
<td>12.4</td>
<td>4.7</td>
</tr>
<tr>
<td>1954-55</td>
<td>21.7</td>
<td>15.6</td>
<td>50.0</td>
<td>7.1</td>
<td>5.5</td>
</tr>
<tr>
<td>1959-60</td>
<td>23.3</td>
<td>9.5</td>
<td>49.8</td>
<td>10.7</td>
<td>6.7</td>
</tr>
</tbody>
</table>

The proportion of students studying basic sciences at Turkish universities fell from 14.8% in 1945 to 11.8% in 1960. Two reasons have been suggested for this. (191) First, the science faculties could refuse to increase their intakes on the grounds of lack of physical facilities such as laboratories. Secondly, social science subjects such as law had gained in prestige over science subjects, since science graduates could look forward to only limited job opportunities and low salary scales.

In spite of the great increase in the number of places at universities, the opportunities of obtaining a university education were still very limited. Thus in 1961, of 100 primary students, only about 10 could expect to enter a middle school, less than 3 a lycee and about 1 a university. Of 100 middle school students, only about 26 could expect to enter a lycee and about 14 a university. Of 100 lycee students about 55 could expect to enter a university. (192) Had this been a selective procedure based on ability alone, these figures might have been more acceptable. However, many potential university students were prevented from attending university from financial or other reasons. Rural youth in general and rural girls in particular were unlikely to be
found at university.

For those who did get to university, there were many difficulties to be faced. Among those mentioned by the National Commission on Education were overcrowding in some faculties, shortages of books, periodicals and laboratories, a short academic year of only about six months, and a lack of well-qualified and able teaching staff. Rising inflation and the difference between the pay of university research assistants and university graduates elsewhere had encouraged many assistans to move out of academic circles altogether. Other academic staff had to take on jobs outside the university in order to supplement their shrinking real incomes, and consequently they had less time for research and publishing. For those who wanted to undertake research, there were many difficulties involved in importing equipment from abroad.

Another critic noticed strait-jacketed thinking and low standards of teaching at universities. A student at one of the universities in Istanbul complained of the "bookish mentality" and "dogmatic teaching methods" he had encountered. In *Forum*, a writer hit out at universities for encouraging memorization and mental laziness, for suppressing curiosity and for teaching material which was irrelevant to modern life. This last point was reiterated in a report by the OEEC which found that Turkish employers considered university education to be too theoretical. The report also noted the problems of undertaking research in the universities: academic staff lacked research assistants and technicians, and funds for materials and equipment were in short supply. As for university publications, one observer commented that most of these were textbooks, while the research papers which did appear seemed strangely irrelevant to the needs of the country.

Many students were not really interested in the subjects they were studying. Their prime motive for entering university was to gain prestige or to avoid military service, and they enrolled in whatever faculties had places available. This lack of interest in the subject combined with the difficulties mentioned above, resulted in students taking inordinate lengths of time to complete their studies. Motivation to pass examinations was not enhanced by the absence of final examinations, and the freedom to repeat courses and enter examinations as many times as they desired. The number of graduates from Ankara University for various years between
1942 and 1960 was 9 - 12% of the total student body, while for Istanbul University it was 6 - 8%.

4.2.10 University laws, and the academic career

The law which regulated the affairs of most of the universities was Law No. 4,936, passed in 1946. This granted universities autonomy in academic and administrative affairs. The only possibility of governmental control over them became an indirect one - by means of allocations from the Budget. Amongst the functions of the university described by the law were "the advancement of science and technology, with first priority being given to those problems which affect the future of the country" and "the propagation among the people, both in writing and in speech, of scientific knowledge conducive to the advancement of Turkish society".

In July 1953, the Democrat government amended the law so that any member of the teaching staff who "committed a dishonourable action" or who "took an active part in politics" was liable to suspension from his or her duties. In December 1956, the Dean of the Political Science Faculty of Ankara University was arrested for allegedly infringing this amendment. There were resignations by other members of staff in protest and students boycotted classes. Such apparent interference by the government in university affairs only served to lower morale amongst university staff in general.

After the military coup which ousted the Democrats from office, the offending amendment was removed in October 1960 by Law No. 115, which was to remain in force until the present university law, No. 1,750, was passed in 1973.

The founding laws of Atatürk University and Karadeniz Teknik University made these universities directly responsible to the Ministry of Education. However, for the most part, both universities were subject to the provisions of Laws No. 4,936 and 115, except that Atatürk University possessed a departmental rather than a chair system of administration.

According to these laws, the basic career structure of university staff was as follows. At the bottom were the asistans, who were selected by examination from university graduates. Once accepted, they became
employees of the university and were required to do research and to assist with the teaching duties of the professor or docent to whom they were assigned. At the end of a probationary year, their appointments were confirmed and they had a further three years in which to obtain their Ph.D. degree. If they failed to obtain their Ph.D. degree within this period, they could apply to the professorial council for a year's extension; however, lack of success at the end of this further year resulted in automatic termination of an appointment. Even with a Ph.D. degree, an assistant was not permitted to lecture, although he could supervise laboratory practicals.

Assistants who obtained their Ph.D. degrees were next required to perform research which would lead to their becoming docents, or fully-qualified members of the teaching staff. At least four years of post-doctoral experience were obligatory for candidates for the docentship examination. The examination itself involved the submission of a research thesis, the sitting of a foreign-language examination, an oral examination on all aspects of the proposed teaching topic, and the delivery of a model lecture. The jury for the docentship examination was composed of five professors chosen by an inter-university commission.

Docents were expected to lecture and do research. They had security of tenure unless they were found guilty by a special university commission of not performing their academic duties or of unprofessional conduct. After five years of teaching at a university or seven years of working in a field related to his subject, a docent could apply to become a professor. A professorial candidate was required to show his ability in a second foreign language, write a professorial thesis based on original research, and show evidence of scholarly publications such as research articles, books and translations. The professorial jury was made up of several professors from the same faculty, and frequently one professor from another faculty.

Under the chair system which obtained in most universities, one professor was elected as chair professor. As such, he had full authority in academic matters within the chair, including the choice of research topics. Such a system gave the chair professor a position of great power over a long period of time, since he had security of tenure. He was a considerable influence for good or bad over his colleagues in the chair.
Thus chairs with mediocre chair professors tended to produce mediocre teaching and mediocre research. A further disadvantage of the chair system was its inflexibility. It assumed that knowledge was composed of closed 'wholes', which could be mastered by certain individuals specializing in each, with no room for change as fields of knowledge touched and overlapped.

In contrast, the departmental system which prevailed at METU, for example, tended to encourage individual creativity and productivity. The chairman of a department was an administrator, with no more influence in academic affairs than any other member of staff of equal rank. Teaching and research activities were distributed among the staff according to their interests and abilities instead of according to their rank, as was often the case with the chair system. Within a department, a number of experts from different sub-specialities could complement each other and form an effective unit capable of adapting to changing configurations in the expansion of knowledge.

METU was regulated by Law No. 7307, which gave it a unique status under the supervision of a board of nine trustees directly appointed by the Council of Ministers. The trustees were authorized to select a President, who was the chief executive officer of the university, with wide-ranging administrative powers. Salaries of teaching staff at METU were significantly higher than at other universities until 1973.

Basic salary scales at universities other than METU were fixed according to civil service regulations. Promotion was by seniority - one grade out of nine possible grades for every three years of service after obtaining a doctorate. There were also special allowances for each academic rank: $22 gross for an asistan, $55 for an asistan with a Ph.D., $66 for a docent and about $110 for a professor. Thus, for example, in 1960 an asistan without a Ph.D. received about $100 per month before tax, and a senior professor about $400.

4.2.11 The training of students abroad

In a series of newspaper articles which were to appear in book form in 1958, Mümtaz Turhan, a professor of psychology at Istanbul University, made an analysis of Turkey's failure to westernize and offered a prescription.
In his view, western civilization was a system made up of institutions which depended on the following elements: science, "scientific mentality", technology, law and freedom. To become part of this civilization, it was necessary to adopt and appropriate its main values and institutions. The reason why Turkey had failed to westernize was that it had not produced enough scientists and scientific institutions. The only solution was to train a large number of scientists in the shortest possible time. (206)

As he was writing, some Turkish students were poring over their books at German, French, British and American universities. Uysal records 447 students as having been sent abroad by the Ministry of Education and other government agencies under Law No. 1,416 between 1946 and 1959. (207) Other Turks were to study abroad under the sponsorship of AID (the American Agency for International Development), the United Nations, NATO, CENTO, and various foundations such as the Ford, Rockefeller and Fulbright Foundations. For example, between 1951 and 1974, 624 students received Fulbright post-graduate scholarships, of whom 349 were in "basic and applied positive sciences". (208)

Also, a number of university teachers and asistan took advantage of provisions in the university law of 1946 to the effect that universities could grant paid or unpaid leave to members of staff who wanted to study abroad. Also about 40 scientists were sent to the United States for further study and training under the atomic energy agreement signed with the Americans in the mid-1950's.

4.2.12 Training and research in physics and chemistry between 1945 and 1966

Despite the comment in 1954 of a top Turkish Army general to von Karman, "There are no scientists in Turkey", (209) a few Turkish scientists were performing good quality research, while others were being trained to do so. Data on Turkish research scientists and their publications has been collected for the period 1933-66 in works by İnönü (210) and Özönün (211) and so I have extended by six years the period we are considering.

At Istanbul University, numbers of students and staff in the Science Faculty increased fairly steadily over the years, except for a lean period between 1950 and 1954: (212)
TABLE 4.23

<table>
<thead>
<tr>
<th>Year</th>
<th>No. students</th>
<th>No. students in/all facs.</th>
<th>No. sc. graduates</th>
<th>No. Sc. Fac. Teaching staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>1945-46</td>
<td>2,180 (23% girls)</td>
<td>9,810</td>
<td>93</td>
<td>109</td>
</tr>
<tr>
<td>1950-51</td>
<td>1,790 (33% &quot; )</td>
<td>11,590</td>
<td>90</td>
<td>120</td>
</tr>
<tr>
<td>1955-56</td>
<td>2,800 (22% &quot; )</td>
<td>13,960</td>
<td>70</td>
<td>137</td>
</tr>
<tr>
<td>1960-61</td>
<td>3,125 (29% &quot; )</td>
<td>21,740</td>
<td>145</td>
<td>153</td>
</tr>
<tr>
<td>1965-66</td>
<td>2,910 (29% &quot; )</td>
<td>27,626</td>
<td>243</td>
<td>150</td>
</tr>
</tbody>
</table>

These figures embrace other fields besides physics and chemistry, such as biology, mathematics, astronomy and geology.

Turkish members of staff continued to work alongside foreign professors for some years after the war. In the 1944-45 academic year, for example, nine British professors took up appointments at Istanbul University, among whom were Prof. T. Royds in astronomy and Prof. F.H. Constable in physical chemistry. Constable was to stay for more than thirty years, during which time he supervised many Ph.D. students and generally encouraged Turkish colleagues in their research. In physics, Prof. M. Fouché continued his study of acoustic waves in various resonators. Prof. K. Zuber arrived in 1946 and began to form a research team to investigate ultrasonic propagation and dispersion. By the time Zuber left in 1960, he had supervised the research of 7 or 8 Ph.D. students and had handed over leadership of the team to his Turkish colleague, Prof. Cavid Ener.

Other research groups were led by Turks who had obtained their Ph.D. degrees abroad. These included the research teams led by Fahir Yeniçay on nuclear physics and plasma physics, by Hilmı Benel on thermoelectric couples, and by Sait Akpınar on pH levels and levels of radioactivity in the atmosphere. Altogether between 1940 and 1966, research leading to 26 Ph.D. degrees was successfully performed in the chairs of physics in the Science Faculty of Istanbul University. (213)

At Istanbul Technical University, about 15 articles on mainly theoretical aspects of physics were written between 1949 and 1966 in various chairs, and published in the university journal, the Bulletin of the Technical University of Istanbul.
Meanwhile, the Science Faculty at Ankara University was experiencing considerable growth:

TABLE 4.24

<table>
<thead>
<tr>
<th>Year</th>
<th>No. students</th>
<th>No. students in all facs.</th>
<th>No. Sc. graduates</th>
<th>No. Sc. Fac. teaching staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>1945-46</td>
<td>81 (31% girls)</td>
<td>4,555</td>
<td>-</td>
<td>29</td>
</tr>
<tr>
<td>1950-51</td>
<td>247 (38% &quot; )</td>
<td>6,810</td>
<td>34</td>
<td>66</td>
</tr>
<tr>
<td>1955-56</td>
<td>575 (29% &quot; )</td>
<td>12,670</td>
<td>22</td>
<td>94</td>
</tr>
<tr>
<td>1960-61</td>
<td>2,025 (16% &quot; )</td>
<td>17,850</td>
<td>98</td>
<td>107</td>
</tr>
<tr>
<td>1965-66</td>
<td>1,621 (22% &quot; )</td>
<td>17,901</td>
<td>204</td>
<td>113</td>
</tr>
</tbody>
</table>

Post-graduate work leading to Ph.D. degrees in mathematics was supervised by Prof. W. Strang, and in physical chemistry by Prof. PArts - both foreigners. Little research was accomplished in physics in the early years, except for a theoretical study in thermodynamics by Enis Erdik under the supervision of Prof. Celâl Saraç.

Experimental research in physics was given a boost by the arrival in 1951 of Prof. Erich Fischer from Tübingen at the invitation of the faculty professors. Fischer had already acquired an international reputation for his studies on the dielectric properties of polar liquids, and he was determined to continue his research in Ankara. Soon after his arrival he began to set up the equipment he had brought with him from Germany, with the help of F. Dieringer, one of his former students. By 1956 when Fischer returned to Tübingen, he had supervised the research for 3 Ph.D. theses and had assisted in the research for 2 more. His work in Ankara was to yield 10 research articles, 6 of which were published in foreign journals. Two more Ph.D. theses were written on research performed by Fischer's group after he had left, but by about 1963, the group had more or less disbanded. In all, between 1949 and 1966, 12 Ph.D. theses in physics were written at Ankara University Science Faculty and about 32 in other subjects such as chemistry and mathematics. The faculty began publishing its own journal, Ankara Üniversitesi Fen Fakültesi Dergisi in 1949.

Fischer was also instrumental in bringing about an important course innovation which was to make physics at the Science Faculty far more attractive to undergraduates. When he first arrived, Fischer found
himself lecturing to 2 or 3 students. Upon enquiring why so few students wanted to study physics, he learned that it held no attraction for undergraduates because they identified all physicists with physics teachers. At that time, "The notion of a physicist doing R and D work in industry was not familiar to the general public and especially not to private or government employment agencies and students". Fischer suggested the establishment of a "physics engineering" degree which would be open to students who had completed their 4-year B.Sc. degree in physics with good grades. The students would be required to take a few advanced courses and write a thesis based on experimental or theoretical research. Fischer's proposal was accepted in 1954, and the course became popular. The title "Mühendis" (Engineer), or better still, "Yüksel Mühendis" (Higher Engineer) carries great prestige in Turkey.

In the early 1960's, scientists at METU began to make their presence felt. One group of physicists including Feza Gürsey, who later was to become internationally renowned, published a series of 22 articles up to 1966 on elementary particles and field theory. Other groups published articles on neutron transport and radiative transfer theories. Meanwhile, scientists in the Chemistry Department at METU were beginning to publish research articles, mainly in organic chemistry.

From 1963 onwards, several research articles on reactor theory and plasma theory appeared from groups of scientists attached to the Çekmece Nuclear Research and Training Centre.

The quality of the research performed in Turkey at that time may be gauged from the following figures for the numbers of research articles in physics published in foreign journals. The numbers of articles published in Turkish journals are given in parentheses for comparison:

<table>
<thead>
<tr>
<th>Years</th>
<th>NF^t</th>
<th>NF^f</th>
<th>NA^t</th>
</tr>
</thead>
<tbody>
<tr>
<td>1923-45</td>
<td>1</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>1946-50</td>
<td>1</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>1951-55</td>
<td>5</td>
<td>5</td>
<td>32</td>
</tr>
<tr>
<td>1956-60</td>
<td>19</td>
<td>2</td>
<td>60</td>
</tr>
<tr>
<td>1961-65</td>
<td>40</td>
<td>11</td>
<td>209</td>
</tr>
<tr>
<td>TOTAL</td>
<td>66</td>
<td>22</td>
<td>321</td>
</tr>
</tbody>
</table>
NFt = Nos. of foreign articles based on work done in Turkey by Turks.
NFf = Nos. of foreign articles based on work done in Turkey by foreigners.
NAf = Nos. of articles based on work done outside Turkey by Turks.

After 1960, there was a distinct trend towards publishing outside Turkey. Since at that time scientific journals in Turkey did not have very stringent referee procedures, if any at all, the quality of articles published abroad may be assumed to have been higher than that of articles published inside the country. A study of the titles published abroad shows that most of them were in theoretical physics.

Another generally-accepted measure of scientific quality is the number of citations made by other scientists of a particular research article. İnönü et al. have investigated the numbers of citations in the Science Citation Index received by scientists of Turkish origin between 1961 and 1971. Up to 1966, only 5 research articles based on work performed in Turkey by Turkish scientists received more than 9 citations. Of these 5, 3 were in physics, 1 in mathematics and 1 in chemistry. The chemistry article was the only one based on experimental work. However, at the same time, articles based on research done outside Turkey by Turkish-born scientists obtained very high citations. For example, three papers by Feza Gürsey received 384, 208 and 119 citations; three by O. Sinanoğlu received 113, 112, and 82 citations; and three by Y. Yafet received 115, 81 and 79 citations. In 1965 alone, Gürsey received a total of 355 citations, while K. Bardakçı received 143.

As for research productivity in the period 1923-66, about 222 physics research papers were written on work done in Turkey either by Turks or by Turks collaborating with foreigners. 59 research papers were written by 25 foreigners alone. Over the same period, about 320 papers were written by Turks based on research work they had performed abroad. In all, about 540 research articles were published inside and outside Turkey by 108 Turkish scientists, 12 of whom published just over half the total number, with at least 11 papers each. The most productive physicists were four who had published 69, 41, 33 and 25 papers each; the second of these was an experimental physicist, while the other three were theoreticians.

İnönü has identified the institutions where 273 pieces of research were
performed. The distribution for the period 1936-66 is as follows:

<table>
<thead>
<tr>
<th>IU</th>
<th>HAI and AU</th>
<th>ITU</th>
<th>METU</th>
<th>CNRTC</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>167</td>
<td>41</td>
<td>15</td>
<td>30</td>
<td>20</td>
<td>273</td>
</tr>
<tr>
<td>(61%)</td>
<td>(15%)</td>
<td>(5%)</td>
<td>(11%)</td>
<td>(7%)</td>
<td></td>
</tr>
</tbody>
</table>

IU = Istanbul University  
HAI = Higher Agricultural Institute (Ankara)  
AU = Ankara University  
ITU = Istanbul Technical University  
CNRTC = Çekmece Nuclear Research and Training Centre

The number of physics research papers produced at Istanbul University each year displays the following trend. Except for a short period at the end of the Second World War, there is a gradual increase, reaching a maximum between 1953 and 1958, and then a decline to pre-1952 levels. A similar trend is displayed at Ankara University, except that the maximum is reached between 1952 and 1957 and is much less pronounced than that at Istanbul. İnönü comments that this trend "apparently shows that the universities have not been able to organize new research groups as the old groups break up and lose their productivity in time". Furthermore, this breaking-up is usually caused by the leader of the group going abroad or moving to another research institution inside Turkey.

In chemistry and related subjects such as biochemistry and chemical engineering, only the total numbers of publications by Turks and by foreigners publishing anywhere are available.

<table>
<thead>
<tr>
<th>Years</th>
<th>( N^t )</th>
<th>( N^f )</th>
<th>( NA^c )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1930-45</td>
<td>63</td>
<td>63</td>
<td>27</td>
</tr>
<tr>
<td>1946-50</td>
<td>131</td>
<td>36</td>
<td>16</td>
</tr>
<tr>
<td>1951-55</td>
<td>218</td>
<td>17</td>
<td>67</td>
</tr>
<tr>
<td>1956-60</td>
<td>142</td>
<td>10</td>
<td>104</td>
</tr>
<tr>
<td>1961-65</td>
<td>197</td>
<td>5</td>
<td>221</td>
</tr>
<tr>
<td>TOTAL</td>
<td>751</td>
<td>131</td>
<td>435</td>
</tr>
</tbody>
</table>
\[ N_t = \text{Nos. of research articles based on work done in Turkey by Turks.} \]
\[ N_f = \text{Nos. of research articles based on work done in Turkey by foreigners.} \]
\[ NAt = \text{Nos. of research articles based on work done abroad by Turks.} \]

The doubling of the number of research articles based on work done abroad by Turkish chemists between 1961 and 1965 is a result of the increasing numbers of Turks sent abroad to obtain higher degrees following the military coup in 1960.

Several trends in the annual figures for publications in chemistry and in physics are discernible. In physics, the number of research articles published by Turks based on work abroad first began to exceed the number based on work in Turkey in 1958; by about 1960 it was double and it continued at that level until 1965 when it became almost three times as great. Publications based on research work done abroad increased around 1957 with the sending of Turkish scientists to America under the auspices of the Atomic Energy Commission. On the other hand, in chemistry the number of articles based on work done abroad first equalled the number based on work done inside Turkey in 1959, and it stayed at about the same level until 1965 when it began to increase.

Publications in chemistry display far more of a local character than those in physics. 63% of all research in chemistry by Turks was published inside Turkey compared to only 41% of all research by Turks in physics. This was probably because the proportion of the 108 publishing Turkish physicists who received their training abroad was higher than the proportion of the 325 Turkish chemists who did so.

Publications by foreigners in chemistry fell steadily after about 1950. In physics, publications by foreigners were still fairly high even in 1966, although none are recorded for some years.

Between about 1955 and 1965, there was no significant increase in publications based on physics and chemistry research performed inside Turkey. In fact in both cases there was a low around 1959-60 and then a fairly rapid increase after 1961. İnönü comments that this situation reflects the critical state of scientific research in Turkey between 1955 and 1960, when it was hampered by economic difficulties in particular. The figures emphasize that research laboratories can seldom be isolated...
from their general economic milieu. Not only was importation of necessary supplies and equipment difficult because of the lack of foreign exchange, but also the high annual rate of inflation (approximately 15%) encouraged lecturers to take up part-time teaching posts outside the universities, a practice which did not leave much time for engaging in research.

In his study, Özönün found that only a non-representative 30% of his respondents replied to questions on publications. However, he did discover the following. The greatest number of books translated by any individual respondent was 13. The greatest number of textbooks written was 11 by a professor, 4 by a docent, and 2 by a Ph.D. The number of papers written by respondents varied from 1 to 45. Visiting foreign professors appeared to publish more than their Turkish counterparts. Turkish scientists who lived abroad or who frequently travelled abroad published more research articles than those who stayed in Turkey.

4.2.13 The training of research personnel

Özönün reported the following distributions of Turkish scientists with Ph.D. degrees in various disciplines for different years.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1942</td>
<td>10</td>
<td>10</td>
<td>1</td>
<td>12</td>
<td>16</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>(16.4)</td>
<td>(16.4)</td>
<td>(1.6)</td>
<td>(19.7)</td>
<td>(26.2)</td>
<td>(4.9)</td>
<td>(9.8)</td>
<td>(4.9)</td>
<td></td>
</tr>
<tr>
<td>1954</td>
<td>34</td>
<td>32</td>
<td>8</td>
<td>50</td>
<td>45</td>
<td>15</td>
<td>22</td>
<td>14</td>
<td>223</td>
</tr>
<tr>
<td></td>
<td>(15.2)</td>
<td>(14.3)</td>
<td>(3.6)</td>
<td>(22.4)</td>
<td>(20.2)</td>
<td>(6.7)</td>
<td>(9.9)</td>
<td>(6.3)</td>
<td></td>
</tr>
<tr>
<td>1966</td>
<td>61</td>
<td>65</td>
<td>11</td>
<td>104</td>
<td>95</td>
<td>26</td>
<td>39</td>
<td>28</td>
<td>429</td>
</tr>
<tr>
<td></td>
<td>(14.1)</td>
<td>(15.0)</td>
<td>(2.5)</td>
<td>(24.1)</td>
<td>(22.0)</td>
<td>(6.0)</td>
<td>(9.0)</td>
<td>(6.5)</td>
<td></td>
</tr>
</tbody>
</table>

Percentages are given in parentheses;
I-D = Inter-disciplinary areas;
E.Scs. = Earth Sciences

The rate of growth in the numbers of chemists and biologists is greater than that in the numbers of physicists and mathematicians.

Overall, Özönün's data shows the following pattern of growth in the numbers of Turks obtaining Ph.D. degrees each year since 1933. After a
spasmodic beginning, there was a steady increase of about 8 scientists a year between 1937 and 1942. The rate of growth slowed during and immediately after the Second World War, and then there was a sharp increase between 1948 and 1951. This may be attributed to the rise in the number of teaching and research posts in the expanding Science Faculties of Istanbul and Ankara Universities, and to the obtaining of Ph.D. degrees by the first batches of Ph.D. students in the same faculties. Between 1952 and 1965 there was a steady increase of about 17 scientists a year.

As for supervisors of Ph.D.'s, about 15% of Özinoğlu's sample were trained by foreign professors abroad, 35% by foreign professors in Turkey and 50% by Turkish professors in Turkey. Of those Ph.D.'s supervised by visiting foreign professors, nearly half were supervised by a small group of highly industrious scientists. At least 40% of the Turkish professors in Özinoğlu's sample had never supervised a Ph.D. student. They explained this by saying that it was customary for chair professors only to supervise research assistants. The number of Turks who supervised Ph.D. students was even less than might have been expected since some chairs were occupied by visiting foreign scientists.

Even with those professors who did begin supervising Ph.D. students immediately after obtaining their professorships, there was still a long gap between the time when they obtained their Ph.D. degree and the time when they supervised their first research student. The average was 15 years while for some it was 28 years. Such a time-lag in disciplines in which the amount of knowledge doubles every 10-15 years meant that there was a good chance of professors being well behind the frontiers of knowledge when they first began to supervise Ph.D. students.

Özinoğlu's data revealed a distorted manpower structure for scientists in basic sciences in 1966:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of professors</td>
<td>= 150 (22%)</td>
</tr>
<tr>
<td>Number of docents</td>
<td>= 100 (15%)</td>
</tr>
<tr>
<td>Number of asistans/instructors with Ph.D.'s</td>
<td>= 180 (26%)</td>
</tr>
<tr>
<td>Number of asistans without Ph.D.'s</td>
<td>= 250 (37%)</td>
</tr>
</tbody>
</table>
The number of docents is small in proportion to the number of professors. This meant that professors had to undertake more teaching than would have been the case if there had been more docents. The reason for the low number of docents was probably that in the mid-1950's, the low pay of asistans in comparison to that in other professions made an academic career unattractive to graduates.

In general, the quality of Ph.D. theses submitted to Turkish universities was not very high. According to Okyar, "doctoral studies probably constitute the most neglected and most haphazard aspect of university teaching... There is little systematic instruction given to the Ph.D. candidate as he advances towards the final stage." While some professors take an active interest in their doctoral students, "more often the student is left simply to his own devices and the outcome is generally a weak piece of writing of a repetitive and descriptive character which the professor has scarcely seen before it is submitted and which in the end somehow gets accepted as a Ph.D. thesis." (232)

4.2.14 The Conducents by 1960

With the increase in the literacy rate, the expansion in the educational system and the more widespread use of media such as the book, the newspaper and the radio, conducents Ib, Ic, Id and Ie were disseminated amongst an increasing number of people between 1945 and 1960.

It is true that in 1951 one observer could write of fatalistic acceptance of disease by Turks as an obstacle to modern medical care; (233) that in 1957 Nabi could lament: "We are still toiling to teach people that natural phenomena are the result of natural causes"; (234) and that in 1959, Bradburn's research in Turkey indicated that the main non-economic forces retarding economic development in Turkey were "cultural value-orientations centering around ... a non-activist approach to the environment and a consequent low need for achievement". (235) Nevertheless Bradburn could also detect evidence of change, while Robinson could discern even at village level a considerable desire for material progress and innovation. (236) A prime agent in arousing such desires was the Democrat government which appeared soundly religious, but which continually held up the prospect of national economic development. In an era of multi-party politics, voters had to be wooed with the promise of future material benefits and
greater religious freedom. The notion of material progress thereby became increasingly diffused throughout even the rural areas of Turkey.

By the end of the 1950's, nearly all parties were agreed, in principle at least, on the need for science and technology as a means of national development (conducent If). On the whole, the Islamist Turks saw no conflict between science and religion, even orthodox Islam. The right-wing Kemalist Turks wanted to see the state run along "scientific" lines, but they also saw the need for an Islam, which in its "uncorrupted form" was not contrary to science but encouraged it. The more left-wing Kemalist Turks continued to view science as an ideology which was in antithesis to religious beliefs and superstitions. Thus, in 1957 a writer in Varlik complained: "What a pity that we have not been able to shine the light of science into our country as it should have been ... we have not been able to save people's minds from the prisons of superstitions inside which they have been locked." Another writer in Yeni Ufuklar saw religion and science as opposed to one another and a true aydın or enlightened person as someone who not only believed in science but who acted to remove from society anything contrary to it, including, presumably, religious beliefs. However, it is unlikely that such brandishing of science as an ideological weapon would have discouraged a right-wing Turk from taking up the study of science; he would have been reassured by the assertions of other rightists that there was no real conflict between science and Islam. Science-as-ideology would probably have been regarded as the propaganda of irreligious materialists.

At the same time, there were voices raised which questioned how much science was being utilized in practice, that is, the extent to which it was really valued in Turkey. The National Commission on Education felt that although lip-service was paid to science, too little importance was given to scientific research in the decision-making processes of the state. Turhan, too, considered that the praises of science had been sung in word but not in deed. According to another commentator, part of the blame for this state of affairs lay with the scholars and scientists themselves; they had perpetuated the notion that the further knowledge was removed from everyday experience, the greater was its value. While such a concept of knowledge may have attracted to science those who were interested in science for science's sake, it cannot have made science attractive to
idealists who were keen to contribute to Turkey's economic development.

However, for most potential research scientists, there were more immediate and practical considerations involved in choosing a career in scientific research, the chief of which was financial. Someone embarking on an academic career had to face the prospect of 7 - 10 years of low pay as an asistan, with the hurdle of the doçentship examination to surmount before becoming a full member of the academic staff. There were higher returns on a career as an engineer in industry, for example. Thus it was unlikely that many able students would be found amongst the intake into basic sciences at university level (conducent VIIa).

It is not clear to what extent experimental research activity was regarded as manual labour, nor the extent to which manual labour was still looked down upon (conducent Ia). One memory of İnönü's may be apposite, however: "When I was studying at university and even when I first took up a post at university [in the early 1950's], the main task of my friends who had completed their education in engineering was to check tenders in an office on behalf of the government. There were very few who worked on a site or who prepared projects. I think proper engineering really got going much later, perhaps within the past ten years [i.e. since 1968]."

The methodological conducents (II) were a function of the educational system, which as we have seen above had many shortcomings. From primary school to university, the main emphasis seemed to be on cultivating an ability to memorize information for the duration of examinations. As Sabahattin Eyuboğlu bewailed, "We know the harm which is caused by bookish, estranged-from-life teaching, which nurtures memorization, don't we? And yet somehow we cannot get out of this rut." Curiosity and original thinking were hardly encouraged by this stress on memorization. The result was that even in scientific research there was a tendency to repeat experiments instead of devising new ones. Another result was a lack of critical thinking; where it did exist, it often descended to the level of personal recrimination instead of remaining on that of objective evaluation.

Even at postgraduate level, the rigid and formal lines of the academic hierarchy were not conducive to two-way intellectual exchange. However, there were some Turks who were obtaining their Ph.D. degrees or who were
undertaking post-doctoral research in the less formal atmosphere of research laboratories outside Turkey. Moreover, there such people had opportunity to learn of the existing scientific and technical consensus of their sub-disciplines (conduent III) and to become familiar with the cognitive and manipulative skills needed for scientific research (conduent IV). Working alongside scientists in some of the best research laboratories in Europe and America, they were also able to form a high conception of the role of a research performer and to experience high informal and even formal role-expectations (conduents V and VI). At the same time, in most cases, role-facilities (VII) were abundantly available. The effect of such factors upon Turkish scientists outside Turkey is apparent from the increasing number of research publications they wrote in the early 1960's.

Much the same was true for postgraduate students working under the supervision of foreign professors in Turkey. Role-facilities such as equipment and supplies, technicians and research literature were, however, lacking in most cases, especially as the general economic situation deteriorated in the second half of the 1950's. Postgraduate students being supervised by Turkish professors probably had some additional handicaps: their supervisors were likely to be out of touch with current developments in the sub-discipline and also were unlikely to devote much time to research because of outside teaching commitments. Moreover, the standard of research work expected from Ph.D. students at Turkish universities seems to have been lower than that expected from Ph.D. students abroad.

However, the 1960's and 1970's were to witness some significant developments in the volume and quality of indigenous Turkish scientific research.

4.3 The Republic from 1960 until 1979

4.3.1 The political background to the period

Political and economic instability continued to characterize Turkey in the 1960's and 1970's. The military coup of May 27th, 1960 led by General Cemal Gürsel resulted in a change of constitution, the banning of the Democrat Party and the execution of Mr. Menderes and two of his former Ministers. Power was handed back to civilians in October 1961, following
a general election. The Justice Party (JP), which had been created earlier in the year with the support of many former Democrats did well, and the Republican People's Party (RPP) did not gain an absolute majority. Ex-President İsmet İnönü was called in to preside over a series of coalition governments which survived until February, 1965. Over the next six years, the Justice Party was in power under the leadership of Süleyman Demirel, winning absolute majorities in the general elections of October 1965 and October 1969.

However, in March 1971, as urban guerillas stepped up their activities and the economy continued to deteriorate, the Chief of Staff and the Commanders of the Land, Sea and Air Forces presented an ultimatum to the politicians calling for strong measures to deal with anarchy and inflation or risk a military takeover. Demirel promptly resigned and was replaced by Nihat Erim and an above-party Cabinet of politicians and technocrats. Martial Law was declared a month later. It was to continue for the next two and a half years, during which thousands of extremists were rounded up and tried by special courts.

From March 1971 until December 1979, there were ten changes of government in Turkey, often interspersed with periods of political stalemate when the heads of various parties endeavoured to form coalitions which would possess an absolute majority in parliament. From about 1974 onwards, Ministers became increasingly partisan and would stock their Ministries with men from their own parties, basing their choices more on political views that on ability for the job. As the balance of power oscillated between Left and Right, the top civil servants in the Ministries changed with each succeeding change of government, resulting in lack of continuity and the appointment of men to positions for which they had little or no previous experience. Also, the bitterness of outgoing senior officials posted from the comparative comfort of Ankara to remote and unattractive corners of Anatolia only increased the hostility between Right and Left.

Two above-party governments under Nihat Erim were followed in May 1972 by another under the leadership of Ferit Melen. In April 1973, this was replaced by a temporary coalition between the left-of-centre RPP and the right-of-centre JP, a coalition designed to prepare the country for a general election in October of that year. The election did not produce an absolute majority for any party and political stalemate ensued. Finally
in January 1974, Eülent Ecevit, the leader of the RPP succeeded in forming a coalition with a fundamentalist Islamic party led by Necmettin Erbakan, a former professor at Istanbul Technical University. The coalition lasted through the Cyprus crisis of August 1974, but in September 1974, Ecevit no longer found it possible to co-operate with his right-wing coalition partner and he resigned the premiership.

Another period of instability followed and a transitional government was formed until Süleyman Demirel was able to organize a "National Front" coalition government consisting of four right-wing parties, including Erbakan's party and a militant right-wing Turkist-Islamist Party called the National Movement Party. This coalition held together for two years until the general election of June 1977 when the RPP increased its share of the vote, but still failed to obtain an absolute majority. Demirel again managed to persuade the other two main right-wing parties to form a National Front. However, this was shortlived. Defections by eleven JP's enabled Ecevit to form a government, until he was again ousted by Demirel supported by the other right-wing parties in October 1979.

There was increasingly bitter and violent polarization between Right and Left from the late 1960's onwards. Initially, violence was confined to university campuses and student hostels. Inspired by the May 1968 riots in Paris, leftist students began a series of boycotts and clashes with the authorities which continued on many campuses until April 1971, when, with the declaration of Martial Law, overt political activity by students was forbidden. Over the next few years, the leftists became increasingly confronted by a growing army of komandos - rabidly anti-communist Turkist-Muslim youths who regarded the extermination of the leftist "microbes" as their holy and patriotic duty. Fights with sticks and stones between the two groups gave way to clashes with guns and bombs. Soon every university campus and student hostel was subject to extraordinary precautions in which students were searched upon entry. By about 1976, violence had spread from the campuses onto the streets. Political assassinations were to become everyday occurrences rising from 1 - 2 people a week in 1976 to about 50 a week in 1979. Finally, following the deaths of 107 people in a series of violent incidents in south-east Turkey in December 1978, Martial Law was declared in thirteen provinces, and in April 1979 was extended to six others.
The effect of all this upon academics was immense. Every act of violence involving students or staff - both on and off the campus - necessitated extraordinary meetings of university senates and other administrative bodies, which disrupted normal routines. Many academics were harrassed by students or even attacked physically, whereupon faculties or even whole universities would be closed in protest. Forums and boycotts took up days and weeks of academic time, which necessitated frequent re-scheduling of curricula in special administrative meetings. Each fresh disturbance would lower the morale of the academic staff. Each break in the term would disturb teaching and research continuity. Moreover, security precautions prevented staff from staying on in university buildings after dark, when perhaps they might have wished to continue with a particular piece of research.

METU was a particularly active site of student unrest. Following several boycotts, it was closed completely for several months in 1971 after students had fought a gun battle with army units. Other boycotts of six months each took place in 1975 and in 1976-77. In nearly every case, students who boycotted classes - usually under duress - were not penalized; time was made up by shortening terms, vacations and syllabi.

Violence on campus and street was nurtured by weak governments and a crisis-ridden economy.

4.3.2 Economic trends over the period

With the coming to power of the military, an element of rationalization was introduced into the Turkish economy. In September 1960, a State Planning Organization was established, and later incorporated into the 1961 Constitution under Article 129. Its main task was to draw up a Five-Year Development Plan, which went into effect in 1963. The Second, Third and Fourth Five-Year Plans were initiated in 1968, 1973 and 1978, although in the 1970's, the policies laid down in the plans were frequently disregarded by the governments of the day.

Also written into the 1961 Constitution as official economic policy was étatisme, or the authorization for state enterprises to exist alongside a private sector. A large number of such enterprises had been established since the 1930's, ranging from those concerned with basic infrastructure
activities such as energy, water, transport and communications to those involved in mining and manufactured goods. In general, they tended to be inefficient and had to be heavily subsidised by the state. Politically unpopular price increases on such things as sugar, paper, cement, railway tickets and telephone and postal charges were often delayed far longer than was economically advisable. Moreover, after about 1974, their top administrative personnel began to be selected more on the basis of their political colours than on their ability, colours which changed with every succeeding government. Overall deficits of State Economic Enterprises amounted to 6,700 million lira in 1976 and 8,800 million lira in 1977.\(^{(248)}\)

Despite the handicap of the SEE's, the economy experienced a fairly steady growth over the period, with the GNP increasing by between 6 and 8% until 1977-78, when there was a drop to 3 - 4%. Near zero growth occurred in 1979.\(^{(249)}\) Per capita GNP increased more than three-fold between 1970 and 1978, but was adversely affected by an annual population increase of 2.5%:

**TABLE 4.30**

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Per capita GNP ($)</td>
<td>240</td>
<td>280</td>
<td>320</td>
<td>350</td>
<td>990</td>
<td>1,200</td>
</tr>
</tbody>
</table>

(calculated from figures given in ESIT, p.11 and TA, p.183)

Although exports increased by a factor of 7 between 1960 and 1978, imports increased by a factor of 10:

**TABLE 4.31**

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Exports (Millions of $)</td>
<td>321</td>
<td>464</td>
<td>588</td>
<td>1,401</td>
<td>1,753</td>
<td>2,288</td>
</tr>
<tr>
<td>Imports</td>
<td>468</td>
<td>572</td>
<td>948</td>
<td>4,738</td>
<td>5,796</td>
<td>4,599</td>
</tr>
<tr>
<td>Trade balance</td>
<td>-147</td>
<td>-108</td>
<td>-360</td>
<td>-3,337</td>
<td>-4,043</td>
<td>-2,311</td>
</tr>
</tbody>
</table>

(from ESIT, p.30 and TA, p.220)

The foreign trade balance was offset to some extent by income from tourism, although this was well below that of northern Mediterranean countries. Another valuable source of income were the remittances sent by Turkish
migrant workers living in Germany and other European countries from 1962 onwards. This movement of labour reached a peak of 100,000 a year before the recession resulting from the 1973 oil crisis persuaded European countries to close their gates to imported labour. Remittances rose from $20 million in 1962 to $78 million in 1965. Income from remittances and from tourism between 1971 and 1979 is shown below:

TABLE 4.32

<table>
<thead>
<tr>
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<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Workers' remittances</td>
<td>471</td>
<td>1,183</td>
<td>1,312</td>
<td>982</td>
<td>1,694</td>
</tr>
<tr>
<td>Tourism</td>
<td>21</td>
<td>78</td>
<td>46</td>
<td>-55</td>
<td>186</td>
</tr>
</tbody>
</table>

(From OECD/T)

The continuous balance of payments deficit was met by loans from various foreign consortia made up of governments and private banks. By 1972, Turkey's foreign debts amounted to more than $3,000 million. However, worse was to come. As 80% of its oil had to be imported, every increase in the price of oil by the OPEC countries sent Turkey's oil bill soaring ever higher. By the end of 1979, the cost of imported oil was running at over $200 million a month, and Turkey's total foreign debts had reached an estimated $15,700 million. Besides oil, the main demand for foreign exchange was on imports of industrial raw materials and investment goods.

As a precondition for obtaining foreign credits, successive Turkish governments had to agree to undertake measures designed to stabilize the economy. These involved devaluations of the lira from 9.00 to the dollar to 14.85 in August 1970, from 17.50 to 19.25 in September 1977, and from 19.25 to 25.00 in March 1978. An even greater devaluation, from 26.50 to 47.10, was undertaken in June 1979. Unfortunately, each devaluation was succeeded by a sharp rise in domestic prices, especially on goods made from imported raw materials.

Although the level of inflation was kept below 10% throughout most of the 1960's, in the early 1970's it began to rise much more steeply. The wholesale price index and the cost of living indices for Istanbul and Ankara over selected years are shown below:
Between 1976 and 1979, the cost of living indices rose by a factor of 3. They did not include rent (and repair), which between 1975 and 1979 is estimated to have increased by 750%. (252)

There were other factors which fuelled inflation besides devaluations and oil price rises. One was the increase in consumer spending power resulting from the remittances of Turkish workers abroad. Another factor was the periodic increases in the salaries of civil servants, although these tended to lag well behind the rate of inflation. Also, in the 1970's, increasingly powerful trades unions were able to obtain very large wage increases for industrial workers, all of which had to be absorbed by increases in the prices of manufactured goods. Average daily wages in 1978 had increased almost sixfold over those in 1970. (253) A third factor was the prices on agricultural products guaranteed to farmers by the government, which in bumper years could add substantially to consumer spending and government deficits.

Until about 1977, industrial production rose in nearly every sector. The production of selected products for various years is shown below (1,000 tons):

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>WPI</td>
<td>100</td>
<td>146</td>
<td>199</td>
<td>312</td>
<td>397</td>
<td>742</td>
<td>1,203</td>
</tr>
<tr>
<td>CLI (Ist.)</td>
<td>100</td>
<td>156</td>
<td>214</td>
<td>302</td>
<td>430</td>
<td>876</td>
<td>1,409</td>
</tr>
<tr>
<td>CLI (Ank.)</td>
<td>100</td>
<td>148</td>
<td>208</td>
<td>278</td>
<td>386</td>
<td>724</td>
<td>1,158</td>
</tr>
<tr>
<td>Rent</td>
<td>100</td>
<td>n.a.</td>
<td>196</td>
<td>239</td>
<td>359</td>
<td>1,015</td>
<td>2,300(est.)</td>
</tr>
</tbody>
</table>

WPI = Wholesale price index n.a. = not available
CLI (Ist.) = Cost of living index for Istanbul
CLI (Ank.) = Cost of living index for Ankara
(from OECDT and SYT, p. 387)
The fall-off in production in various industries in 1977 and thereafter was due to the severe shortage of foreign exchange, which prevented the importation of sufficient raw materials and machinery. By 1979, Turkish industries were working only at about 50% capacity. All available foreign exchange was being used for the purchase of oil for an important power-station and for petrol and diesel fuel, upon which Turkey's transport system depended. Turkish industries were further affected by electricity cuts - scheduled and unscheduled - which became a regular feature of Turkish life from the winter of 1977-78 onwards.

A significant feature of Turkish industry is the sparseness of its research effort. This is particularly true of the private sector, where several studies in the late 1960's found research to be almost non-existent, a situation which in 1978 qualified observers felt had not changed much since. In the ten or so research laboratories found in industries in the public sector, research was mainly confined to solving manufacturing problems, doing routine analysis, or making minor modifications to already-existing plants and processes. New products are built under licence, either by companies in the public sector or by the 100-odd multi-national companies operating in Turkey. As the Second Five-Year Plan observed, "Research activities in the private sector are generally limited to quality control and testing. Firms have no need to do research because they can make
There are several other noteworthy characteristics of the Turkish economy. An industrial census in 1970 recorded a total of 175,300 industrial establishments of which less than 3% (4,820) employed more than 10 workers; however, these establishments produced about 88% of the total manufacturing income of Turkey. Such a proliferation of small industrial establishments means that the very structure of Turkish industry hinders the formation of industrial research laboratories and hence limits employment prospects for potential industrial research scientists.

A similar unevenness exists in the income distribution of society. In 1973, about 15% of the population received 50% of the national income. Such extreme differences between rich and poor have only served to aggravate social unrest. Furthermore, the tax system does nothing to compensate for inequalities in earnings. While comparatively low-income civil servants and workers are taxed up to one third of their gross income at their place of employment, wealthy self-employed professionals and businessmen are able to escape taxation because of weak tax inspection and loopholes in the law. Farmers, too, are largely exempt from taxation, even though the agricultural sector produces over a quarter of the GNP. The politically powerful rural voters have resisted any attempts to change this situation.

As for unemployment, it remained high throughout the period. Seasonal and partial employment made unemployment figures difficult to determine. However, in 1978-79, the number of unemployed Turks probably amounted to 15 - 20% of the labour force. Out of 450,000 Turks who entered the job market each year, only 40% could expect to find work. The situation was alleviated until about 1974 by the migration of Turkish workers to (mainly) European countries. In 1976, over 800,000 Turkish workers were registered as being employed abroad.

Difficulties in the economy affected Turkish research scientists to a considerable extent. The shortage of foreign exchange was probably the most influential factor. It resulted in frequent electricity cuts which defeated even stand-by generators and so disrupted experiments. The importing of equipment, spare parts and materials needed for research became virtually impossible for most scientists. Even when foreign
exchange was available, devaluations raised the equivalent price in Turkish lira by as much as 85% overnight. Only those scientists who had access to foreign currency supplied by foreign foundations and organizations such as NATO and CENTO were able to obtain research requirements from abroad. At the same time, constantly rising prices reduced research allocations in real terms. Meanwhile salary increases lagged behind the rate of inflation, and, as in the late 1950's, academics became increasingly tempted to take on part-time teaching posts at other establishments, at the expense of time which could have been spent on research. The increase in the price of houses and rented accommodation, and of heating costs, which shot up with every devaluation, also put a considerable strain on the average academic. Thus, an academic career became increasingly unattractive to able students, who could achieve a much higher standard of living as doctors, or as engineers in the private sector. By the end of 1979, even unskilled workers, with advantageous wage agreements and fringe benefits arranged through powerful trades unions, seemed to be catching up on the salary scales of academics.

4.3.3 Other socio-economic trends

The increase in the population showed no signs of flagging over the period. Birth-control was not encouraged either by religious authorities or by militant nationalists, who took pride in depicting a population of 50 million Turks by 1985, even though in reality the burden of an additional one million people a year was severely overstraining the social and economic infrastructure. The rural and urban population by various years was as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Total (Millions)</th>
<th>Urban %</th>
<th>Rural %</th>
<th>Urban %</th>
<th>Rural %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>20.9</td>
<td>5.2</td>
<td>15.7</td>
<td>24.9</td>
<td>75.1</td>
</tr>
<tr>
<td>1955</td>
<td>24.1</td>
<td>6.9</td>
<td>17.2</td>
<td>28.6</td>
<td>71.4</td>
</tr>
<tr>
<td>1960</td>
<td>27.8</td>
<td>8.9</td>
<td>18.9</td>
<td>32.0</td>
<td>68.0</td>
</tr>
<tr>
<td>1965</td>
<td>31.4</td>
<td>10.8</td>
<td>20.6</td>
<td>34.4</td>
<td>65.6</td>
</tr>
<tr>
<td>1970</td>
<td>35.6</td>
<td>13.7</td>
<td>21.9</td>
<td>38.5</td>
<td>61.5</td>
</tr>
<tr>
<td>1975</td>
<td>40.3</td>
<td>16.9</td>
<td>23.5</td>
<td>41.8</td>
<td>58.2</td>
</tr>
<tr>
<td>1979 (est.)</td>
<td>44.2</td>
<td>21.5</td>
<td>22.7</td>
<td>48.6</td>
<td>51.4</td>
</tr>
</tbody>
</table>

Urban = provincial and sub-provincial centres
Rural = villages
(from ESIT, p.1 and SYT, p.30)
The percentage of the population living in urban areas almost doubled between 1950 and 1979, highlighting the migration to urban centres. The big cities grew in a spectacular fashion. In the 20 years between 1955 and 1975, the populations of Istanbul and Izmir doubled, to become 2.5 million and 0.6 million respectively, while that of Ankara more than tripled, to become 1.7 million. Over the same period, the number of cities with populations of more than 100,000 rose from 6 to 27. (263)

The literacy rate rose to 61.6% in 1975, although it was still only 48.3% for females:

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Male</th>
<th>Total Female</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.of literates</td>
<td>No.of literates</td>
</tr>
<tr>
<td></td>
<td>PP6+</td>
<td>No.of literates</td>
</tr>
<tr>
<td>1950</td>
<td>5.9</td>
<td>4.1</td>
</tr>
<tr>
<td>1955</td>
<td>7.9</td>
<td>5.5</td>
</tr>
<tr>
<td>1960</td>
<td>8.9</td>
<td>6.2</td>
</tr>
<tr>
<td>1965</td>
<td>12.5</td>
<td>8.4</td>
</tr>
<tr>
<td>1970</td>
<td>16.2</td>
<td>10.3</td>
</tr>
<tr>
<td>1975</td>
<td>20.7</td>
<td>12.8</td>
</tr>
</tbody>
</table>

PP6+ = As percentage of population 6 years old and over.
(from ESIT, p.5 and SYT, pp.41-42)

The percentage of male and female literates almost doubled between 1950 and 1975. However, some provinces, especially in the south-east, still had much lower literacy levels than the national norm.

The number of books published annually increased steadily until 1973, after which it declined slightly. In 1977, 6,830 books were published and 2,352 newspapers and periodicals, divided among the following subjects:
<table>
<thead>
<tr>
<th></th>
<th>No. of books</th>
<th>% of total</th>
<th>No. of newspapers, periodicals</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>General:</td>
<td>689</td>
<td>10.1</td>
<td>1,134</td>
<td>48.2</td>
</tr>
<tr>
<td>Philosophy:</td>
<td>196</td>
<td>2.9</td>
<td>11</td>
<td>0.5</td>
</tr>
<tr>
<td>Religion:</td>
<td>327</td>
<td>4.8</td>
<td>24</td>
<td>1.0</td>
</tr>
<tr>
<td>Social Sciences:</td>
<td>2,158</td>
<td>31.6</td>
<td>734</td>
<td>31.2</td>
</tr>
<tr>
<td>Philology:</td>
<td>166</td>
<td>2.4</td>
<td>5</td>
<td>0.2</td>
</tr>
<tr>
<td>Fine arts, sport, tourism:</td>
<td>346</td>
<td>5.1</td>
<td>113</td>
<td>4.8</td>
</tr>
<tr>
<td>Literature:</td>
<td>950</td>
<td>13.9</td>
<td>65</td>
<td>2.8</td>
</tr>
<tr>
<td>History, geography, biography:</td>
<td>483</td>
<td>7.1</td>
<td>19</td>
<td>0.8</td>
</tr>
<tr>
<td>Basic sciences:</td>
<td>502</td>
<td>7.3</td>
<td>32</td>
<td>1.4</td>
</tr>
<tr>
<td>Applied sciences:</td>
<td>1,013</td>
<td>14.8</td>
<td>215</td>
<td>9.1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>6,830</strong></td>
<td><strong>100.0</strong></td>
<td><strong>2,352</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

(totals from SYT, p.117)

Thus, basic and applied sciences accounted for 22.1% of the total number of books published, and 10.5% of the total number of newspapers and periodicals published. The science books were mainly textbooks.

The combined daily circulation of Turkish daily newspapers grew to a total of more than 2 million in May 1979. (264) The political slant of the newspapers ranged from extreme right-wing to extreme left-wing, although the high circulation newspapers tended to be independent or moderate.

From personal observation, Turks in general read very few books, preferring to read newspapers, magazines and periodicals. While scientific articles of a popular nature - especially on the latest technological developments outside Turkey - do appear in many newspapers and magazines, the only popular magazine devoted to scientific topics was *Bilim ve Teknik* (Science and Technology), published by TÜBİTAK, the Scientific and Technical Research Council of Turkey. This had a circulation of 70,000 at the end of 1979. (265)

The number of radios increased rapidly over the period, especially in the villages. Also, from 1971 onwards, there was a remarkable expansion in
the television transmitting network, from a small station serving only part of Istanbul one evening a week to a chain of transmitters reaching 96% of the population with up to 56 hours of programmes a week in 1979. The numbers of registered radio and television sets for selected years are shown below:

TABLE 4.38

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>No. of radio sets (1,000's)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in towns/cities:</td>
<td>1,414</td>
<td>2,083</td>
<td>2,615</td>
<td>2,777</td>
<td>2,908</td>
</tr>
<tr>
<td>in villages:</td>
<td>402</td>
<td>1,085</td>
<td>1,396</td>
<td>1,343</td>
<td>1,371</td>
</tr>
<tr>
<td><strong>No. of T.V. sets (1,000's)</strong></td>
<td>2,083</td>
<td>2,615</td>
<td>2,777</td>
<td>2,908</td>
<td>3,431</td>
</tr>
<tr>
<td>in towns/cities:</td>
<td>600</td>
<td>2,194</td>
<td>1,343</td>
<td>1,371</td>
<td></td>
</tr>
<tr>
<td>in villages:</td>
<td>11</td>
<td>39</td>
<td>337</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(from SYT, 1975, p.288 and 1979, p.298)

From personal observation, the effects of the spread of television viewing were twofold. First, skilful television advertising aroused the desire of most Turks for more consumer goods. Second, television acted as an educative influence upon the population as a whole, but on Turkish females in particular, who in the past had often been cut off from the outside world because of lack of education and strong social mores. Although programmes on specifically scientific and technological themes appear only rarely, there are a large number of series of American origin (Star Trek included) which in all probability raise the conscious or subconscious level of technological awareness.

Telephone communications were still poor by the end of 1979, although the number of telephones had doubled since 1973. Direct dialling was introduced only in 1978 and then only between a few selected cities. Telephoning via the operator can take up to three hours unless the costly "Urgent" or "Lightning" priority services are utilized. This has not encouraged rapid oral communication between research scientists in different cities.

On the other hand, travelling from one city to another became relatively easy over the period. Rail services between the big cities improved, and
access to eastern parts of the country was facilitated by the opening of provincial airports in such places as Trabzon, Diyarbakir, Van and Erzurum. A cheap and highly efficient network of coach services extending all over Anatolia developed as roads improved and the production of buses, minibuses and long-distance coaches increased. By 1978, there were 85,234 units on the roads, more than double the 1971 figure. (267) The number of kilometres of all-weather roads rose as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Kilometres</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>24,215</td>
</tr>
<tr>
<td>1965</td>
<td>42,585</td>
</tr>
<tr>
<td>1970</td>
<td>48,125</td>
</tr>
<tr>
<td>1975</td>
<td>51,510</td>
</tr>
<tr>
<td>1978</td>
<td>52,510</td>
</tr>
</tbody>
</table>

(from SYT, p.273 and ESIT, p.29)

Travel by private car also became increasingly common as the number of mainly middle-class private car owners rose sharply from 1971 onwards, exactly quadrupling to a total of 403,000 in 1977. (268) However, massive price increases on petrol and severe shortages drove a number of private car-owners off the roads from 1978 onwards.

On the basis of an agreement signed in September 1963, Turkey became an associate member of the European Economic Community. Full membership was to be attained over a period of 22 years. However, the more extreme right-wing parties which held the balance of power from 1974 onwards were not very disposed towards integration with the EEC, and relations with the Community reached a stalemate. Nevertheless, the European Investment Bank did grant Turkey two loans, of $175 million and $277 million.

In March 1979, Turkey left the Central Treaty Organization (CENTO). One side-effect of this move for research scientists was that they were no longer able to apply to the CENTO Technical Assistance Programme for scientific equipment and supplies which required foreign exchange.

4.3.4 Attitudes towards science

In his speech opening the Acting Assembly in January 1961, General Cemal Gürsel, the Head of State and Prime Minister, said these words: "Dear Members, for nearly one and a half centuries the Turkish nation has sought the paths of positive science, truth, justice and freedom in order to liberate itself
from the darkness it was in ... But it has not been able to achieve what it aspired to ... It cannot be doubted that just as for both the individual and for society freedom is the first condition of evolving, the power which illuminates the paths leading to perfection is science."(269)

The coming to power of the military brought a renewed emphasis on science as ideology. One commentator observed that all the pronouncements of the military had touched on the importance of two factors: science and morality.(27)

The new constitution was described as "being prepared in the light of science and of the bitter experiences of the past long years".(271) The constitution itself had an article (Article 21) entirely devoted to freedom of science and art, an article which also forbade the setting-up of anti-scientific educational establishments (presumably such as those offering Koran courses): "Everyone has the right to learn, teach, explain, and propagate science and art, and to perform any kind of research in these areas ... No educational or teaching establishments can be opened which are contrary to contemporary scientific and educational principles."(272)

When in later years, pro-Islamic government officials turned a blind eye to the opening of official and semi-official Koran courses, several writers protested that the latter part of Article 21 was being ignored.(273) However, from the late 1960's onwards, the polemic of the 1950's between Kemalists and reactionaries largely seems to have turned into a polemic between Right and Left. The extreme leftists did insist that their world-view was scientific materialism, but as the influential extreme Muslim National Salvation Party (NSP) pressed for technological development as well as a return to conservative Islam from 1973 onwards, it became increasingly difficult to argue that religion/Islam was anti-scientific. After all, the Party's Chairman, Necmettin Erbakan, had formerly been a professor at Istanbul Technical University, and he claimed publicly and confidently that Muslims in general and Turks in particular were the founders of modern science.(274) Finally, when in January 1978, the Republican People's Party founded by Atatürk appointed Lüfti Doğan, a former Müfti of Ankara and Director-General of the Religious Affairs Department as Minister of State, it seemed that once-positivistic Kemalism had officially agreed to a compromise with religion.

From the early 1960's onwards, politicians began to speak of science and scientists as factors in Turkey's national development. In his government programme of July 1962, İsmet İnönü touched on the training of "high quality
scientists and technicians in areas necessary for the realization of our social and economic development." (275) In November 1965, Süleyman Demirel spoke of his government's desire to utilize scientists in solving the problems of the country. (276) Five years later, he spoke of his government's belief that "only the torch of positive science will show the way for the country to reach the level of contemporary civilization and to bring it into a stronger and more prosperous state". (277) In 1972, İlhan Öztrak, then Minister of State, emphasized the link between advances resulting from scientific and technological research and economic development. (278) Two years later, the Deputy Prime Minister, Necmettin Erbakan, stated: "It is beyond argument that scientific and technological research in a country should be directed towards the economic development of that country." (279) In 1978, Turhan Feyzioğlu, then Deputy Prime Minister, reiterated his belief that the level of productivity and prosperity in a country was linked to its level of scientific and technological development. (280)

Similar themes were expressed in the first three Five-Year Plans. The First Five-Year Plan stated that an organization would be set up to co-ordinate and encourage basic and applied research, and to direct research into fields in which the targets of the plan would be realized. (281) The Second Five-Year Plan was even more explicit: "The research potential of research organizations and of universities, together with their educational activities, will be increased to meet the requirements of economic and social development ... Scientific and technological progress is an effective means of increasing the general welfare, in the progress of individuals and society, and, in short, in ensuring economic and social development (sic)." (282) Such sentiments were repeated in the Third Five-Year Plan: "Scientific research and development activities are being seen as influential means of economic and social development." (283)

However, such an emphasis on the 'useful' aspects of scientific research left basic scientific research in a somewhat ambiguous position. Traditionally, Turkish scientists seem to have adopted a laisser-faire approach to research topics. (284) However, as the day-to-day problems of Turkey involving energy and industrial production grew worse, there was more of a call to direct scientific attention to these very pressing problems. (285)
A nationalistic theme was introduced into Turkish science with the coming to power of Erbakan and the NSP. Later the theme was reinforced by the American arms embargo following the Turkish invasion of Cyprus, and by the reluctance of western creditors to lend Turkey more money. Erbakan stressed the need for a "national" science and technology which would not have to rely on foreign expertise or equipment. (286) Although this proved impossible to arrange before Erbakan's fall from power, his nationalistic theme found an echo amongst some (mostly less-knowledgeable) Turks. (287)

4.3.5 Support for science by government and grant agency

Official support for science was not merely verbal. Foreign aid was still available in the 1960's, and at the request of different governments, a number of science-related projects were undertaken. These included the establishment of a centre for the making and distribution of educational materials in 1961, the translation and publication of twenty-three science and mathematics books in Turkish in 1962, the setting-up and equipping of several mobile laboratories to tour schools in poor areas with no scientific equipment, and the establishment of an Educational Technology Centre.

The Ford Foundation was particularly active in supporting scientific research and science education in Turkey. (288) In the 1950's, it had allotted about $1 million to teacher training, to the Bahcelievler Experimental Lycee, and to funding the study by the National Commission on Education. As a result, in 1959 the Foundation had been requested by the Minister of Education to appoint a representative in Turkey to supervise its projects and also to act as an adviser to the Ministry. Eugene Northrop, a professor of mathematics from the University of Chicago and an expert on science education, accepted the appointment and arrived in Turkey early in 1960. Over the next seven years, he was to exert a considerable influence upon government attitudes towards science and science education.

Northrop spent his first nine months in Turkey in discussions with scientists, educationalists and businessmen attempting to diagnose Turkey's problems in the area of science and mathematics. He then presented his conclusions at a meeting in January 1961 with three Ministers, including
Turhan Feyzioglu, who was then Minister of Education. He had two proposals. One was for the establishment of a National Advisory Committee on Science which would represent scientific interests to the government and to the nation as a whole. The other was for the building of a special high school which would train gifted science students to become the country's future scientists. Both ideas were seminal. The first found wide acceptance amongst government officials and scientists, and contributed to the establishment of Türkiye Bilimsel ve Teknik Araştırma Kurumu (TÜBİTAK), the Scientific and Technical Research Council of Turkey in 1963. The second, however, required a great deal of selling and three years of delicate negotiations before it led to the building of the Fen Lisesi, the Science Lycee, which was completed in 1964 and equipped with the help of a $1.1 million grant from the Ford Foundation.

At Northrop's suggestion, the Foundation also underwrote a modern science curriculum development project and gave several million dollars towards supporting graduate studies in physics, chemistry, biochemistry and mathematics at METU and towards supporting undergraduate teaching in physics, chemistry and mathematics at Hacettepe University, which was opened in Ankara in 1967. The same two universities also received loans of $4.5 million each for books and equipment from the U.S. Agency for International Development, which they began to draw on from 1970 onwards.

By the early 1970's, large-scale aid from outside agencies was no longer forthcoming, and financial support for science had to come from the government. Investment of any kind in new laboratories and equipment would probably not have been forthcoming but for the tremendous pressure of public opinion to create new university places. The result was that between 1970 and 1979, about $140 million were invested in nine new universities. Of these, only Anadolu, Cumhuriyet and 19 Mayıs Universities, which by 1979 still consisted of one faculty of medicine each, did not have a faculty of basic science or engineering.
Research institutes of various kinds were also set up between 1960 and 1979. These included the Ankara Nuclear Research and Training Centre in 1967, and the TÜBİTAK Marmara Scientific and Industrial Research Institute (1972) and Building Research Institute (1970). Research laboratories or institutes which were opened in public sector industries included those attached to the Turkish Sugar Factories (1966), the Post and Telecommunications Service (1967), the Petkim Petrochemical Company (1969), the Kütahya Nitrogen Factories (1971), the Sümerbank Textile Factories (1972), the Turkish Electricity Authority (1974), and the Turkish Petroleum Corporation (1974).

Agricultural research institutes were set up in Diyarbakır, Afyon (1962), Çanakkale (1965), Erzurum, Kars, Menemen (1969), Edirne (1970) and Isparta (1973). Soil and water research institutes were established in Tokat (1963) and Samsun (1970). Forestry research institutes or directorates were opened in Ankara, İzmit, Samsun, Torbalı, Erzincan, Diyarbakır (all 1962), Adana (1964), Bolu (1965), Tarsus (1967), Isparta, Erzurum (1968), and Istanbul (1975). Efforts were made in the area of animal husbandry with the opening of research institutes in Sakarya (1961), Ereğli (1965), Samsun (1966), Bandırma, Sivas and Bursa (1970); Veterinary food control laboratories were set up in Afyon, Adana (1965), Kayseri (1967), Kars (1968) and Antalya (1969), while Veterinary Control and Research

### Table 4.40

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<td>40.7</td>
<td>81.9</td>
<td>112.4</td>
<td>164.2</td>
<td>199.0</td>
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<td>486.3</td>
<td>430.7</td>
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<td>626</td>
<td>630</td>
<td>937</td>
<td>1,126</td>
<td>1,252</td>
<td>1,537</td>
<td>1,471</td>
<td>981</td>
<td>617</td>
<td>10,088</td>
</tr>
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</table>

TABLE 4.40

Investment in New Universities (Millions TL - 1976 prices; $ =≈ 16TL)

More specialist establishments were opened to undertake research on earthquakes in Ankara (1969); on seed testing in Balıkesir (1964) and Tarsus (1970); on cotton in Aydın (1973), Kars (1974) and Antalya (1975); on horticulture in Yalova (1961) and Erdemli (1965); on viniculture in Nevşehir (1961); on leather in Pendik (1974); and on tobacco in İzmir (1975).

Altogether about 45 research establishments were opened in the 1960's and about 30 in the 1970's. By 1979, the total number of research stations, institutes and directorates attached to various Ministries had exceeded 150. However, only about 45 of these employed more than 10 researchers, which shows that 70% of these research units are very small.

4.3.6 The founding of the Scientific and Technical Research Council of Turkey (TÜBİTAK)(291)

The National Assembly passed Law No. 278 concerning the establishment of TÜBİTAK on 17 July 1963. After the votes had been counted, the Deputy Prime Minister, Turhan Feyzioğlu, addressed the Members as follows: "With the passing of this law, a great thrust has been given to scientific research and technology in Turkey ... With this law, the National Assembly has added another new work to the works needed for establishing the Turkey of tomorrow. I want to thank you."(292) There was loud applause.

According to the law, the purpose of the Council was "to develop, encourage, organize and co-ordinate basic and applied research in the area of positive sciences".(293) The latter apparently referred to mathematics, physics, chemistry, biology, botany, engineering, medicine, veterinary medicine, animal husbandry, agriculture, forestry, and related fields. The Council's specific duties were then spelled out. They included the setting up of research institutes, assisting the government to formulate a national science policy, providing means such as scholarships for training young scientists, establishing links with domestic and foreign research institutes, organizing courses, seminars and conferences "to propagate the concept of
research", and the setting-up of a documentation centre. (294)

The law gave the Council a special legal status whereby it was linked directly to the Prime Minister's Office, but had autonomy in financial and administrative matters. The Council's decision-making body was a "Science Board", consisting of eleven members and the Secretary-General. Nine members were to be distinguished scientists, five from basic sciences and four from applied sciences. Of the other two, one was to be selected from the state economic enterprises and the other from private industry. In addition to the Science Board, there was to be an Advisory Board consisting of representatives from the universities, various ministries, the State Planning Organization, and various professional associations, who were to advise on basic policy and to make recommendations concerning the annual report of the Council.

The promotion and co-ordination of research was to be effected by a series of Research Groups, each with an executive committee of five members. The Basic Sciences, Engineering, Medicine, and Agriculture and Forestry Research Groups, and the Young Scientists Training Group were set up in 1964, the Veterinary Medicine and Animal Husbandry Research Group in 1965, and the Environment Research Group in 1977. The duties of each research group were to determine areas of research and development which required the attention of Turkish scientists, and to prepare or have prepared research projects in these areas; to assess the feasibility of research projects submitted to them by outsiders; and to organize and promote seminars, symposia and conferences in their field. The Young Scientists Training Group was also responsible for giving scholarships to potential scientists and advising the Science Board about methods of training research scientists.

Various other units were formed under the administration of two Deputy Secretary-Generals. These were the Science Policy Unit in 1965, the International Relations Division in 1966, the Turkish Scientific and Technical Documentation Centre (TÜRDOK) in 1966, and the Industrial Liaison Unit in 1969. A library, a printing press and a unit to publish the popular science Bilim ve Teknik magazine were developed when the Council moved to its present buildings on Atatürk Boulevard in Ankara in June 1973.
To stimulate research, funds were allotted by the Council to sponsor research projects. Scientists could apply for funds of up to 100,000 TL ($7,000) for one-year projects and 150,000 TL ($11,000) for two-year projects in 1973. These Turkish Lira limits had been raised twofold by 1978. Successful publication of the results of a project was rewarded by an honorarium of 10,000 TL. The criteria by which a project was selected by the executive committees of the relevant research group were as follows: its scientific quality and feasibility; its potential contribution to science, technology or national development; the training and experience to be gained from it by the participant researchers; the degree of co-ordination it could realize amongst various research organizations; whether it led on from an already completed TÜBİTAK project; and its estimated duration, preference being given to shorter projects. Applications for projects with budgets which exceeded the financial limits mentioned above had to go before the Science Board. Once a project was accepted, regular progress reports were required from the project director, and also a final report within two months of its completion.

By 1970, pressure had built up for TÜBİTAK to support more mission-oriented projects which would help the country attain the economic and social objectives laid out in the Five-Year Plans. The research groups were asked to prepare such projects and encourage established scientists to take them on. Support was also offered to scientists who would work as a team in "research units" attached to universities, research institutes or public sector industries.

4.3.7 The development of TÜBİTAK's activities

From fairly modest beginnings, TÜBİTAK has developed to the point where it is enjoying an annual allocation from the budget of over $12 million per year, plus an additional income of $1 - 2 million from other sources. About 50% of this income goes towards its two research institutes at Gebze (Marmara) and Ankara.

4.3.7.1 Science policy

One of the least successful areas of TÜBİTAK activity has been that of formulating science policy and advising the government accordingly. The Science Policy Unit (SPU) was active until the early 1970's, but then
key personnel became disenchanted and found other appointments. From about 1975 until 1980, there was no director of the unit, apparently because no-one with adequate qualifications wanted the post. One of the main problems of science policy-making is that R and D efforts in Turkey are concentrated in the universities, and as Turkish universities have full autonomy, academics have been suspicious and resentful of attempts by bureaucrats to direct or even co-ordinate their research.

Thus, when in 1965 and 1967, the SPU tried to obtain information about research units, research scientists and the research in which they were engaged, with a view to compiling a research inventory, it encountered a disappointing response. In 1965, only 254 out of 894 research units in universities and research institutes (or 28% of the total) working in basic sciences, engineering, agriculture or medicine replied to general questionnaires on the units, while only 2,057 out of 3,800 research workers (or 54%) replied to questionnaires of a more personal nature. There was an even lower response to questionnaires sent out in 1967. Only 2,194 out of 5,856 researchers (37%) in universities and the public and private sectors filled in their answer sheets. One of the aims of the surveys was to determine in which areas research was and was not being performed. The SPU then tried to establish some basic principles for a research policy, which were utilized in the section on science and technology in the Second Five-Year Plan.

In 1967-68, several members of the SPU were incorporated into a Pilot Team under the sponsorship of the OECD to evaluate the contribution which research on science and technology could make to the economic development of Turkey. They presented their findings in 1968. In the late 1960's, the Unit also did work on technology transfer and technological gaps. In May 1970, the SPU helped to organise a seminar in Istanbul on "The Planning and Management of R and D" at which foreign experts such as Derek de Solla Price and Michael Moravcsik presented papers. In June 1971 and March 1972, Stevan Dedijer made two visits to Turkey to advise the SPU about various aspects of science policy, under the sponsorship of the OECD.

Thereafter, the SPU was concerned mainly with the preparation of various collections of data on research establishments in Turkey. In 1974, it published a guide to the research organizations and units in Turkish
universities, with postal addresses, personnel details, their 1971 budgets, the numbers of books in their libraries, and their publications. (306) A similar guide for research units in the public sector followed in 1976. (290) In the same year, it published a useful bibliography of publications on or related to science policy. (307) Surveys of R and D expenditure in Turkey were published in 1977, 1979 and 1980, following on from earlier surveys made in 1964, 1959, 1970, 1971 and 1972. (308) In 1977 and 1978, the SPU co-operated with the Ministry of Industry and Technology and the State Planning Organization in drawing up a report for the UNCTAD Conference in Vienna in August 1979. In this document, the failure to establish a formal science policy in Turkey was admitted. (309)

4.3.7.2 Research support

Between 1964 and 1979, a total of 1,735 research projects were accepted and supported from 2,567 research applications: (310)

TABLE 4.41

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<thead>
<tr>
<th>Year</th>
<th>BSRG</th>
<th>ERG</th>
<th>MRG</th>
<th>VAHRG</th>
<th>AFRG</th>
<th>YSTG</th>
<th>EVRG</th>
<th>TOTAL</th>
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<td>55</td>
<td>13</td>
<td>20</td>
<td>58</td>
<td>83</td>
<td>88</td>
<td>50</td>
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<td>9</td>
<td>25</td>
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<td>12</td>
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<td>21</td>
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<td>1975</td>
<td>21</td>
<td>18</td>
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<td>23</td>
<td>27</td>
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<td>1978</td>
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<td>1979</td>
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<td>32</td>
<td>24</td>
<td>5</td>
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<tr>
<td>TOTAL</td>
<td>371</td>
<td>377</td>
<td>264</td>
<td>390</td>
<td>273</td>
<td>39</td>
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</table>

BSRG = Basic Sciences Research Group
ERG = Engineering Research Group
MRG = Medical Research Group
VAHRG = Veterinary Medicine and Animal Husbandry Research Group
AFRG = Agriculture and Forestry Research Group
YSTG = Young Scientists Training Group
EVRG = Environment Research Group

The completion rate for all projects was about 90%. By the end of 1979, of the 1,735 projects supported by TUBITAK, 1,094 had been successfully
completed, 178 had been abandoned or aborted, and 463 were continuing. 21% of the projects supported were in the area of basic sciences.

Excluding the YSTG, the financial support for the projects supported by the various groups was as follows: (311)

TABLE 4.42

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<th>No. of projects supported</th>
<th>Total value of support (1000 TL)</th>
<th>Percentage of total spent</th>
<th>Average support per project (1000 TL)</th>
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<td><strong>TOTAL</strong></td>
<td><strong>1,696</strong></td>
<td><strong>113,954</strong></td>
<td><strong>100.0</strong></td>
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</tbody>
</table>

* 1978-79 only

The share of the total received by basic science research projects amounted to 19.3%. However, the average support per basic science project was below the average for all projects.

Over a period of 16 years, approximately $6.5 million was spent on 1,700 odd research projects, giving an average figure of $3,800 per project. (312)

A study of the projects supported by TÜBİTAK between 1964 and August 1973 criticizes TÜBİTAK for not supporting projects which led to the production of new industrial technology. (313) Of a total of 610 projects sponsored over the period, 419 had been concluded by July 1973. Of these, 148 (or 35%) were in engineering, but only 43 of the 148 (or 10% of all completed projects) were related to science-based industries - 28 projects in chemistry and 15 in electrical engineering and electronics. Only 2 projects had led to the granting of patents: one for a chemical separation method, and one for the design of a garden tractor. Moreover, the study found that few of the project applicants - 24% from scientists in the public sector and 3%
from scientists in the private sector were employed in industry. 73% of the applicants were employed at universities.

However, since about 1975, a number of research projects have been successful undertaken under the auspices of the TÜBİTAK Marmara Research Institute at the request and with the support of the public and private sectors. In 1979 alone, 35 projects were completed and another 80 were in various stages of completion. The Institute has been more successful than the central TÜBİTAK organization in attracting research projects from industry because of its stronger links with the latter.

TÜBİTAK's plan to sponsor mission-oriented projects important to national economic development was mooted as early as 1965, but found little enthusiasm from research scientists themselves. In 1977, only 3 were completed (under the auspices of VAHRG), in 1978, 6 were begun (3 under AFRG and 3 under ERG), and in 1979, 4 others were begun (3 under AFRG and 1 under VAHRG). Those sponsored by ERG included "The Collecting and Evaluation of Data Concerning Petroleum Surveys in Turkey" and "Research in the Technical Aspects of Using Ethyl Alcohol Mixtures as Automobile Fuel".

TÜBİTAK has also supported a number of research units. Its support for units responsible to BSRG between 1977 and 1979 was as follows (1000 TL):

<table>
<thead>
<tr>
<th>TABLE 4.43</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Energy Physics Unit (Ankara Univ.)</strong></td>
</tr>
<tr>
<td>Magnetic Resonance Unit (Hacettepe Univ.)</td>
</tr>
<tr>
<td>Pure Maths Unit (Hacettepe Univ.)</td>
</tr>
<tr>
<td>Space Sciences Unit (Ankara Univ.)</td>
</tr>
<tr>
<td><strong>TOTAL spent on basic sc. res. units</strong></td>
</tr>
<tr>
<td><strong>TOTAL spent on all res. units</strong></td>
</tr>
<tr>
<td>(18 units)</td>
</tr>
<tr>
<td>or</td>
</tr>
<tr>
<td>$503,800</td>
</tr>
</tbody>
</table>
4.3.7.3 **Sponsoring of conferences and other activities**

TÜBİTAK has also sponsored conferences, symposia and summer schools. Its National Science Congresses were organized every two years from 1967 until 1977, when the decision was made to hold them thereafter every three years. In 1977, for example, the following numbers of papers were read to the different groups:

**TABLE 4.44**

<table>
<thead>
<tr>
<th>No. of papers read</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>BSRG</td>
<td>296</td>
</tr>
<tr>
<td>ERG</td>
<td>277</td>
</tr>
<tr>
<td>MRG</td>
<td>147</td>
</tr>
<tr>
<td>VAHRG</td>
<td>81</td>
</tr>
<tr>
<td>AFRG</td>
<td>149</td>
</tr>
<tr>
<td>YSTG</td>
<td>22</td>
</tr>
<tr>
<td>EVRG</td>
<td>48</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>1,020</td>
</tr>
</tbody>
</table>

Financial support has also been given to enable national conferences to be held in various fields such as spectroscopy, metallurgy, pathology, physiology and psychiatry. The total support amounted to 0.96 million TL in 1977, 1.21 million TL in 1978, and 1.73 million TL in 1979 - or about $50,000. In this way, TÜBİTAK has contributed to the building-up of links between scientists working in similar disciplines or sub-disciplines.

In order to allow young scientists to attend international conferences in their sub-discipline, until 1977 TÜBİTAK awarded scholarships to scientists whose papers had been accepted by the conference organizers. In 1977, about 20 young scientists were sent to conferences abroad at a total cost of 175,700 TL (approximately $10,000). However, in 1978 and 1979, the foreign exchange crisis hindered TÜBİTAK from rendering such a service. Nevertheless, a few scientists who could obtain their own foreign currency were repaid in Turkish lira.

Successful scientists have been honoured by a series of TÜBİTAK prizes.
which were first awarded in 1966. The annual prize-giving ceremony has often been featured on Turkish Television (TRT) news bulletins and is always mentioned in the serious press. Three types of prizes are given:

"Science Awards" are given to Turkish scientists who have made important contributions to national development or to science at international level.

"Service Prizes" are given to Turkish scientists who have made important contributions to science and technology in Turkey with respect to scientific studies or the training of young scientists. "Prizes for Encouragement" are given to Turkish scientists under forty who have completed advanced scientific studies or studies which have made important contributions to national development.  

In 1978, 4 Service Prizes and 10 Encouragement Prizes were awarded at a cost of 337,000 TL (§13,500). In 1979, the prize money dropped in real terms to 350,000 TL, shared amongst winners of 1 Science Award, 4 Service Prizes and 5 Encouragement Prizes.

In order to stimulate the publication and dissemination of scientific articles and reviews, in 1976 TÜBİTAK began producing a quarterly journal entitled Doğa Bilim (Natural Science). It contained 72 articles in 1977 and 47 in 1979 on all subjects covered by the research groups. The number of subscribers rose to 1,382 in 1979.

4.3.7.4. Supplying research literature and other information: TÜRDOK

The Turkish Scientific and Technical Documentation Centre (TÜRDOK) has a twofold aim: to develop and co-ordinate the documentation of scientific literature in Turkey, and to disseminate information about scientific activities in Turkey to scientists both inside and outside Turkey. It also trains manpower in documentation and information transfer. (317)

The second aim has had less attention that the first. Few Turkish periodicals are abstracted in international secondary journals. In order to bring Turkish scientific research before a wider audience, TÜRDOK produces a monthly publication entitled Current Titles in Turkish Science in both English and Turkish, which gives a short abstract of articles appearing in Turkish scientific journals. Dissertations written in Turkey are listed in an annual Turkish Dissertation Index, again in both English and Turkish. TÜRDOK has also produced a number of bibliographies
of Turkish research publications on various topics, mostly in agriculture
and animal husbandry.

For most Turkish scientists, TÜRDOK has the more important function of
obtaining photocopies of current research articles, and also when necessary
of undertaking a literature search on a particular topic. Whenever
possible, articles requested are obtained from serials held in libraries
within Turkey. Catalogues of serials held in libraries in Ankara and
Istanbul have been compiled, and a catalogue of serial holdings in İzmir
is in preparation. The third edition of the Ankara catalogue (1977),
contains entries of 14,607 Turkish and foreign serials distributed amongst
149 libraries. (318) The Istanbul catalogue, published in 1972, contains
about 13,000 entries distributed amongst 100 libraries in and around
Istanbul. (319)

The large numbers of serials held are somewhat misleading, however, since
many of the volumes are missing.

Requests for articles are made by post or in person to the TÜRDOK office
in Ankara. No limit is set on the number of requests made by any one
person. 14 full-time information specialists, 4 of them in physics,
chemistry, medicine and related fields are employed to obtain photocopies
either from one of the libraries in Ankara or Istanbul, or from the
British Library Lending Division, or from other foreign libraries such as
the Library of Congress. Until 1979, the foreign currency needed for
obtaining articles from abroad was met by an annual grant of $2,500 worth
of coupons from CENTO. The cost to the requester of a local photocopy
was 1 TL ($0.04 - 0.05) per page until March 1978, when it became 2 TL
($0.08) per page and then 5 TL per page in 1979. For articles obtained
outside Turkey, the charge for every 10 pages was the TL equivalent of
$2.5. Thus, until 1979, the cost of obtaining photocopies was fairly
low. Moreover, TÜRDOK officials claim that articles photocopied locally
are in the requester's hands within 7 - 10 days of the request being made,
while it is under 3 weeks when the British Lending Library is used.
However, the whole scheme depends on a scientist having access to abstracts
in or near his place of work.

The number of scientists using the scheme from universities and the public
sector has steadily increased; (320)
TABLE 4.45

<table>
<thead>
<tr>
<th>Place of employment of requester</th>
<th>Number of requesters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1975</td>
</tr>
<tr>
<td>University</td>
<td>864</td>
</tr>
<tr>
<td>Public sector</td>
<td>180</td>
</tr>
<tr>
<td>Private sector</td>
<td>231</td>
</tr>
<tr>
<td>TÜBİTAK</td>
<td>202</td>
</tr>
<tr>
<td>Foreign country</td>
<td>61</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1,538</strong></td>
</tr>
</tbody>
</table>

The reason for the fall-off in the number of users from the private sector is not clear. The number of TÜBİTAK personnel using the scheme has probably fallen because of developing library facilities at the TÜBİTAK research institutes.

The numbers of scientists in basic science using the service were as follows:

TABLE 4.46

<table>
<thead>
<tr>
<th>Area of research of requester</th>
<th>Number of requesters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1975</td>
</tr>
<tr>
<td>Atom physics</td>
<td>13</td>
</tr>
<tr>
<td>Physics (other areas), maths.</td>
<td>67</td>
</tr>
<tr>
<td>Chemistry</td>
<td>140</td>
</tr>
<tr>
<td><strong>TOTAL in basic sciences</strong></td>
<td><strong>220</strong></td>
</tr>
</tbody>
</table>

Thus, in 1977, for example, about 20% of users of the service were working in basic sciences.

TÜRDOK has been able to meet 70 - 75% of the requests for articles.

The numbers of articles obtained by years are:
TABLE 4.47

<table>
<thead>
<tr>
<th>Obtained from within Turkey</th>
<th>1975</th>
<th>1977</th>
<th>1979</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. articles</td>
<td>4,985</td>
<td>4,761</td>
<td>5,674</td>
</tr>
<tr>
<td>No. pages</td>
<td>56,589</td>
<td>46,732</td>
<td>62,172</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Obtained from outside Turkey</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No. articles</td>
<td>7,583</td>
<td>8,933</td>
<td>5,435</td>
</tr>
<tr>
<td>No. pages</td>
<td>122,831</td>
<td>116,018</td>
<td>73,044</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TOTAL</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>no. articles</td>
<td>12,568</td>
<td>13,694</td>
<td>11,109</td>
</tr>
<tr>
<td>no. pages</td>
<td>179,420</td>
<td>162,750</td>
<td>135,216</td>
</tr>
</tbody>
</table>

Foreign exchange difficulties were responsible for the drop in the number of articles obtained from abroad in 1979. The worsening economic situation may also have affected the desire of researchers to follow the current literature, since general demand for articles fell from 19,091 requests in 1978 to 15,791 in 1979.

Literature searches are also undertaken by the information specialists. Until March 1978, this service was free. Thereafter a charge of 250 TL ($10) was levied for lists of references on topics which had already been searched. More specialized topics have a higher charge and are referred to one of more than 100 consultants. In 1979, 668 literature searches out of 1,040 requests were successfully undertaken, 32 out of 54 in physics, 1 out of 3 in mathematics, and 121 out of 191 in chemistry and chemical engineering. Where necessary, TÜRDOK also arranges for translations to be made of scientific articles in foreign languages on terms arranged between translator and the individual or research establishment.

The TÜBİTAK library is a major source of information for literature searches. It contains about 500 secondary publications, including journals of abstracts, and bibliographies.

4.3.7.5 Other co-ordinating activities

The International Relations Division of TÜBİTAK was formed to liaise with international and national organizations both inside and outside Turkey and to co-operate with them on a scientific basis. It has been involved in the
signing of scientific agreements with Yugoslavia, Romania, Iraq and India. Scientists from these countries have visited Turkey to identify areas of mutual scientific interest, and their visits have been reciprocated by one Turkish scientist going to Yugoslavia and two to Iraq. Lack of foreign exchange has prevented further visits by Turkish scientists. The Division has also arranged for organizations such as NATO, CENTO, OECD and the Organization for Regional Co-operation and Development (RCD) to sponsor projects, meetings and visits by 'experts'.

A successful project has been developed by the Division in co-operation with the United Nations Industrial Development Organization (UNIDO), whereby specialists of Turkish origin living abroad are brought to Turkey for short periods of about three weeks to share their expertise. Their travel and living expenses are paid for by UNIDO. Under the scheme, known as TOKTEN (Transfer of Know-How Through Expatriate Nationals), 72 Turkish expatriates had been brought to Turkey by the end of 1978, 28 of whom were specialists in various branches of natural sciences and 35 in applied sciences and engineering. Several of these consultants were able to advise on the use of solar energy, others on nuclear energy research and design, and another on the secondary recovery of high-viscosity oil. Another 57 consultants visited Turkey in 1979. The U.N. officials in charge of the scheme claim that it provides Turkey with a pool of technical expertise at a relatively low cost and that it promotes links with institutions abroad long after the consultants have returned home.

Members of the Division also represent Turkey on various committees of organizations such as the European Science Foundation and the European Economic Community.

Closer co-operation with industry has been a long-term aspiration of TÜBİTAK's. Its Industrial Liaison Unit was established in 1969 to provide a bridge between industry and research institutes and university research groups. Members of the Unit visit industry and try to encourage companies to formulate and present their research problems to researchers working in that particular sub-discipline. At the same time, the Unit attempts to interest companies in the utilization of the results of successful TÜBİTAK research projects. For example, it arranges seminars between researcher and interested parties. In 1978, it presented 36 projects to potential利用者, 32 of them in veterinary medicine and animal husbandry, and 4
in engineering, and also it passed on 11 research problems gathered from industry to various research groups. The effectiveness of the Unit seems to have been blunted by the lack of interest shown by industry in performing research. In 1979, an OECD expert was called in to prepare a report on the reorganization of the Unit.

4.3.7.6 Training and encouragement of young scientists

Soon after its formation in 1964, the executive committee of the Young Scientists Training Group decided to award scholarships in basic and applied sciences to lycee and university graduates of high ability to attend higher education or research establishments abroad. A legal problem then arose. Turkish lira could not be converted into foreign currency for purposes of education other than under the aegis of Law No. 1416 (see above p.182). However, in 1965 the Ford Foundation was able to assist with a grant of $250,000 to be used over a five-year period. Five students were sent the first year, and another eight followed.

Meanwhile, from 1959 onwards, NATO had been awarding science fellowships for undergraduate, postgraduate and post-doctorate studies abroad. Between 1959 and 1967, 211 NATO Science Fellowships were awarded: 111 for post-doctoral work and 83 for postgraduate studies abroad, and 17 for undergraduate studies in Turkey. Of the 83 postgraduate fellowships, 26 (or 31%) were for physicists, and 10 (or 12%) were for chemists.

Until 1967, these fellowships were awarded by the Foreign Ministry, but in February of that year, the task was handed over to TÜBİTAK. About 340 fellowships were awarded to prospective Ph.D.'s between 1968 and 1979. Out of 227 for which information could be obtained, 32 were in physics, and 15 in chemistry, making a total of about 20% for the two fields. The figures for 1977-79 in these fields have ranged from 17% to 25%, with 25-35 fellowships being awarded each year in all fields. Fellows are chosen by examination from applicants who must be Turkish citizens under 30 years of age with good honours degrees.

In a study of the TÜBİTAK Ph.D. grants, Özoğlu found that out of 200 grant-holders who went abroad between 1959 and 1975 and for whom information was available, 25 (12%) did not receive a Ph.D. degree at all, 74 (37%) received them after the period of the grant, and 101 (50%) received them within the
period of the grant. The grants of 58 out of 295 grant-holders (or nearly 20%) were terminated prematurely for various reasons. These figures suggest that either selection procedures are inadequate or that students are not properly prepared for studying abroad.

TÜBİTAK provides other opportunities for research and study abroad. Post-doctoral fellowships funded by the Ford Foundation are offered to research scientists who have obtained their Ph.D. degrees but who require a period of from two to six months at a research establishment abroad in order to utilize facilities for research not available in Turkey. Travel expenses and allowances of $600 per month (1979) are paid to successful applicants, the number of whom was 14 in 1977 and 27 in 1979.

A new scholarship programme was introduced in 1978 to enable young researchers with at least a master's degree to follow the latest developments in their fields at seminars, summer schools and other short courses. 4 of these were awarded in 1978 and 8 in 1979.

4.3.7.7 Scholarships for study and research inside Turkey

Over the years since 1964, scholarships for use inside Turkey have been offered by TÜBİTAK at various levels from lycee to post-doctorate. At the lowest level, they are offered to students in country areas who graduate from middle school with high marks and yet who are unable to attend a lycee because of the absence of one in the vicinity. Students who perform well in a competitive examination are awarded scholarships to study at boarding lycees. Scholarships are also awarded to students in the first and second years at all lycees. By 1980, over 1500 lycee students had obtained TÜBİTAK scholarships, 212 of them in 1979.

Undergraduates are able to benefit from TÜBİTAK scholarships by entering a competitive examination either in their first or their second year. There are separate scholarships for M.Sc. students. Continuation of these scholarships is usually dependent upon obtaining grades of at least 80%. Between 1965 and 1979, 2,019 scholarships had been awarded to university students, of which 589 (or 29%) had been terminated before the holder had graduated. In 1979, 192 scholarships were awarded. A total of 544 were still continuing at the end of 1979, 12 in physics, and 7 in chemistry.

Since 1964, TÜBİTAK has also supported Ph.D. candidates at Turkish
universities. At first, awards consisted of supplements of 1,000 TL to the pay of research assistants working in basic science disciplines. After one year, however, research assistants in other disciplines were also included in the scheme. The format of the scheme had to change when it was pointed out that giving supplements to the pay of research assistants was contrary to the Civil Service Law. In 1971, the NATO "Turkey Doctoral Scholarships" scheme was transferred to TÜBİTAK's care, and this provided sufficient income for TÜBİTAK to give adequate financial support to Ph.D. students who were not employed as research assistants at universities. (324) By the end of 1979, 315 TÜBİTAK scholarships had been awarded to Ph.D. students to study in Turkey. However, the attrition rate was extremely high, with half the scholars not completing their studies. (325)

Post-doctoral fellowships of up to six months duration for use at research establishments in another city to that in which a scientist is normally employed have also been provided since 1978, but so far only one or two people have taken advantage of them.

4.3.7.8 Other TÜBİTAK efforts to stimulate an interest in science amongst young people

The YSTG has arranged several competitions which are designed to arouse an interest in science and scientific research among schoolchildren. At middle school level, it organizes an annual mathematics competition amongst 230 middle schools divided into 8 geographical regions. At lycee level, there are mathematics, physics and chemistry competitions in which students from over 300 lycees in 8 geographical regions participate. Students who come first in each region are rewarded by TÜBİTAK scholarships, and if they are due to go to university, by an appropriate scholarship on condition they read a basic science subject.

For several years, the YSTG has also organized an inter-lycee science project competition. In 1978-79, 34 physics projects, 15 chemistry projects, 10 biology and 12 medical projects were entered for the competition, and were exhibited in the State Fine Arts Gallery in Ankara for a week. A similar competition amongst university students did not arouse as much interest, with only 14 entries in all fields.
Every summer, the TÜBİTAK lycee scholars are invited to a summer camp beside the sea, at which some time each day is devoted to lectures and discussions on topics of scientific interest. 184 students attended the 1979 camp, at which they were joined by students from Cyprus, West Germany, Britain, Libya and Yugoslavia.

4.3.8 The TÜBİTAK Research Institutes

4.3.8.1 The Marmara Scientific and Industrial Research Institute

The prestigious Marmara Research Institute is relevant to this thesis in two ways. First, it has established valuable links with some sectors of Turkish industry and shown to both scientists and industrialists that Turkish scientific research can be utilized to commercial advantage. Second, it has provided employment possibilities for research scientists and so has contributed to the formation of the concept of a research career outside the universities. At the end of 1979, 160 research workers were employed at the Institute.

The decision to found the Institute was taken in 1966 after a study of industrial research needs in Turkey had been made which involved visits to 40 industrial firms. The study showed that little or no research was being undertaken in the public and private sectors and what research there was amounted to little more than routine testing. The rationale for founding a research institute was that research work could play a major role "in the solution of significant problems such as the achievement of economic and social development, improvement of health and welfare standards and increase in national defence power". The study was critical of the research effort in Turkey at that time, which was concentrated at universities, where it came a poor third after educational and administrative duties. Moreover, research at universities was generally too theoretical to contribute towards the solution of technological problems, and also certain important fields were being neglected. The institute would provide facilities and trained personnel for both public and private sectors to have research done under contract.

The fine new buildings at Gebze, near Istanbul were opened in 1972. The Institute is divided into seven research units, plus a computer centre: Materials, Electronics, Applied Mathematics, Applied Physics, Nutrition
and Food Technology, Chemistry and Operations Research Units. In addition to engaging in research projects under contract, these units perform research in areas regarded by Institute officials as important to national economic and social development. Its budget in 1977 was 154 million TL ($9 million) and in 1979, 265 million TL ($7 million).

By 1978, the Institute had expanded to possess a laboratory area of 20,000 square metres. Most of the research units were provided with modern equipment. Amongst its research personnel were 50 scientists with Ph.D. degrees and 65 with M.Sc. degrees. Its three-storey library contained 14,000 volumes and was subscribing to 650 serials, including over 550 foreign journals. Fine accommodation was provided for personnel beside the sea near the Institute at very reasonable rates. Daily transport was provided across the Bosphorus Bridge into the centre of Istanbul. A career structure with "Researcher" and "Senior Researcher" grades had been established, with promotion depending on achievement rather than on mere seniority.

However, from 1977 onwards, the Institute was badly affected by Turkey's foreign exchange crisis. Many research projects came to a standstill because of the lack of foreign currency with which to import supplies and new equipment, while the building programme was hit by the steep rise in the price of building materials. At the same time, there were disquieting turnovers of personnel. In 1979 alone, 6 key members of the Electronics Research Unit left for posts abroad.

4.3.8.2 The Building Research Institute

Founded in 1969, the activities of the Building Research Institute in Ankara are largely confined to research related to the construction industry. By the end of 1979, it had a staff of 60, which included 28 researchers, and a budget of 31 million TL (approximately $860,000).

4.3.9 Official attitudes towards education

The main concern of this thesis is with conducents present within and around research scientists and potential research scientists in the late 1970's, and for a research scientist to have obtained his Ph.D. degree by 1977, he would have had to have left lycee in 1969 at the latest. However,
for the purposes of extrapolation, and also because teaching is a central activity of most Turkish research scientists, I shall dwell briefly on changes in the educational system up to 1978.

The 1961 military government opted for educational planning and established an educational planning group within the Ministry of Education and later within the State Planning Organization. Successive governments held that education was one of the keys to economic and social development, and promised to make every effort to expand it, especially vocational and technical education. (329) Spending on education amounted to 11 - 15% of the national budget, compared with the rather higher 15 - 21% spent on defence. (330) Investment in all forms of education hovered around 10 - 12% of total investment until 1970, and then gradually fell to 8% in 1976 and 5.7% in 1979. (331)

Science and scientific thinking were written into a new National Education Law, No. 1739, which was passed in June 1973. Under Article 2 of the section entitled "General Aims", it gave as one aim of education "to train all the individuals of the Turkish nation ... to possess the ability to think scientifically and independently, and a broad world-view". (332) Also as one of fourteen basic principles of Turkish National Education, it gave Bilimsellik (Scientific-mindedness). This was then spelled out as developing curricula, educational methods and educational materials according to scientific and technological principles and innovations and the needs of the country; increasing educational productivity and innovation by means of scientific research and evaluation; and equipping, strengthening and supporting educational institutions concerned with the production of knowledge and technology.

4.3.10 Changes and problems in primary education

There was a large expansion in primary education over the period. The numbers of primary schools and pupils almost doubled, while the number of teachers almost tripled. By 1977 only 2,880 villages out of 36,094 had no schools of any kind. (333) Figures for selected years are as follows: (334)
TABLE 4.48

<table>
<thead>
<tr>
<th></th>
<th>No. of primary schools</th>
<th>No. of teachers</th>
<th>No. of pupils</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960-61</td>
<td>24,400</td>
<td>62,530</td>
<td>2,866,500 (1,066,470 girls)</td>
</tr>
<tr>
<td>1965-66</td>
<td>30,860</td>
<td>89,105</td>
<td>3,933,200 (1,555,585 &quot; )</td>
</tr>
<tr>
<td>1970-71</td>
<td>38,500</td>
<td>134,180</td>
<td>4,937,800 (2,098,100 &quot; )</td>
</tr>
<tr>
<td>1977-78</td>
<td>43,220</td>
<td>184,130</td>
<td>5,454,600 (2,453,800 &quot; )</td>
</tr>
</tbody>
</table>

The proportion of girls in primary schools rose from 37% in 1960 to 44% in 1977, with the proportion of girls in village schools rising from 34 to 44%.

The percentage of children of primary school age in school increased from 68% in 1960 to 77% in 1965 and 83% in 1970. (335)

However, despite the greatly increased primary education opportunities, there were still many problems. (336) These included a high number of repeaters, (in 1971, for example, only 67% of city children and 59% of village children finished primary school within the normal five-year period); teaching methods which encouraged memorization; a curriculum which was essentially irrelevant to most villagers; a lack of books and other materials; and overcrowded schools and classrooms.

Thus as a result of the lack of buildings, 17,235 primary schools (or 45%) were on double shift in 1970-71, and 72 on triple shift. (337)

4.3.11 Changes in secondary education

An even greater expansion occurred in secondary education. The number of middle schools and pupils nearly quadrupled, and the number of teachers nearly tripled over the period. (338)

TABLE 4.49

<table>
<thead>
<tr>
<th></th>
<th>No. of middle schools</th>
<th>No. of teachers</th>
<th>No. of pupils</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960-61</td>
<td>745</td>
<td>12,080</td>
<td>291,270 (70,780 girls)</td>
</tr>
<tr>
<td>1965-66</td>
<td>943</td>
<td>15,080</td>
<td>412,450 (112,780 &quot; )</td>
</tr>
<tr>
<td>1970-71</td>
<td>1,848</td>
<td>22,300</td>
<td>810,980 (217,570 &quot; )</td>
</tr>
<tr>
<td>1977-78</td>
<td>3,305</td>
<td>32,390</td>
<td>1,105,190 (354,130 &quot; )</td>
</tr>
</tbody>
</table>

The proportion of girls rose from 24% in 1960 to 32% in 1977, while the
pupil/teacher ratio rose from 24 to 34. Between 1950 and 1970, the percentage of children aged 12-15 in middle school rose from 17 - 34%, with the percentage of girls rising from 8 to 17% (339). The success rate, or percentage of those who completed their studies within three years was 48% in 1960 and 58% in 1970 (340).

The percentage of those who went on to lycees of those who graduated from middle school remained at about 75% between 1960 and 1970.

The increase in the number of middle schools was matched by an increase in the number of lycees (341).

TABLE 4.50

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of Lycees</th>
<th>No. of Teachers</th>
<th>No. of Pupils</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960-61</td>
<td>194</td>
<td>4,219</td>
<td>75,630 (19,620 girls)</td>
</tr>
<tr>
<td>1965-66</td>
<td>240</td>
<td>5,994</td>
<td>111,180 (22,680 &quot; )</td>
</tr>
<tr>
<td>1970-71</td>
<td>518</td>
<td>10,136</td>
<td>253,740 (72,800 &quot; )</td>
</tr>
<tr>
<td>1977-78</td>
<td>979</td>
<td>31,310</td>
<td>454,400 (156,920 &quot; )</td>
</tr>
</tbody>
</table>

The five-fold increase in the number of lycees between 1960 and 1977 was a response to public demand for schools which would prepare children for entrance to university. The same public demand led to the re-naming of Trades Institutes, Technical Schools and Teacher Training Schools to include the magic word "Lycee" after about 1975. The 979 lycees in 1977 include 71 private lycees.

4.3.12 Shortcomings in secondary education

Many of the maladies of Turkish secondary schools in the 1950's continued to plague them in the 1970's (342). There was a continuing trend away from technical and vocational schools to classical lycees because graduates of the latter had a better chance of succeeding in the university entrance examination. Moreover, technical and vocational schools were only to be found in certain places, whereas the classical middle schools and lycees could be and were opened in nearly every town without investment in workshops and equipment. As a result, the supply of qualified technicians fell far below the needs projected in the Five-Year Plans (343).
The classical middle schools and lycees themselves were overcrowded, short of books and equipment, and short of teachers. In 1970, 616 (or 41%) out of 1,507 middle schools had to have two shifts to accommodate all their pupils. In many schools, especially in the east of Turkey, part-time teachers with no teacher training had to be employed to make up the shortfall. It has been estimated that in the 1970-71 academic year only 69% of secondary school lessons were given by qualified teachers, 28% were given by non-teachers and nearly 17,500 class hours passed with no teaching of any kind. Mathematics and science teachers were in particularly short supply. The teaching profession continued to be unattractive because of low pay, the possibility of being posted to remote and underdeveloped corners of Turkey, and because of the growing difficulty of coping with pupils increasingly polarized into right-wing and left-wing groups. Moreover, the highly-centralized and politically-prone administrative structure continued to stifle initiative at a local level.

The old-fashioned examination system did nothing to encourage pupils to pursue their studies. One qualified Turkish educationalist observed: "The present examination system makes classwork extremely theoretical, forces the student to memorize, blunts his curiosity and thereby makes middle schools and lycees no different from 19th century medreses." He goes on to tell of a common reaction to the system: students who have passed their final examinations burn their books and vow never to look at them again. With 10 - 15 subjects at both middle school and lycee level, and three written and one oral examination required per semester, each secondary school child faced 60 - 90 written examinations in the two-semester academic year. An average grade for the year of at least 4.5 out of 10 had to be achieved in each subject. Those who failed in more than four subjects had to repeat the whole year, while those who failed in four or less could take "make-up" examinations in the summer, with passes in all but one subject a precondition for moving up to the next class. Not surprisingly the number of repeaters was extremely high. In the 1970-71 academic year, the number was estimated at 55,250 lycee students (or 23% of the total lycee population) and 162,495 middle school students (or 21% of the total middle school population). Boredom and feelings of inferiority amongst repeaters made them disruptive influences in the classroom. Some students who were unsuccessful in examinations became too discouraged to continue. Thus in 1972-73, 37,000 students are reported to have dropped
Another ramification of the heavy examination load was that it encouraged students to cheat. In one survey, 65% of the students questioned said that they cheated regularly and over half of the 235 lycee teachers admitted to having cheated while they themselves were students.

The reason for the heavily weighted lycee curriculum lay in the two-fold educational function of the lycee derived from its French original. It was supposed to turn out selected men and women of "culture", that is, whose minds had been trained by a knowledge of certainly mainly non-utilitarian "disciplines", and to prepare students for university.

The tendency of the Turkish educational system to encourage rote-memorization has been a recurring target of criticism over the years. In 1962, the matter was raised at the 7th National Education Convention, and a suggestion for its origin found in the high status attached to memorizing the Koran. At the next Convention in 1970, a report was presented by professors from Istanbul Technical University which criticized students coming up from lycees for being unable to apply their knowledge to new situations, a characteristic it traced to the practice of memorization. A similar criticism was made in a report presented by professors from Ankara University. At the 9th National Education Convention in 1974, a call went out for new curricula to be prepared which would discourage memorization. In 1978, a psychology docent at Ankara University Faculty of Education blamed rote-memorization for the ease with which young people became attached to authoritarian ideological groups and subsequently party to political violence. Personal observation and discussions with Turkish students confirms that memorization is still the key to making one's way through the Turkish educational system.

A further shortcoming of Turkish secondary schools is the tremendous disparity between the quality of instruction in different regions of the country. The best teachers try to avoid posts in underdeveloped areas where, moreover, educational facilities are worse than in the big cities.

4.3.13 **Science in the school curricula**

Students in Turkish lycees following the classical science curriculum are
divided into two streams after their first year, namely the **Fen** (Science) stream and the **Edebiyat** (Literature) stream. A third **Matematik** stream is open to students at lycées following the modern science curriculum. In 1970 in the classical **Fen** stream, 26% of the weekly total of lessons were devoted to physics, chemistry and nature-studies. In 1976, the percentage was 26% under the classical curriculum and 24% under the modern science curriculum. (355) The percentage of lesson hours devoted to science subjects has changed little since the 1930's.

A study of curricula in Turkish lycées published in 1972 suggested that they too had changed little since the 1930's. (356) The study was also critical of the content of curricula for having little connection with their educational aims.

Personal observation of schools following the classical science curriculum confirmed that the latter did not encourage practical work. Thus, in 1970-71 at one of the best private lycées in Turkey, only one of the eight chemistry teachers (and he a foreigner) used the one laboratory and lecture theatre, and then only for demonstrations. Physics, chemistry and biology were largely a matter of talk and chalk. However, with the advent of the Modern Science Curriculum Development Project, laboratory practicals were to become widespread.

4.3.14 The Science Lyceé and the Modern Science Curriculum Development Project (357)

The Science Lyceé mentioned above (p.242), which was opened in 1964 just outside Ankara, was built with two aims in mind. The first was to provide an opportunity for gifted students to obtain a good scientific training such that they could then go on to meet Turkey's need of first-class research scientists. The second was to provide a milieu in which modern science curricula and methods and materials could be developed and then extended to other lycées in Turkey. (358)

The Science Lyceé is a free, co-educational boarding school of 300 pupils. 100 pupils a year are selected by competitive examination from up to 20,000 middle school students with good science grades. The buildings are purpose-built, with spacious laboratories, and equipment which was originally excellent but which now suffers from lack of spare parts due
to foreign exchange difficulties. Over the years, some teachers have been above average. The original members of staff were specially selected and trained by Turkish scientists who had been taken to inspect various curriculum development projects in the United States. For the first two years, the teachers received supplements to their ordinary teacher's salaries from the Ford Foundation, but after these had been discontinued, many of the original teachers left.

The textbooks are adapted Turkish translations of American modern science curriculum texts (see the list below) in which the emphasis on "learning by doing", on acquiring scientific principles rather than on memorizing mere facts, and on developing each pupil's creative abilities and critical faculties. A substantial proportion of the timetable is given to the teaching of science, culminating in the undertaking of various science projects in the final year. However, the original timetable in which mathematics and science lessons occupied more than 50% of the weekly total in each of the three years has now been brought more into line with that of other lycees; history, geography, moral instruction and other lessons have been introduced, and science and mathematics now occupy only about 38% of the timetable. (359)

How far has the Science Lycee succeeded in its aim of providing Turkey with scientific research personnel? Although its graduates always do well in the University Entrance Examination, the number of those who opt for a research career in any field is small and in basic sciences almost nil. Thus, in 1978 only one pupil in the final year of the Science Lycee put a basic science subject as his first choice of study at university. (360) Even amongst the first set of graduates in 1967, of 76 graduates about whom information could be obtained, only 29 had chosen to study basic sciences, and by 1969 the figure had dropped to 12 out of 70. (361) Interest in and love for science and scientific research has not been able to overcome the desire for job security and material prosperity.

Moreover, there is some evidence to suggest that the success of Science Lycee graduates in the University Entrance Examination is merely a result of 100 of the best middle-school graduates in Turkey having been selected to enter the school. (362) Furthermore, personal discussions with Science Lycee graduates and university teachers indicate that many Science Lycee graduates rely on their academic ability at university at the expense of
hard work, and so do not achieve as great academic success as might be expected. In Maybury's view, the Science Lycee "is now an ordinary secondary school, struggling against the same problems of niggardly budgets, inadequate equipment and indifference amongst teachers that afflict most secondary schools in most economically-deprived countries". My personal impression is similar to Maybury's, although by Turkish standards the Science Lycee is one of the best in the country.

It seems that the second aim of the Science Lycee to act as a "laboratory" for the testing of modern science curriculum materials has also not been realized. Nevertheless, the modern science curriculum first tried at the Science Lycee has been developed and extended so that in the 1977-78 academic year the modern mathematics curriculum had been introduced into all the 979 lycees in Turkey, whilst the modern science curriculum was being taught in 357 of these.

The project to extend a modern science curriculum into ordinary Turkish lycees began with the establishment of a five-man - later eight-man - Science Education Development Commission (SEDC) in April 1967. The Commission soon decided on a pilot scheme to introduce the materials produced for the Science Lycee into nine other lycees and nine teacher training schools. Funds were provided largely by the Ford Foundation. At the end of three years, the general consensus of evaluators and participant teachers was to extend the scheme to other lycees. Tests given to participating pupils showed that the single most important variable was teacher ability, which suggested that raising the quality of teachers had to go hand in hand with revamping of curricula. Modern science curriculum materials were then introduced into 100 regular lycees and 89 lycee-level teacher training schools in the 1971-72 academic year.

The materials first used in the modern science curriculum development project were slightly adapted versions of the materials of American origin used in the Science Lycee. However, the SEDC has now commissioned and published adaptations of these materials based on the experience of teachers and pupils in Turkish classrooms and laboratories. Suitable teachers' guides and other supplementary books have also been prepared. At the same time, seminars and courses for teachers have been held to acquaint them with the new methods, attended by over 12,000 teachers between 1971 and 1975, and laboratory kits have been sent to schools newly entering
the scheme. A pilot scheme to extend the teaching of a modern science curriculum into middle-schools was begun in 1974.

Although it is still too early to make a proper evaluation of the project, first reports indicate that students who have followed the modern science curriculum fare better in the University Entrance Examination than students who have followed the classical curriculum. (369) Also, a recent study suggests that the modern science curriculum arouses more of a critical faculty in students than does the classical science curriculum. (370)

4.3.15 Entry into university

Until about 1955, the sole condition for entry into Turkish universities was a lycee diploma with a "good" or "very good" grade. After 1955, however, as the number of applicants exceeded the number of places available, each faculty or university made an additional condition - that of success in its entrance examination. Efforts were made to centralize the system in the early 1960's, but METU, for example, continued to hold its own entrance examination until 1974. Finally in 1975, a Üniversitelerarası Seçme ve Yerleştirme Merkezi (ÜSYM) (The University Selection and Placement Centre) was given overall responsibility for organizing an examination for entry to all higher educational establishments.

In June or July of each year, the Centre holds a one-day examination in various centres throughout Turkey. (371) Each candidate has to answer multiple-choice questions in four sections: General Ability, Natural Sciences, Social Sciences, and Foreign Language. He is allowed eighteen choices of faculties or other higher educational establishments, and he will gain entry to the place of his highest choice for which his marks are acceptable. The results are processed by computer, which selects the quota of students for each faculty from those applicants who have gained the best marks.

The number of applicants for the examination increased by a factor of 10 between 1964 and 1977, while the number of places increased by a factor of 3: (372)
### TABLE 4.51

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of applicants</th>
<th>Nos. of those who entered</th>
<th>Percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>all high ed.</td>
<td>univ.</td>
</tr>
<tr>
<td>1964</td>
<td>33,760</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1966</td>
<td>41,330</td>
<td>28,300</td>
<td>12,200</td>
</tr>
<tr>
<td>1968</td>
<td>51,300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1970</td>
<td>76,540</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1972</td>
<td>111,690</td>
<td>31,010</td>
<td>13,275</td>
</tr>
<tr>
<td>1974</td>
<td>229,990</td>
<td>59,230</td>
<td>19,875</td>
</tr>
<tr>
<td>1976</td>
<td>316,340</td>
<td>79,980</td>
<td>22,370</td>
</tr>
<tr>
<td>1977</td>
<td>357,510</td>
<td>84,360</td>
<td>22,555</td>
</tr>
</tbody>
</table>

The figures for the numbers of places in "higher education" are somewhat inflated by the inclusion of some establishments such as education institutes which have a somewhat ambiguous status similar to that of American junior colleges. Thus, in 1976 and 1977, for example, the entry into two-year education institutes was 16,000 students each year. There appear to be several factors involved in the dramatic increase in the number of applicants for higher education in Turkey. One factor is the overall increase in population by about one million every year. A second factor is the great increase in the number of middle-schools and lycées. Also, until 1974, graduates of lycée-level technical and vocational schools could only enter non-university establishments of higher education, but after this restriction was lifted, the number of applicants to universities increased. Another very important factor is that a male with a university diploma can undergo his military service as a reserve officer instead of having to do it under the rigorous conditions experienced by the average Turkish private. Recently, there have been signs that the authorities want to reduce the demand for university places by changing the automatic reserve officer status for university graduates. For example, the Fourth Five-Year Plan stated that a new system would be introduced to that end. (373) A fourth factor is that a degree in medicine, engineering or business administration can lead to a very financially secure and socially prestigious future, and most Turkish lycée graduates hope that somehow the door to such a degree will open to them in what is often regarded as the "chance" business of the University Entrance Examination. (374) The drive
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>587.7</td>
<td>640.2</td>
<td>615.3</td>
<td>614.1</td>
</tr>
<tr>
<td></td>
<td>570.0</td>
<td>602.5</td>
<td>598.0</td>
<td>599.8</td>
</tr>
<tr>
<td></td>
<td>568.5</td>
<td>582.2</td>
<td>561.9</td>
<td>590.5</td>
</tr>
<tr>
<td></td>
<td>560.2</td>
<td>572.4</td>
<td>544.7</td>
<td>588.6</td>
</tr>
<tr>
<td></td>
<td>553.0</td>
<td>565.0</td>
<td>542.9</td>
<td>578.4</td>
</tr>
<tr>
<td></td>
<td>546.2</td>
<td>541.8</td>
<td>538.1</td>
<td>565.8</td>
</tr>
<tr>
<td>7th</td>
<td>AU Ch.Eng.</td>
<td>BU Eng.</td>
<td>HU Eng.</td>
<td>HU Co.Scs.</td>
</tr>
<tr>
<td></td>
<td>536.7</td>
<td>539.4</td>
<td>531.6</td>
<td>561.6</td>
</tr>
<tr>
<td></td>
<td>535.5</td>
<td>537.4</td>
<td>531.0</td>
<td>556.7</td>
</tr>
<tr>
<td></td>
<td>533.5</td>
<td>534.5</td>
<td>529.6</td>
<td>553.5</td>
</tr>
<tr>
<td>10th</td>
<td>METU M.Eng.</td>
<td>IUC Med.</td>
<td>ITUM Electr.</td>
<td>ITUM Electr.</td>
</tr>
<tr>
<td></td>
<td>532.9</td>
<td>528.6</td>
<td>528.9</td>
<td>552.1</td>
</tr>
<tr>
<td></td>
<td>530.9</td>
<td>527.5</td>
<td>528.8</td>
<td>551.6</td>
</tr>
<tr>
<td></td>
<td>529.5</td>
<td>524.1</td>
<td>528.1</td>
<td>549.4</td>
</tr>
<tr>
<td></td>
<td>521.7</td>
<td>522.6</td>
<td>524.6</td>
<td>549.0</td>
</tr>
<tr>
<td>14th</td>
<td>IU G.Lang</td>
<td>HUE Med.</td>
<td>AU Med.</td>
<td>BU Ch.Eng.</td>
</tr>
<tr>
<td></td>
<td>521.1</td>
<td>521.0</td>
<td>522.9</td>
<td>546.0</td>
</tr>
<tr>
<td></td>
<td>519.0</td>
<td>520.2</td>
<td>522.0</td>
<td>542.8</td>
</tr>
<tr>
<td></td>
<td>518.7</td>
<td>519.6</td>
<td>520.8</td>
<td>540.3</td>
</tr>
<tr>
<td></td>
<td>516.3</td>
<td>516.8</td>
<td>520.5</td>
<td>538.7</td>
</tr>
<tr>
<td></td>
<td>515.6</td>
<td>516.7</td>
<td>519.6</td>
<td>537.9</td>
</tr>
<tr>
<td></td>
<td>513.8</td>
<td>515.4</td>
<td>519.4</td>
<td>537.3</td>
</tr>
<tr>
<td></td>
<td>513.6</td>
<td>513.9</td>
<td>517.7</td>
<td>536.2</td>
</tr>
</tbody>
</table>

AU = Ankara Univ., BU = Bosphorus Univ., BRU = Bursa Univ., ÇÜ = Çukurova Univ.,
EU = Ege Univ., GMYO = Galatasary Engineering School, HU = Hacettepe Univ.,
HUE = Hacettepe Univ.(Eskişehir), IUC = Istanbul Univ., IUC = Istanbul Univ.
(Cerrahpaşa), IUE = Istanbul Univ.(Eskişehir), ITU = Istanbul Technical Univ.,
ITUM = Istanbul Technical Univ.(Maçka), METU = Middle East Technical Univ.,
A = Aeronautical, Am = American, Ad = Administrative, C = Civil, Ch = Chemical,
Co = Computer, Eng = Engineering, Electr. = Electronics, E = English, F = French,
G = German, I = Industrial, It = Italian, Lang = Language, Lit = Literature.
to gain high marks has led to the development of a "cramming" industry of private schools in nearly every large city, at which students are prepared in exam-taking techniques.

4.3.16 The low intake into basic sciences

Departments or faculties whose graduates can obtain high-paying jobs are usually put down as first choice by students entering the Entrance Examination and so such places can demand the highest points. The result is that most of the able students go into medicine, some form of engineering, or English language and literature, as may be seen in Table 4.52. The top faculties largely reflect the prestige attached to certain professions in Turkey. As a study undertaken in 1963 amongst a wide sample of lycee students, and another study in 1972 amongst students at Ankara University Faculty of Letters have shown, doctors and engineers are ranked very highly by Turkish young people.

Physics and chemistry are noticeably absent from the list, except for the more applied electronics and chemical engineering. For example, the cut-off points for Ege University Chemistry Department, one of the most sought-after basic science departments, were as follows for successive years.

<table>
<thead>
<tr>
<th>TABLE 4.53</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cut-off point</td>
</tr>
<tr>
<td>458.0</td>
</tr>
<tr>
<td>No. of students obtaining more than this No. of points (approx.)</td>
</tr>
</tbody>
</table>

In 1978 the highest ranking pure science department or chair was the Chemistry Department at Bosphorus University in 85th position, entry to which required some 489.8 points. The number of the 373,000 applicants who put physics or chemistry as their first choice in the entrance examination was low in comparison to the numbers who opted for non-science departments or chairs with similar cut-off points the previous year:
Table 4.54

<table>
<thead>
<tr>
<th>Dept./Chair</th>
<th>Places available</th>
<th>No.1</th>
<th>No.18</th>
<th>*1977 cut-off points (approx.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IU Chem.</td>
<td>120</td>
<td>257</td>
<td>7,633</td>
<td>474</td>
</tr>
<tr>
<td>AU Physics</td>
<td>65</td>
<td>105</td>
<td>3,318</td>
<td>466</td>
</tr>
<tr>
<td>METU Chem.</td>
<td>150</td>
<td>138</td>
<td>6,648</td>
<td>445</td>
</tr>
<tr>
<td>Ege Physics</td>
<td>60</td>
<td>32</td>
<td>4,158</td>
<td>444</td>
</tr>
<tr>
<td>AU Chem.</td>
<td>20</td>
<td>25</td>
<td>2,434</td>
<td>444</td>
</tr>
<tr>
<td>HU Chem.</td>
<td>70</td>
<td>45</td>
<td>5,898</td>
<td>444</td>
</tr>
<tr>
<td>IU Physics</td>
<td>100</td>
<td>42</td>
<td>2,994</td>
<td>421</td>
</tr>
<tr>
<td>IU Law</td>
<td>800</td>
<td>14,965</td>
<td>99,857</td>
<td>454</td>
</tr>
<tr>
<td>BRU Econ./Soc.Scs.</td>
<td>250</td>
<td>810</td>
<td>47,459</td>
<td>435</td>
</tr>
</tbody>
</table>

No. 1 = No. of applicants putting this as first choice.
No.18 = No. of applicants putting this as one of their 18 choices.
IU = Istanbul Univ., AU = Ankara Univ., HU = Hacettepe Univ.,
METU = Middle East Technical Univ., BRU = Bursa Univ.

(*The previous year's cut-off points are shown in the USYM guide to assist the applicants in their choice of departments/chairs)

Istanbul University Chemistry and Ankara University Physics attracted a comparatively larger initial clientele probably because they offered the opportunity to become a Yüksek Mühendis (Higher Engineer). METU Chemistry had a lower cut-off point than Istanbul University Law and yet it did not even attract one first-choice applicant for each of its 150 places, whereas IU Law attracted more than 18 for each place. Besides leading to a lucrative career, one of the advantages of studying Law and Political Sciences has been that until recently attendance at lectures has not been compulsory. This has allowed students to work in a full-time job and merely appear at the respective faculties for examinations.

Further evidence that top students do not choose to study basic sciences comes from TÜBİTAK. In 1979, it obtained a list of the top 1,000 students in the "Science" section of the entrance examination with a view to giving scholarships to those students who had opted to study basic sciences at university. Apparently only 15 students were in this category.

The lack of interest shown by able students in a career in basic sciences...
was bemoaned in nearly every TÜBİTAK Annual Report from 1965 onwards. Some comments made in the 1965 Report are typical: "Influenced by the faulty wages policy now being pursued and by value judgements which have changed to a great extent especially in the past few years, sufficient personnel are not being trained in the fields of positive sciences such as mathematics, physics and biology. Careers in these fields are not as financially-rewarding as careers in other fields, and do not provide opportunities to earn a supplementary income in activities unrelated to scientific research."

The same lack of interest in a career in basic sciences was reported in a 1969 study of the students who entered the METU Entrance Examination. Students who put basic sciences as their first choice of study were generally weak students.

Why is it that good students do not choose to study basic sciences at university, even though some of them - such as Science Lycee graduates - might be expected to have a real interest in science? First of all, the number of job-opportunities for graduates in physics and chemistry is rather small. Some are taken on by government research institutes, others go into state controlled industries, a few go on to do research at university, while the remainder have to go into teaching in secondary schools. The latter is looked upon as a rather second-rate occupation; not only is the salary comparatively low, but there is always the possibility of being posted to an undesirable part of the country. In general, Turkish industry has no real demand for chemists and physicists. Thus a number of science graduates end up in jobs quite unconnected with science. Not surprisingly, Turkish students prefer to study subjects which provide a greater guarantee of obtaining a reasonably secure and well-paying job.

Second, what job opportunities do exist in basic science fields are unattractive for various reasons. In the state controlled industries there are no real career prospects for research scientists, even in more applied fields. Since they are regarded mainly as people who maintain and repair machinery, promotion in research units is much slower than in other parts of the organization. Hence, research units are not favoured even by personnel with research capabilities. Also, in government research institutes research workers often do not qualify for financial perks such as severance pay which are awarded to researchers elsewhere. Moreover,
research scientists outside the universities do not have the social prestige which academic researchers can obtain by gaining academic titles such as "docent" and "professor". (385)

On the other hand, before about 1973, a career as a research scientist at a university was also unattractive because of the long years of study required to become a docent or professor and because of low salary scales in comparison to graduates in professions such as engineering and medicine. Thus in 1967, for example, a newly graduated chemical engineer received 1,440 TL per month while an asistan received 692 TL and a chemistry teacher received 513 TL. (386) Although the salaries of university lecturers were increased considerably in 1973, because of high taxes taken at the source, lecturers were still financially disadvantaged in comparison with free professionals and professionals in the private sector who could become wealthy in a very short time by taking advantage of poorly-enforced tax laws. A further negative factor associated with an academic career since 1968 has been the increasing problem of student unrest which has resulted in the deaths of hundreds of students and several academics.

Economic considerations are very prominent in the minds of Turkish students for several reasons. First, a great many students in Turkey support themselves while studying by obtaining government loans - which have to be paid back over a period of years once they have graduated. Others who do not obtain such loans are supported by relatives, who expect to be remunerated once the borrower is in a position to do so. Second, there are strong social expectations on Turkish men to support their parents in their old age. Old-age pensions are available only for ex-government or private sector employees of long standing. In addition, graduates are often expected to help support younger brothers or sisters who are still studying. Besides these factors is a high rate of inflation, and a growing 'crisis of rising expectations' fuelled by clever television advertisements which succeed in persuading people of the (sometimes artificial) need of buying more and more consumer goods.

An interest in science for its own sake might be reinforced by seeing it as a means of solving the economic problems of the country. However, this is not the case with pure scientific research. Thus although some students may become interested in pure science, they are not prepared to sacrifice themselves economically when the end result and relevance of doing
so seems at best rather nebulous. Furthermore, in Turkey the possibility of international recognition seems rather remote because of the physical difficulties involved in obtaining supplies and equipment.

In comparison, able students in most Western European countries are able to look forward to careers in scientific research which will not leave them much worse off financially than their friends who graduate in other fields. Heavy taxes in such countries tend to smooth out differences in income between different professions. There is also the prospect of promotion within a reasonably short period. At the same time, the average science graduate there is not expected to support members of his family, and in some countries does not have to pay back the state for his student grant.

As a result of the factors mentioned above, the career of a university research scientist is not a particularly competitive one in the Turkish job market. Although some brilliant people seem to make it their career, the evidence suggests that the proportion of such is smaller than in the more financially rewarding professions.

4.3.17 Expansion in university education

Between 1960 and 1977, the chances of a Turkish young person going to university were considerably enhanced by the expansion in Turkish higher education. The number of faculties tripled and the number of students more than doubled. (387)

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of univ. faculties</th>
<th>No. of students</th>
<th>No. of graduates</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960-61</td>
<td>27</td>
<td>44,460 (22.6% girls)</td>
<td>3,455</td>
</tr>
<tr>
<td>1965-66</td>
<td>36</td>
<td>55,560 (24.6% &quot; )</td>
<td>5,370</td>
</tr>
<tr>
<td>1970-71</td>
<td>55</td>
<td>66,460 (20.6% &quot; )</td>
<td>10,685</td>
</tr>
<tr>
<td>1977-78</td>
<td>96</td>
<td>108,220 (25.0% &quot; )</td>
<td>11,250*</td>
</tr>
</tbody>
</table>

* 1976-77 figure

The increase in the number of faculties was a result of expansion in the already-existing universities and of the establishment of new universities.
Of the older universities, Istanbul University expanded from 6 faculties in 1960 to 13 in 1978, including separate faculties of chemistry (1967) and pharmacy (1962); Istanbul Technical University grew from 5 to 9 faculties, including a faculty of basic sciences (1971); Ankara University expanded from 8 to 11, including a faculty of pharmacy; Ege University grew from 2 to 8, including faculties of science (1961) and pharmacy (1974); Erzurum Atatürk University increased from 2 to 7; Karadeniz Technical University grew from 1 (of basic sciences) in 1963 to 5. In addition, some older universities had second faculties of medicine, agriculture or engineering in other cities.

The first new university to be granted its charter during the period was Hacettepe University in Ankara in 1967. As the brain-child of an enterprising Turkish pediatrician, it had originally developed out of the Hacettepe Children's Hospital and Research Institute of Child Health, which in 1963 had become part of a second medical faculty of Ankara University. In 1964, a School of Basic Sciences was opened at which incoming students had to undergo a year's instruction in French, German or English, and take a further year of courses in the natural and social sciences. From 1967 to 1973, Hacettepe University had its own law, No. 892, but in 1973 it came largely under the new Universities Law passed in that year. Its administrative structure tended to resemble METU's in being American-style departmental. However, instruction in most departments was given in Turkish.

Hacettepe University started with 3 faculties, of medicine, health sciences and science, situated beside its twin teaching hospitals in the centre of Ankara. In 1974-75, the non-medical faculties moved to a new campus at Beytepe, 12 kilometres west of Ankara. By 1979, the university had 8 faculties, including those of pharmacy (1971) and chemistry (1971), besides medical faculties in other cities. From the first, lecturers at Hacettepe were rewarded with much higher salaries than their colleagues at other universities, on condition that they did not take on any post outside the university.

In the face of increasing demand for higher education during the 1960's, a number of private colleges of higher education were opened, mainly in engineering, architecture and commerce. Entry to such institutions was open to any lycée-level graduate who was prepared to pay the high fees.
However, laboratory and library facilities were poor, and questions were raised about the educational standards of such establishments. Finally, in 1971 the Constitutional Court declared that such institutions were unconstitutional, and they were subsequently nationalized and attached to existing universities.

One ramification of the 1971 ruling was that the upper division of Robert College, which had been awarding degrees in commerce, science and engineering, had to cease functioning as a private institution. In September of that year, its buildings and other facilities were handed over to the Turkish government, and Bosphorus University was born, with three faculties – of science, engineering and business administration. Instruction continued to be in English, and the university was run along departmental lines.

1973 saw the passing of two laws concerned with Turkish universities and teaching staff. The Universities Law, No. 1,750, laid down regulations pertaining to the administration of Turkish universities. It reaffirmed the special status of METU, and allowed Hacettepe University to retain special provisions which were not contrary to the law. The law also allowed asistans with Ph.D. degrees to lecture with the approval of the Administrative Council of the department or chair (Article 31). The second law, No. 1,765, the University Personnel Law, raised the salaries of university staff quite considerably so as to compete favourably with the salaries of staff at METU and Hacettepe. This had the effect of making the salary of an asistan much more attractive, since it brought it up to the level of and even above the salaries of middle-order civil servants. Moreover, after four or five years, there was a good chance of earning the title of dozent, with an accompanying significant increase in salary. In the same year, a provision was made by Parliament which exempted all supplies and equipment for research from import duty.

In 1974, great pressure to admit more students was put upon higher educational establishments by the Ecevit government. As a result, the number of students in higher education doubled between 1974 (177,000) and 1977 (344,000). The latter included students who enrolled in YAYKUR, an attempted scheme of higher education by correspondence course. In 1975 at its peak, the scheme attracted over 89,000 students, but enthusiasm faded in later years because of poor organization and management. The universities managed to keep their new enrolments down to about 20,000 in
1974-75, compared with about 16,000 in 1973-74. At the same time, steps were taken to form nine new universities. These were founded at Diyarbakır (1973), Adana (Çukurova University, 1973), Eskişehir (Anadolu University, 1973), Sivas (Cumhuriyet University, 1974), Malatya (İnönü University, 1975), Elazığ (Fırat University, 1976), Samsun (19 Mayıs University, 1976), Konya (Selçuk University, 1976), and Bursa (1976). However, lack of planning meant that in many cases, universities were opened without proper buildings, facilities or personnel. Staff had to be enticed from more established universities on a part-time basis by means of generous expenses and air tickets.

4.3.18 Undergraduate physics and chemistry by 1978

In 1978, the number of places in 'pure' physics and chemistry offered at Turkish universities had risen to 1,129. No figures are available for years earlier than 1976, but for all subjects taught at science faculties, including mathematics, biology, botany, geology and astronomy, the total number of students tripled between 1960 and 1977.

| TABLE 4.56 |
|---|---|---|---|
| AUSF | 2,025 | 1,621 | 2,026 | 2,233 |
| BUBSF | - | - | - | 500 |
| ÇUBSF | - | - | - | 50 |
| DUSF | - | - | - | 317 |
| EAUSF | 36 | 90(est.) | 133 | 956 |
| EUSF | - | 403 | 790 | 2,113 |
| FUSF | - | - | - | 65 |
| HUCF | - | - | - | 598 |
| HUSF | - | - | - | 1,432 |
| IUCF | - | - | 1,012 | 872 |
| IUSF | 3,125 | 2,914 | 5,205 | 3,793 |
| KTUBSF | - | 363 | 180 | 792 |
| METUFAS | 66 | 688 | 1,500 | 2,688 |
| MIUSF | - | - | - | 100 |
| SUSF | - | - | - | 225 |
| TOTAL | 5,252 | 6,079 | 10,846 | 16,734 |
AUSF = Ankara Univ. Science Faculty (SF), BUBSF = Bosphorus Univ. Basic Sciences Faculty (1977), DUSF = Diyarbakır Univ. SF (1974), EAUSF = Erzurum Atatürk Univ. SF (Faculty of Arts and Sciences until 1970-71, when a separate Faculty of Arts was formed), EUSF = Ege Univ. SF (1961), FUSF = Fırat Univ. SF (1974), HUCF = Hacettepe Univ. Chemistry Faculty (1971), HUSF = Hacettepe Univ. SF (1971), IUCF = Istanbul Univ. Chem. Fac. (1966), IUSF = Istanbul Univ. SF, KTUBSF = Karadeniz Technical Univ. Basic Sciences Faculty (1963), METUFAS = METU Faculty of Arts and Sciences, MIUSF = Malatya İnönü Univ. SF (1976), SUSF = Selçuk Univ. SF (1976).

At Istanbul University and Hacettepe University, the chemists managed to form separate chemistry faculties in 1966 and 1971 respectively. This enabled them to obtain a larger share of their university budgets than if they had been addenda to the science faculties.

The increase in the number of students has meant an increase in the amount of teaching and administration. This has not been merely because of the additional numbers of students reading physics and chemistry, but also because physics and chemistry are taught as "service" courses to burgeoning engineering, medical and pharmacy departments or chairs.

More able students have been lured into studying physics at Ankara University since 1954 by the promise of a Fizik Yüksek Mühendis (Higher Physics Engineer) degree. This is given after one year of postgraduate studies, which normally include a thesis. Since 1968, the same degree has been offered at Hacettepe University after a four-year course leading to a Fizik Mühendis (Physics Engineer) degree. Karadeniz Technical University followed suit in 1972 and Xonya Selçuk University in 1976. "Engineer" and "Higher Engineer" have the advantage of giving higher starting-points on the civil service salary scale, as well as possessing higher social prestige than an ordinary "Physicist" degree. "Physics Engineers" seem to have found non-teaching jobs more readily than mere physics graduates. However, with over 100 a year potential graduates, it seems that 70% will not be able to find work in a sphere related to physics. 

Chemical engineering degrees are offered at most universities, either by engineering faculties (as at Bosphorus University), or by science faculties (as at Ankara University), or by chemistry faculties (as at Hacettepe...
University. They are more realistic than physics engineering degrees in that they can be utilized in the chemical industry, but they do not lead on as readily to a career as a research scientist.

The intake into physics and chemistry and the teaching of undergraduates taking those subjects only affects this thesis insofar as it influences the research time availability and perhaps the morale of each university lecturer. The conditions prevailing at undergraduate level up to the end of the 1960's would have been far more influential upon present-day research scientists.

4.3.19 The quality of teaching at undergraduate level

The problems of Turkish universities at undergraduate level have been noted by several observers. One problem is that students come up from secondary schools with a poor basic knowledge of their subject or subjects. (395) Another is that many students have little or no interest in the subject, for they enrol in whatever department or chair they can to avoid military service and to gain social prestige. (396) A recent survey of students at Istanbul University showed that only four out of ten students were studying in the department or chair of their choice. (397) In the 1960's, complaints were made about classes being too big, (398) and efforts were made to increase staffing levels. (399) Classrooms and libraries were in short supply and there were also few practicals or seminars. (400) What practicals there were in physics, for example, were not aimed at increasing the student's curiosity, level of awareness or problem-solving ability. (401) Methods of instruction were extremely formal, with an emphasis on memorization. (402) In 1975, one prominent professor of chemistry and expert on science education described teaching at university as follows: (403) "In every level of higher education, the student is being taught by what we call the 'classic' method. The lecturer gives his lectures in detail from a set book or from notes. Most of the students take notes. Few of them are content with merely listening to the lecturer. It is almost a duty for the majority of our students to copy down whatever comes out of the lecturer's mouth and whatever he writes on the board... The key to everything are those notes taken down during the lecture, because if the content of those notes is learned, or rather memorized, the chances of success in the examination are very high. There is no need to learn anything else... If the lecturer were to ask anything different from that given in the lecture, all hell
would break loose. Therefore the lecturer only asks what he has gone over in the lecture or in the duplicated lecture notes. The lecturer’s method of teaching a topic, however, is quite contrary to that of modern scientific curricula. The result is a lack of critical appraisal in the Turkish university world. Also a conservatism is built into the system; a physics student in the late 1960’s could graduate without learning anything about some important aspects of modern physics such as quantum mechanics and electromagnetic theory. It was no wonder that a 1974 survey found that 73% of the 491 respondents considered that the education they had received was irrelevant to the job they were doing. Furthermore, the curricula did not foster the concept of research, while textbooks left much to be desired.

In view of all these shortcomings, it is not surprising that a large number of students at Turkish universities drop out or take an inordinately long time to complete their studies. A study of students at Istanbul University between 1971 and 1975 showed that only about 20% graduated on time, with a further 40% graduating eventually. Most students took 1-2 years longer than the normal period of instruction. 70% of Freshmen in the Science Faculty and 75% in the Chemistry Faculty graduated eventually, but attrition rates in the first year were high: 25% and 13% respectively. The situation at other universities was equally gloomy.

<table>
<thead>
<tr>
<th>Univ.</th>
<th>Average intake</th>
<th>% of 1st year drop-outs %</th>
<th>% of graduates eventually</th>
<th>Repeaters and drop-outs after 1st year</th>
</tr>
</thead>
<tbody>
<tr>
<td>IU</td>
<td>4,123</td>
<td>15 25</td>
<td>21 59</td>
<td>26</td>
</tr>
<tr>
<td>ITU</td>
<td>1,484</td>
<td>10 -</td>
<td>14 55</td>
<td>35</td>
</tr>
<tr>
<td>BU</td>
<td>338</td>
<td>7 36</td>
<td>56 80</td>
<td>13</td>
</tr>
<tr>
<td>AU</td>
<td>2,940</td>
<td>11 20</td>
<td>34 87</td>
<td>2</td>
</tr>
<tr>
<td>METU</td>
<td>1,827</td>
<td>1.6 40</td>
<td>n.a. 50</td>
<td>48</td>
</tr>
<tr>
<td>HU</td>
<td>1,841</td>
<td>8.5 35</td>
<td>n.a. 26</td>
<td>n.a.</td>
</tr>
<tr>
<td>EU</td>
<td>2,400</td>
<td>6 24</td>
<td>n.a. 52</td>
<td>42</td>
</tr>
<tr>
<td>KTU</td>
<td>773</td>
<td>11 n.a.</td>
<td>n.a. 53</td>
<td>36</td>
</tr>
</tbody>
</table>

The high percentage of drop-outs amongst Freshmen in basic sciences probably reflects a desire to transfer to another more attractive chair or department, as well as a reaction to poor teaching methods and curricula.

Some students who could obtain scholarships or whose parents could afford the expense went to Europe or the United States to study.

4.3.20 Study abroad and the brain drain

According to a study of the students sent abroad between 1929 and 1971 under the aegis of Law No. 1416 through the Ministry of Education (see p.182 above), the total number of officially sponsored students was 3,232. Of these about 10% were in basic sciences, with 69 in chemistry and 79 in physics. Until about 1961, the majority of students sent abroad were lycée graduates, but thereafter they were masters or Ph.D. students. Another study reported a total of 8,336 officially and privately sponsored students studying abroad up to April 1971. More recent figures are as follows:

TABLE 4.58

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>Officially sponsored</th>
<th>Privately sponsored</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973</td>
<td>15,683</td>
<td>818</td>
<td>543</td>
</tr>
<tr>
<td>1978</td>
<td>16,449</td>
<td>1,171</td>
<td>469</td>
</tr>
</tbody>
</table>

Apparently these figures do not include those students sent abroad by TÜBİTAK/NATO, by universities and by foundations such as the Fulbright Foundation.

The First Five-Year Plan had required that 3,000 students be sent abroad for postgraduate training between 1963 and 1967, but only 500 were sent. The Second Five-Year Plan projected a further 3,000, but only 681 were sent. About 10% of those sent abroad between 1963 and 1971 studied basic sciences. Thus there were some, although limited, opportunities for prospective research scientists to study outside Turkey.

However, certain factors tended to diminish the effectiveness of training
abroad, not least of which was the language difficulty. Also, the opportunities for obtaining government scholarships were not widely publicized, while motivation to study abroad was scarcely raised by having to resign and remain at the same point on the civil service scale until the 4 - 7 years of study were over - something which meant that a newly graduated Ph.D. found himself at a lower point on the scale than his colleagues who had stayed in Turkey. (414)

One consequence of Turkish students' studying abroad was that some of them decided to stay there. It has been estimated that in 1962 the number of Ph.D.'s in natural sciences who emigrated from Turkey was seven times the country's annual production of Ph.D.'s in the national sciences. (415) Between 1962 and 1966, 512 Turkish scientists, engineers and doctors are reported to have settled in the United States alone, 21 of them with Ph.D. degrees in physics, 7 in chemistry and 6 in earth sciences. (416)

Many of those Turkish scientists who did emigrate tended to be the most productive in terms of research papers published. (417) Among them was Feza Gürsey, a professor of Yale University, who amongst his other honours shared the 1976 Oppenheimer Prize with Sheldon Glashow for his contributions to theoretical physics.

4.3.21 Fundamental research in Turkey: 1960-1978

With research in the private sector either non-existent or limited to modifications to industrial processes, (418) fundamental research in Turkey was undertaken only at the universities or at the two nuclear research institutes, the Çekmece and the Ankara Nuclear Research and Training Centres. (419)

The Çekmece Centre was opened in 1962 with a 1 megawatt reactor costing 30 million TL ($3.3 million). (420) By 1977, it had a staff of 260 including about 40 research scientists, of whom 26 had Ph.D. degrees. Amongst its 9 sections were those of physics, chemistry, radiobiology and electronics, and it was funded by a budget of over 80 million TL (1975), or nearly $6 million. During the 1960's, Çekmece was a centre of scientific activity, having close links with universities in Istanbul and Ankara. By the end of 1969, its personnel had published 19 research papers in foreign journals. One of its far-sighted early directors ensured that experiments
would not be hampered by a lack of small sums of foreign currency; he deposited $1,000 worth of the original aid funds in a New York bank account. However, the original momentum of the early years was halted by jealousies and disagreements among administrative personnel, and the subsequent adoption of a policy to limit basic research. Key personnel also left. For this and other reasons, by 1969 more than 60% of the 260 scientists who had been trained for or by the Atomic Energy Commission had emigrated from Turkey. Relations with the universities also deteriorated. However, some research was accomplished in the 1970's on nuclear physics, plasma physics, and solid state physics, besides the routine production of radioisotopes for local use.

The Ankara Centre was set up in 1966, and by 1978 had about 60 research workers in 10 groups working in both basic and applied fields. The groups working in basic fields were the Nuclear Physics, the Nuclear Chemistry and the Plasma-Laser Groups. No research articles in basic fields were reported in 1977. In 1978, 11 articles were published in foreign journals, 4 of them in non-applied fields. In 1979, the figure was 3, with only one in a non-applied field. Several students from Ankara University have been able to undertake research for Ph.D. degrees there, and research leading to at least 2 doctorate theses has been completed. Unfortunately, research output at the centre seems to have been affected by frequent turnovers of personnel.

The bulk of non-applied research work in Turkey is undertaken at the universities.

4.3.22 Quantitative aspects of research at Turkish universities

In general, expenditure on research at Turkish universities doubled between 1969 and 1978, reaching a trough in 1971 and dropping quite sharply between 1977 and 1978.
TABLE 4.59

Spending on R and D at Selected Turkish Universities (1969 prices)
(millions TL, with percentage contribution of each university in parentheses)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>AU</td>
<td>13.1(21%)</td>
<td>15.5(23%)</td>
<td>12.3(24%)</td>
<td>19.3(22%)</td>
<td>31.6(18%)</td>
<td>21.6(17%)</td>
</tr>
<tr>
<td>EAU</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5.8( 3%)</td>
<td>4.3( 3%)</td>
</tr>
<tr>
<td>BU</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6.1( 3%)</td>
<td>3.4( 3%)</td>
</tr>
<tr>
<td>ÇU</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5.9( 3%)</td>
<td>4.7( 4%)</td>
</tr>
<tr>
<td>EU</td>
<td>8.9(14%)</td>
<td>10.0(15%)</td>
<td>7.4(15%)</td>
<td>11.3(13%)</td>
<td>40.1(22%)</td>
<td>29.5(23%)</td>
</tr>
<tr>
<td>HU</td>
<td>4.8( 8%)</td>
<td>6.4(10%)</td>
<td>3.8( 7%)</td>
<td>11.4(13%)</td>
<td>20.6(11%)</td>
<td>15.2(12%)</td>
</tr>
<tr>
<td>ITU</td>
<td>6.3(10%)</td>
<td>6.3( 9%)</td>
<td>3.9( 8%)</td>
<td>7.6( 9%)</td>
<td>16.0( 9%)</td>
<td>8.7( 7%)</td>
</tr>
<tr>
<td>IU</td>
<td>12.4(20%)</td>
<td>12.6(19%)</td>
<td>9.3(19%)</td>
<td>15.7(18%)</td>
<td>25.7(14%)</td>
<td>18.5(15%)</td>
</tr>
<tr>
<td>KTU</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.7( 1%)</td>
<td>2.0( 2%)</td>
</tr>
<tr>
<td>METU</td>
<td>9.0(14%)</td>
<td>9.2(14%)</td>
<td>8.8(17%)</td>
<td>15.0(17%)</td>
<td>12.6( 7%)</td>
<td>7.9( 6%)</td>
</tr>
<tr>
<td>Other</td>
<td>7.6(12%)</td>
<td>6.3( 9%)</td>
<td>4.7( 9%)</td>
<td>8.2( 9%)</td>
<td>12.6( 7%)</td>
<td>7.9( 6%)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>62.2</td>
<td>66.2</td>
<td>50.1</td>
<td>88.5</td>
<td>179.7</td>
<td>123.6</td>
</tr>
</tbody>
</table>


Research expenditures of EAU and KTU are included in 'Other' for 1969-72.

The drop between 1977 and 1978 reflects the poor economic situation and very high rate of inflation.

Spending on research in basic science faculties in 1978 was as follows. (426) 10% of lecturers' salaries are included since 10% was the amount of time lecturers estimated they spent on research when figures were first collected in 1964.
There is considerable variation in the percentage of the faculty budget spent on research, even amongst established universities.

Total expenditure on research in basic sciences at Turkish universities rose sixfold between 1964 and 1977, while the number of scientists rose fourfold. Annual research expenditure per scientist, therefore, showed a significant increase, to about $2,000. (427)
### TABLE 4.61

<table>
<thead>
<tr>
<th>Year</th>
<th>Expenditure (1,000 TL)</th>
<th>No. of scientists</th>
<th>Expenditure per scientist (1,000 TL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1964</td>
<td>5,516</td>
<td>393</td>
<td>14</td>
</tr>
<tr>
<td>1970</td>
<td>13,451</td>
<td>780</td>
<td>17</td>
</tr>
<tr>
<td>1977</td>
<td>30,574</td>
<td>1,548</td>
<td>20</td>
</tr>
</tbody>
</table>

('Basic Sciences' includes physics, chemistry, mathematics, biology, botany and nuclear physics)

Over the period, there was some evidence to suggest that on average the number of research publications by Turkish scientists working in Turkey was low compared with the number published by scientists at American and European universities. On the basis of a 30% sample of research scientists' publications up to 1966, Özinöö observed that Turkish scientists who frequently travelled outside Turkey or who lived outside Turkey published more research papers than scientists who stayed in Turkey.\(^{(428)}\) A TÜBİTAK study of Turkish scientists in 1967 showed that the average docent completed one piece of research in 3.7 years, while the average professor did so in 4.1 years. The OECD Pilot Team remarked:\(^{(429)}\) "The number of theses per year per institute shows a fairly high degree of correspondence with the numbers of publications produced. This suggests that the output of research is rather closely associated with the production of academic theses. It may be that this is the factor that determines the average length of projects, which corresponds to a period more or less equivalent to the time normally required for a doctoral thesis." Also, Türkeli has indicated that doctoral training environments affect post-doctoral productivity of Turkish physicists, with the Turkish university environment not being as helpful as that of an American or European university.\(^{(430)}\)

Publishing rates in the social sciences seem to be even lower. A survey of 565 university researchers in the social sciences showed that the average number of printed publications between 1960 and 1970 was about 2, or one in 5 years.\(^{(431)}\)

The lack of research publications in the basic sciences may be a partial result of the reluctance of professors to take on Ph.D. students. Thus
In her 1970 study of Turkish university research scientists, Varış found that 80 out of the 196 professors in her sample appeared not to do any teaching or supervision of Ph.D. students; the figure for docents was 115 out of 148. Özinönu's earlier findings showed that only 60% of 'senior Turkish scientists' had supervised any Ph.D. students.

Even inside Turkey, there are differences in research productivity at different universities. Thus in physics, for example, Istanbul University made significant contributions until about 1963 when METU took its place as a prime producer. Significant differences among scientists at different universities were reported by Özinönu and Tinto. Thus the average number of foreign publications by 20 professors at Ankara University was 2.6, for 9 professors at Erzurum Atatürk University it was 5.4 and for 5 professors at METU it was 11.0. More recently, however, especially in physics, the research output of Ankara University has increased (13 publications in Western journals in 1977), while Hacettepe University has also become a prime producer (80 publications in 9 years).

4.3.23 Problems identified in scientific research in Turkish universities over the period

In 1961, Eugene Northrop, the Ford Foundation representative in Ankara described research in Turkey as follows: "The conditions and climate for research and communication between scientists are so bad that there is no steady output of research work, scientific publication is sporadic and sparse, and good foreign scientists - who are needed to bolster research and teaching - are discouraged from accepting any visiting appointments." The 1968 OECD Pilot Team's remarks on the state of scientific research in Turkey were also quite pessimistic: "We may conclude that Turkey has not yet been able to use the results of scientific discovery on any significant scale, nor has she been able to generate a major advance in scientific work." Turkish academic researchers themselves were aware that all was not well. Varış's 1970 study reported that 54% of the 713 professors, docents and asistans questioned thought that the progress of their disciplines in Turkey was academically "inadequate" and a further 22% thought it was "less than adequate."
Although very little research by Turkish scientists which gained international recognition was accomplished inside Turkey between 1961 and 1971, the situation was to improve by the late 1970's. However, over the period, there were to be many critics of different aspects of research in Turkey.

One complaint that was frequently made was that there was no demand for research in Turkey, due perhaps to a lack of co-operation between the universities and industry. Moreover, what research was being done seemed irrelevant to the needs of the country. Several observers touched on the absence of a "research atmosphere". This absence was partly related to low role-expectations for a scientific researcher, both informal and formal. Such low expectations lowered motivation to engage in research. Motivation was probably lowered further by the general lack of appreciation of scientific research and its applications. Moreover, greater prestige than could be gained from research could be gained by going into administration or even politics.

The lack of personnel was another criticism. In each sub-speciality there were very few scientists. The consequent small size of the Turkish scientific community did not encourage criticism - for scientists knew each other too well. Also, a large scientific field could be dominated by an autocratic administrator for many years. Furthermore, research personnel were unevenly divided amongst professors, docents and asistans, with a disproportionate number of older scientists, and some of these of mediocre ability. Administration and teaching wholly occupied some potential research workers.

A further repercussion of the small size of the Turkish scientific community was that scientists had few opportunities for information exchange with other scientists in the same sub-discipline and so they went abroad in search of greater intellectual stimulation.

University teaching staff appeared to give little time to research. An early survey by the Science Policy Unit of TÜBİTAK found that the average time devoted to research was 10% of the total working time available. The remainder of the time went to teaching and administrative duties. Staff were not persuaded to spend time on research by low salary scales, which encouraged them to seek part-time teaching posts outside the universities. Also, in the 1960's, low salary scales resulted in some staff shortages, since able people were not attracted to an academic career.
The shortage of adequate supplies and equipment for research was frequently pointed out. This was largely due to a lack of funds - whatever funds there were were spread over too many research units.

Also shortages were compounded by importation difficulties, and lack of foreign exchange. Once equipment was procured, there were few qualified technicians to maintain them.

It was noted that comparatively few scientists excelled in foreign languages, and yet the up-to-date research literature was unavailable in Turkish. Libraries and foreign journals were not accessible to some scientists.

Lack of co-ordination among and even within universities came in for extensive criticism. Universities misused the concept of autonomy, it was claimed, while within individual chairs, there was often little real academic freedom. The academic hierarchy was too rigid and formal for proper intellectual exchange, in the chair-system universities at least.

Finally, the troubles caused by clashes between right-wing and left-wing students, which sometimes ended in loss of limb or even life, were a cause of concern.

The above observations, therefore, formed a background against which I set out to investigate the presence and absence of the different conducive factors in 1978 by means of interviews with 75 Turkish scientists engaged in research at Turkish universities in the areas of physics, chemistry and biochemistry.
In March and April 1978, I undertook a survey amongst Turkish chemists, physicists and biochemists engaged in experimental research in seven universities in the three largest cities of Turkey.

5.1 Aim of the Survey

The aim of the survey was to attempt to identify which conducents for the performance of experimental scientific activity were still not fully realised in and around those scientists actually engaged in experimental basic research in Turkey. In addition, the respondents were asked which values, mores, customs and folkways present in Turkish society they considered might be influential in partial or non-realization of certain of these conducents.

At the same time, information was obtained about the social background, education and research performance of each respondent.

5.2 Nature of the Inquiry

A structured interview was preferred to a postal questionnaire for several reasons. First, the potential respondents, in common with scientists in any other country of the world, might have been tempted to put off filling in a questionnaire in the middle of a busy academic life. Second, there might have been a psychological resistance to filling in a questionnaire for a completely unknown foreigner. Third, some scientists might have hesitated to put answers to sensitive questions in writing. Fourth, with some respondents a bias might have been introduced by their discussing some of the questions with their colleagues before answering them. Finally, a structured interview gave the opportunity to probe more deeply when a respondent's reply was not fully explicit or else when it suggested that something of great interest lay behind it.

I decided not to use a tape-recorder, since previous experience and the advice of other Turks suggested that some respondents would be more loth to speak their minds if each word were recorded for posterity.

When a pilot survey showed that the interview was taking from 1½ - 2 hours, I decided to undertake a structured interview lasting approximately 1 hour,
and then to leave some of the more routine, time-consuming questions with
the respondent to be filled in and returned by post. As far as possible,
questions of a more sensitive nature were asked during the interview.

After the hour-long structural interview, a rapport had been established
such that only 4 out of the 75 respondents did not send in their completed
questionnaires in time, although in fact all 4 did send them in eventually.
Only one potential respondent did not wish to be interviewed, and this was
because a spate of personal problems had disturbed her psychologically (this
was attested by her colleagues). At the end of the structured interview,
each respondent was asked not to consult anyone else when filling in the
second section, and the reason for this was explained.

5.3 The Sample

It was decided to confine the sample to Turkish physicists, chemists and
biochemists engaged in experimental research inside Turkey. The few
foreigners working in these fields in Turkey were included afterwards for
comparison, but the number of these (4) was too small to make up a
significant control group.

Scientists engaged in theoretical research were excluded since the performing
of such research involved fewer and perhaps different conducents than was the
case with experimental research.

Scientists in other, more applied fields were excluded since the performance
of research in such fields could be affected by additional variables. For
example, some academics in engineering faculties took on part-time
consultancies outside the universities, which would be expected to affect
their motivation and ability to undertake research. Also, many academics
in medical faculties had private clinics, as well as the routine but
time-consuming clinics in their teaching hospitals.

Preliminary enquiries showed that the majority of published research in
physics, chemistry and biochemistry had been performed in the universities.
Of the government research institutes with at least a minimum involvement in
basic research, the Çekmece Nuclear Research Institute in Istanbul and the Anka
Nuclear Research Institute were felt by many scientists to have become
victims of political intrigue, and this appeared to have had an effect upon
research performance (see above p.286). The Marmara Research Institute at Gebze had all but abandoned experimental basic research by 1978. Furthermore, the performance of research at such institutions did not appear to involve such factors as the teaching of undergraduates and the supervision of postgraduates, which could affect the research performance of academic researchers. This latter reason also applied to scientists working in the few research laboratories of state-owned companies. Scientists from these institutions were therefore excluded from the sample.

Research workers in the private sector were also excluded as they did not usually publish their findings in international journals, and also because their numbers were too small to be known even by the Scientific and Technical Research Council of Turkey.

The sample was confined to the universities in Istanbul (Istanbul University, Istanbul Technical University, and Bosphorus University), Ankara (Ankara University, Hacettepe University, and Middle East Technical University or METU) and Izmir (Ege University). Research scientists in universities outside these three centres were not considered for one or more of the following reasons: (i) the university at which they were employed was too new to have become properly established, (ii) their departments were understaffed and so what staff there were did not have time for anything but teaching, (iii) additional difficulties were met with in pursuing experimental research outside the three largest cities, mainly involving the obtaining of equipment, supplies and qualified technicians, all of which discouraged academics interested in doing such research from taking up posts there, (iv) many of the staff at such universities had moved there after appointments in universities in the three main cities, and so their views on many topics could be considered to be similar to those of their ex-colleagues in the main cities. Additional variables would, of course, have been introduced as a concomitant of (i) to (iii) above.

A slight bias in the sample was introduced by opting for scientists who had worked or studied abroad for a few months or more. Such scientists were obviously in a better position to answer questions comparing the performance of research inside Turkey with that done outside. This bias only really appeared at the Ph.D. level, since nearly all the potential respondents of docent and professorial rank had studied abroad.
Also, a preference was shown towards scientists in English-medium and mixed types of universities, as they were assumed to be more in touch with the international scientific community and less parochial in outlook. Where potential respondents had the same qualifications, the actual respondents were chosen using random numbers.

A greater bias was introduced by interviewing more professors and docents than was warranted by their relative proportions in the "universe". It was felt that older, more senior scientists would be in a better position to answer some of the questions involving role expectations and values in the scientific community in Turkey.

Thus of the sample of 75 scientists, 21 were professors (30.0% of all potential respondent professors), 23 were docents (25.8% of all potential respondent docents), and 31 were Ph.D.'s (13.6% of all potential respondent Ph.D.'s). With 387 post-doctoral physicists, chemists and biochemists engaged in experimental research in the universities of the three main cities of Turkey, this gave an overall sample of 19.4%. 52 (or 69.3%) of the scientists interviewed were men and 23 (or 30.7%) were women.

Without visiting each of the universities outside Ankara, Izmir and Istanbul (precluded by the time and expense involved), figures for the number of scientists engaged in experimental research in those universities were found to be impossible to obtain. Neither the Ministry of Education nor the Universities Commission nor TÜBİTAK were able to supply the necessary information. However, as no claim is being made that the sample was typical of all post-doctoral physicists, chemists and biochemists engaged in experimental research in all the universities of Turkey, the lack of this information is not as great a loss as first it might appear.

After allowing for the various biases mentioned above, therefore, the sample should be fairly representative of the 387 research scientists within its frame of reference.

5.4 Language Medium of the Interviews

With the exception of interviews with two respondents who insisted on answering the interviewer's Turkish questions in perfect English, all the interviews were conducted in Turkish.
5.5 Order of Questions

A surmise was made beforehand that some respondents might be on the defensive when faced with a foreign interviewer. In preparing the questions, therefore, an effort was made to avoid being patronising about science in Turkey. Questions which might have been interpreted as putting Turkish science or Turkish customs in a bad light were spaced as far away from each other as possible.

5.6 Pilot Survey

Before the main survey was begun, ten scientists, several of whom were known to the interviewer, were interviewed. On the basis of the impressions gained by the interviewer, and of the recommendations of those interviewed, several questions were deleted, others added and still others modified.

5.7 Processing of the Results

Answers to questions which lent themselves to computer processing were transferred to computer cards, and processed by means of the SPSS (Statistical package for the Social Sciences) programme. The answers to other, more open-ended questions were collated manually.

5.8 Nature of the Results

Since many of the questions were asking the respondents' opinions about a given topic or relationship, the results of the survey must be somewhat subjective. There is also the point that some respondents may have held back from stating their true opinions for fear that a third party might have found out about them. It might also be argued that the respondents would have been tempted to have given cliché-type responses, that is, responses which they felt an "ideal" scientist would probably give.

However, the impression I gained was that most of the respondents were genuinely concerned about the state of Turkish science, and were anxious to gain an objective picture thereof. Although a few respondents were obviously on the defensive, most of them seemed prepared to respond even to questions which may have appeared to paint the state of Turkish science a rather dark shade of grey. On several occasions examples were given, anecdotes related
or comments made which obviously corroborated the response that had been made. As regards questions which compared research done inside Turkey with that done outside, there appeared to be enough scientists who were ready to down things Turkish to balance off those who were only prepared to elevate them.

5.9 Analysis of the Results

5.9.1 Appertaining to conceptual and attitudinal conducents

Three questions were designed to show to what extent beliefs and attitudes found in the wider society impinged upon and influenced the beliefs and attitudes of scientists.

The respondents were asked if they considered that an attitude of fatalism was prevalent in contemporary Turkish society (Q.44). If they replied in the negative, the interviewer reminded them that expressions such as Ne yapalım? ("What can we do?") and Elimizde de değil ("It's not in our hands") are extremely widespread and are frequently heard several times a day. (6) Most respondents then agreed that even though the past few years had seen a change in fatalistic attitudes in general, remnants of such attitudes still prevailed. Respondents were then asked to imagine a situation in which a researcher faced practical difficulties which were great, but which with a little more exertion could be surmounted. In such a situation, did the respondents consider that a researcher's desire and zeal to overcome these difficulties were in any way (consciously or unconsciously) affected by a fatalistic attitude in society (Q.44b)? Of the 70 respondents who were asked, 2 (3%) thought it lessened them greatly, 39 (56%) thought it lessened them a little, 26 (37%) thought it did not lessen them at all, and 3 (4%) were undecided. (7)

Cross-tabulation by domicile until the age of twelve showed that a higher proportion of respondents brought up in a village (6 out of 7) thought fatalistic attitudes in society might influence a scientist to give up more easily in the face of difficulties. This may have been due to such respondents' being more sensitive to the influence of fatalistic attitudes on their fellow-countrymen, or else, more unlikely, they may have been extrapolating from the influence they felt that such attitudes still had over they themselves.
Incidentally, the word "fatalism" - which has been transliterated into Turkish as it is - was not used in the question, as it has acquired rather negative connotations. Rather, the term "a tendency to accept conditions as they are" was used.

A significant proportion of respondents, therefore, considered that a societal attitude might negatively affect the desire and zeal of a researcher to overcome the natural world (conducent Ie), although most would see this effect as rather small. The extent to which this desire and zeal is linked to a general conviction that the natural world can be controlled, rather than to an individual's self-confidence in his or her own ability to change the conditions around them is not clear, however.

While discussing the subject of fatalism, one professor made the following comment, which suggests that resignation to the status quo may be encouraged both by bureaucratic problems and by the resignation of bureaucrats to the status quo: "Sometimes people try to discourage you when you want a new piece of equipment, or something. They try to hinder your attempts to obtain it by saying 'This is the state of the country. Why work in this field? There's nothing we can do'." A further alternative, then, is that scientists may have a conviction that the natural world can be understood and controlled, but that they consider such understanding and control in Turkey is prevented by bureaucratic and economic difficulties.

An attempt was made to assess whether or not the respondents saw any conflict between science and religion (conducent If). They were asked whether they thought that religion had had a negative influence - direct or indirect - upon the development of science in Turkey since 1923 (Q.41). 37% thought that it had, 57% thought that it had not, and 5% did not know. Respondents who thought that it had were then asked to elaborate. 2 respondents thought there was a conflict between science and religion per se; another 3 felt that conflict had arisen because certain religious elements had despised science and technology since they were seen as products of the Christian West, that is, as irrelevant for Muslims.

Other respondents, too, felt that religion in Turkey had discouraged belief in scientific knowledge as relevant knowledge for Turkish society. 2 scientists expressed this as "the men of religion thought that religious knowledge was the only knowledge worth having", while 7 considered that more
importance had been given to religious education than to secular education by the people (4) and by various governments (3). 2 respondents felt that it was more a matter of power and status; the men of religion had turned people against secular schools when they found their authority being threatened, especially in rural areas. 4 other respondents considered that the Islamic religion had deprived Turkey of a number of potential scientists in this fashion: people in country areas often kept their girls away from secular schools because of a belief that the only knowledge their girls needed was religious knowledge. 2 respondents held that religion had nurtured an attitude of fatalism, undermining the belief that the natural world can be understood and controlled. Yet another respondent suggested that religion had undermined belief in the uniformity of natural causes: it had "encouraged superstitions which weakened people's interest in the positive sciences". Other respondents gave reasons appertaining to other conducents which will be considered later.

Considering that the reasons given by the respondents were quite unprompted, it is significant that so many gave the responses they did. Indirect effects are not easy to identify. Had all the respondents been presented with them, a higher proportion might have considered that religion had negatively affected scientific development. Furthermore, I have often detected an Islamic chauvinism in Turkey, even amongst those who ostensibly have rejected religious beliefs; this may have tilted the scales slightly more in favour of religion than might have been the case had the interviewer not been a non-Muslim.

On the other hand, it is interesting to note how few respondents (2) saw a conflict between science and religion per se. Or rather, few respondents saw that any conflict there might have been was great enough to disturb the development of science. That even some imams saw no conflict between science and religion was shown by two of the respondents having fathers who were (educated) imams, both of whom had encouraged their children to pursue science as a career. (8)

The respondents were also asked if they had ever heard an older person say that studying science made people lose their religious faith (Q.42) Not one had ever heard this, though several scientists held that people who would make such a statement probably existed in Turkey. It could be argued, of course, that anyone who had heard such a statement from an older
person they respected would not have become a scientist.

In short; the results show that whilst very few of the scientists interviewed saw a direct conflict between science and religious belief, 17 (23%) believed that religion had indirectly affected the development of science in Turkey by fostering beliefs and attitudes at variance with conducents Ic, Ie and If.

An attempt was also made to determine the absence of conducent Ig. It was hypothesized that experimental research might not be seen as a favourable activity, because it frequently involves a fair amount of manual work; previous personal observation had shown that rich or elite Turks usually paid someone else to do their carrying and lifting, even when it only involved a suit-case. Q.50 asked, therefore, whether in the respondent's opinion, tasks which involved some manual work were looked down upon by the well-educated and rich people in society. Although several respondents thought that the situation was changing, only 1 out of 64 refused to admit that there was such a value in the aforementioned group in Turkish society.

Respondents were then asked the following question (50b): "Some experimental research may require the research worker to do some manual work. Do you think that the attitude just mentioned might be one reason why an able student might choose not to go into a career in experimental research?"

Responses were as follows, for 65 respondents:

Yes: 13 (20%)  
No: 50 (77%)  
Don't know: 2 (3%)

However, the results of this must be treated with some caution, since it is not clear to what extent university lecturers understand the reasons for the career choice of their students. Some lecturers said quite openly that they felt there was little choice in the matter of career in Turkey; often it was a matter of coincidence. Others thought that people who had the above attitude would in any case go into the family business. One professor made the following comment: "The main factor affecting choice of career in Turkey is the economic one. In any case, no one outside the university would think of a member of the teaching staff as someone who did manual work. Inside the university, such work is considered a normal part of the job."

This question 50b was then followed by Q.50c: "How does the attitude mentioned above affect a scientist's desire to do experimental research?"

Responses were as follows:
It can lessen it greatly: 0
It can lessen it to some extent: 19 (30%)
It doesn't lessen it at all: 45 (70%)

Most respondents felt that once a person had embarked upon a career in experimental research science, he would realize that tasks involving a certain amount of manual work would be inevitable. In their opinion, what was more important in lowering motivation to do experimental research were the difficulties involved in obtaining and maintaining equipment. Nevertheless, 19 of the 64 scientists questioned did think that an unfavourable attitude towards the doing of physical tasks, to some extent still prevalent in Turkish society at large, might act to keep some research scientists away from the laboratory.

5.9.2 Appertaining to methodological conducents

An attempt was made to ascertain to what extent two of the methodological conducents described earlier were present among Turkish scientists. These two, which are closely linked to one another, were "An openness to the possibility of alternative explanations" (conducent IIe) and "A scepticism towards the results and hypotheses of oneself and others" (conducent IIIf).

Earlier, in Section 2.3 - IIIf, I argued that a scepticism on the part of a scientist towards his own results and hypotheses will enable him to publish more research work, and so achieve greater recognition, while a scepticism towards the results and hypotheses of others will enable him to discriminate between significant and insignificant work in periods of normal science, and in times of scientific "crisis" may lead to public recognition.

The interviews with Turkish scientists suggested that a high proportion of them had subjected at least some of their research to critical appraisal. Out of 73 scientists who responded, 59 (81%) had managed to satisfy the referees of foreign research journals at least once. Altogether, the 59 scientists had published 348 pieces of research abroad (although 78 of these publications were by 2 exceptional producers). However, the sample was biased towards scientists who had been abroad. It was noticeable that some chairs or departments, especially in the more classical types of universities, had hardly fostered any foreign research publications. Some respondents emphasized that most research published abroad by Turkish scientists had been performed outside Turkey, and cross-tabulation of foreign publications by years abroad indicated a rough correlation. For example, 11 of the 14
scientists who had never published abroad had never been abroad (8), or had been abroad for only a few months (3). At the same time, there are other factors besides critical appraisal involved in publication of research reports abroad, including availability of apparatus and knowledge of a foreign language.

It seemed likely that scientists who had been abroad for a reasonable length of time would have inculcated a fairly sceptical attitude not only towards their own results and hypotheses but also to those of others. On the other hand, it seemed probable that in those departments where the influence of the international scientific community was rather minimal, particularistic factors would tend to counteract any tendencies to engage in free and critical intellectual exchange. The results of a series of questions appeared to bear this out.

Respondents were asked whether they thought a body of scientists who were prepared to criticise in an open manner existed in Turkey (Q.58). The responses of the 74 scientists who answered were as follows:

Yes : 37 (50%)  No : 13 (18%)  Only in some fields : 24 (32%)

Cross-tabulation by university showed that higher proportions of respondents at the more classical Istanbul and Ankara Universities doubted its existence:

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<tbody>
<tr>
<td>No. of respondents at this university:</td>
<td>13</td>
<td>3</td>
<td>8</td>
<td>14</td>
<td>18</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>No. of respondents at this university answering &quot;No&quot;:</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>2</td>
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A.U. = Ankara University, B.U. = Bosphorus University, E.U. = Ege University, H.U. = Hacettepe University, I.U. = Istanbul University, I.T.U. = Istanbul Technical University, M.E.T.U. = Middle East Technical University

It was thought that respondents might be tempted to say that such a critical body of scientists did exist even when they did not really think so, since an ideal type of scientist might be considered to be a ready giver and receiver of criticism. Those who replied in the affirmative, therefore, were then asked if they had ever openly criticized another Turkish scientist either at a conference or in a journal. If they said they had, they were asked how the scientist being criticized had received their criticism; if they said they had not, they were asked, "Haven't you ever seen a research
### TABLE 5.2

Factors considered responsible for reticence to criticize amongst Turkish scientists in some fields at least

<table>
<thead>
<tr>
<th>Factor</th>
<th>i</th>
<th>s.i.</th>
<th>i+s.i.</th>
<th>n.i.</th>
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<tbody>
<tr>
<td>Turkish scientists do not criticize one another openly because --</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1. they think this may adversely affect their chances of promotion in the future</td>
<td>24</td>
<td>23</td>
<td>47</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>(35)</td>
<td>(36)</td>
<td>(69)</td>
<td>(31)</td>
</tr>
<tr>
<td>2. people in Turkey are less individualistic than people in the West</td>
<td>21</td>
<td>32</td>
<td>53</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>(30)</td>
<td>(46)</td>
<td>(76)</td>
<td>(23)</td>
</tr>
<tr>
<td>3. they think that the person being criticized may take it as a personal attack upon himself and become offended:</td>
<td>21</td>
<td>30</td>
<td>51</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>(30)</td>
<td>(44)</td>
<td>(74)</td>
<td>(26)</td>
</tr>
<tr>
<td>4. due to the small size of the scientific community in Turkey, scientists tend to know each other rather well</td>
<td>21</td>
<td>28</td>
<td>49</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>(30)</td>
<td>(41)</td>
<td>(71)</td>
<td>(29)</td>
</tr>
<tr>
<td>5. doubt and criticism are discouraged by certain authoritarian institutions in Turkish society (e.g. the family, religious and educational institutions)</td>
<td>8</td>
<td>22</td>
<td>30</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>(12)</td>
<td>(32)</td>
<td>(44)</td>
<td>(56)</td>
</tr>
<tr>
<td>6. criticizing the work of a more senior scientist is 'not done'</td>
<td>8</td>
<td>19</td>
<td>27</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>(12)</td>
<td>(28)</td>
<td>(40)</td>
<td>(60)</td>
</tr>
<tr>
<td>7. of other reasons</td>
<td>8</td>
<td>4</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

i = important,  s.i. = of some importance,  n.i. = of no importance at all

Numbers in parentheses are rounded off percentages
paper worthy of criticism?"

28 of the 37 (67%) claimed that they had criticized another Turk at a conference but not in print and that their criticisms had been received mostly in a positive way, though a few had experienced a sharp reaction. Of the 14 respondents who had never criticized openly, only 2 admitted that they had seen something to criticize but that they had not had sufficient confidence in their own abilities to speak out.

Such questions were a preliminary to a loaded question (Q.58d), "Wouldn't you agree that in some fields Turkish scientists refrain from criticizing one another openly?" 12 of the original 37 respondents who had held that an openly critical body of scientists did exist in Turkey still stood by their claim, whereas the other 25 accepted that this was only the case in certain fields. Thus, of the 74 scientists asked, 13 (or 18%) were certain that in general Turkish scientists refrained from openly criticizing one another, while 49 others (or a further 66%) admitted that they did refrain in certain fields, in a number of cases at least.

The next step was to ask the respondents which socio-cultural factors they considered might be responsible for this reticence to criticize openly (Q.58e). Six factors were suggested, and the respondent was asked to mark which of them he thought were important, of some importance, or of no importance at all. The results are shown in Table 5.2, for 69 respondents.

Since it is not easy to decide whether or not to apportion a 'negative weight' to the 'not important at all' column, perhaps it would be best to note merely that items 1, 2, 3 and 4 are considered at least of some importance by a minimum of 68% of the 69 respondents who answered the series of questions.

The following reasons were given under 'Other': 'Lack of qualified people in the same sub-discipline' (5 respondents), 'Lack of confidence in one's ability to criticize' (5), 'Fear of the caprices of those in higher academic positions' (1), 'People do not take enough interest in each other's work' and 'Professors don't criticize another professor's Ph.D. student so that in turn he won't criticize theirs' (1).
Of the items the respondents were asked to mark, item 5 referred to a lack of socialization into scepticism in general. Item 2 may be correlated with lack of socialization into thinking for oneself and into being ready to challenge the results and hypotheses of others. The other four items refer more directly to a lack of open criticism; even though something worthy of criticism may be noted, scientists refrain from pointing it out either because of fear of the consequences or because such an action would go against a cultural more. These would affect motivation to criticise openly. Also, to avoid the conflict between seeing points worthy of criticism and yet not wanting to make them public, eventually a scientist might be tempted not to question the postulates and results of other scientists. This, in turn, would rub off onto younger scientists under his supervision or with whom he was in close contact in other ways, affecting their role conception of a research scientist.

It was interesting to find one respondent making the following entry under 'Other' in a question (Q.43) which asked which customs or mores had been inimical to the development of science in Turkey during the Republican era: "It is not considered proper to disagree with the ideas of an older or more important person".

Another two questions in the survey attempted to determine both how ready the respondent was to consider the possibility of alternative hypotheses and suggestions, and to what extent a young research scientist might feel free to challenge the ideas of an older, more senior scientist. One question (Q.64) asked, "While you were doing research, has one of your research assistants ever proposed a solution different from the one you had proposed?" Of the 31 respondents who had research assistants, all of them replied "Of course" or an immediate "Yes". However, to have answered "No" would have allowed aspersions to be cast on the degree of their "scientific open-mindedness", and so the results of this must be treated with caution.

The second question (Q.65) was intended to be less personal, and so to avoid the above difficulty: "Does a young research worker (in Turkey) normally challenge the suggestions of a more senior scientist?" The answer was mostly "Yes", although a few respondents thought that it depended on the senior scientist or upon the age difference between the two. It is questionable, however, the extent to which scientists would be able to generalize about the working relationships of other scientists, and so in
retrospect this was probably not a good question. It is not surprising, therefore, that these results appear to conflict with the responses to a question concerning the existence of an atmosphere of critical appraisal in Turkey (Q.69), responses which to my mind are more trustworthy.

In Q.69, respondents were asked to mark a number of factors according to whether they considered each one as important, of some importance or of no importance at all in hindering the development of science in Turkey. The results are given in Table 5.3

**TABLE 5.3**

Factors considered as influential in hindering the performance of more, good, experimental research in Turkey

<table>
<thead>
<tr>
<th></th>
<th>i.</th>
<th>s.i.</th>
<th>i.+s.i.</th>
<th>n.i.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. It is difficult to obtain supplies and equipment:</td>
<td>60</td>
<td>9</td>
<td>69</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>(84)</td>
<td>(13)</td>
<td>(97)</td>
<td>(3)</td>
</tr>
<tr>
<td>2. There is a lack of co-operation amongst research scientists in Turkey:</td>
<td>45</td>
<td>21</td>
<td>66</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>(64)</td>
<td>(30)</td>
<td>(94)</td>
<td>(6)</td>
</tr>
<tr>
<td>3. There are not enough qualified laboratory technicians:</td>
<td>45</td>
<td>16</td>
<td>61</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>(65)</td>
<td>(23)</td>
<td>(88)</td>
<td>(12)</td>
</tr>
<tr>
<td>4. There is a lack of research planning amongst the relevant university departments:</td>
<td>41</td>
<td>17</td>
<td>58</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>(61)</td>
<td>(25)</td>
<td>(86)</td>
<td>(13)</td>
</tr>
<tr>
<td>5. Creativity is not encouraged by the educational system:</td>
<td>38</td>
<td>22</td>
<td>60</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>(55)</td>
<td>(32)</td>
<td>(87)</td>
<td>(13)</td>
</tr>
<tr>
<td>6. There is a lack of access to current research literature:</td>
<td>37</td>
<td>19</td>
<td>56</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>(53)</td>
<td>(27)</td>
<td>(80)</td>
<td>(20)</td>
</tr>
<tr>
<td>7. There is little motivation to do research:</td>
<td>34</td>
<td>25</td>
<td>59</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>(50)</td>
<td>(37)</td>
<td>(87)</td>
<td>(13)</td>
</tr>
<tr>
<td>8. Teaching and administrative duties leave little time for research:</td>
<td>32</td>
<td>26</td>
<td>58</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>(46)</td>
<td>(38)</td>
<td>(84)</td>
<td>(16)</td>
</tr>
<tr>
<td>9. An atmosphere in which critical appraisal is encouraged is lacking:</td>
<td>29</td>
<td>31</td>
<td>60</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>(43)</td>
<td>(46)</td>
<td>(88)</td>
<td>(12)</td>
</tr>
<tr>
<td>10. There is a lack of initiative to overcome problems encountered during research:</td>
<td>28</td>
<td>29</td>
<td>57</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>(41)</td>
<td>(42)</td>
<td>(83)</td>
<td>(18)</td>
</tr>
<tr>
<td>11. There is a reticence to use experimental apparatus:</td>
<td>8</td>
<td>35</td>
<td>43</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>(12)</td>
<td>(51)</td>
<td>(62)</td>
<td>(38)</td>
</tr>
<tr>
<td>12. Other</td>
<td>13</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* i. = important, s.i. = of some importance, n.i. = of no importance at all

Numbers in parentheses are rounded off percentages
A significant number of the 68 respondents marked the factor "An atmosphere in which critical appraisal is encouraged is lacking"as important or of some importance:

Important = 29(43%), Of some importance = 31(46%), Of no importance = 8(12%)

In comparison, the figures for the responses to the earlier question (Q.58) "Do you think a body of scientists who are prepared to criticize in an open manner exists in Turkey?" were as follows, for 74 respondents:

No = 13(18%) In some fields only = 49(66%) Yes = 12(16%)

The responses to these questions and my own personal impressions suggest the following. In common with scientists of other nationalities, most Turkish scientists tend to avoid public confrontation with other Turkish scientists - either verbally or in writing - especially since the small size of the Turkish scientific community means that there are few scientists in any one sub-discipline and also that scientists know each other well.

However, in contrast to their counterparts in scientifically more developed countries, many Turkish scientists are not able to benefit from an atmosphere of critical appraisal. Not only is the small size of the Turkish scientific community again relevant but also, in some cases, other particularistic factors such as those mentioned in Table 5.1. Also, the rather formal academic hierarchies in the more classical universities would seem to hinder critical intellectual exchange. In the survey, the respondents who were most vehement that critical appraisal existed amongst Turkish scientists were usually at universities such as METU and Bosphorus University, which have less formal organisational structures. Moreover, an atmosphere of critical appraisal is not helped by authoritarian teaching methods.

Closely related to an attitude of scepticism is the other methodological conduent investigated in the survey, "An openness to the possibility of alternative explanations". The antithesis of this is intolerance, or a conviction that only one theory or one way of looking at phenomena is possible. The hypothesis was made that people would be socialized into such a conviction by authoritarian institutions such as the educational and religious institutions.

The scientists in the sample were asked to give their opinions as to how the classical (i.e. pre-Modern) secondary school science curriculum had
hindered the training of good experimental research scientists (Q.39c), following a question in which every respondent except one agreed that it had had a negative effect upon the training of such. Respondents simply had to mark whether they agreed that a certain facet of the curriculum had been a hindrance or not.

Of the 70 scientists who replied, 52 (or 74%) indicated that they considered its encouraging of memorization had had a negative effect upon the training of good research scientists. 42 (or 60%) of the respondents also felt that the science curriculum's encouraging of an acceptance of exactly what the teacher said had had a negative effect. A higher proportion of respondents, 63 (or 90%), held that the curriculum's not developing the student's creative ability was also an important negative factor.

As the Modern Science Curriculum is taken up by more and more lycees, the heavy emphasis on memorization will probably change. However, because this is a comparatively recent project with the exception of the Science Lycees, nearly all of the research scientists in Turkey were trained using the old, classical science curriculum. As has been explained before, this involves no practical work, a certain amount of problem solving, and a great deal of memorization.

Many of the respondents admitted that memorization was still very prevalent even at the university level. A conversation with a docent at a fairly new university illustrates this point:

Respondent: "Our whole educational system is based on memorization. It even comes up at the university level".

Interviewer: "But isn't this something the lecturer can prevent by asking questions which demand application of knowledge rather than simple recall? I have heard of some lecturers who have tried giving their students 'open-book' exams".

Respondent: "Yes, that's true. But then when we ask that type of question, the students kick up a great fuss. The exams they hate most are 'open-book' exams. They have simply got used to memorizing their way through exams all the way up the system".

There appear to be a number of ramifications of this heavy emphasis on memorization. First, the student comes to think that the pursuit of knowledge is merely the acquisition of a set of closed facts. Second,
he is led to believe that the purveyors of knowledge are always right, and therefore beyond criticism. Third, he is not encouraged to think for himself, to look for new relations between facts. Fourth, when he in turn becomes a teacher, he has little conception of his role as that of stimulating his students to question what they hear and read, or to apply their knowledge to new situations. Thus, not only is the student not socialized into having an openness to the possibility of alternative explanations, but he is not socialized into doubting results and theories.

When questioned as to the source of this tradition of memorization, respondents pointed to the acquisition of religious knowledge being accomplished in this way. Outside the big cities, the hafiz, or person who has memorized the Koran, still enjoys widespread prestige amongst the people. When scientists in the sample were asked whether they thought that this traditional respect for memorized knowledge had directly or indirectly had a negative influence on the development of science in Turkey since the Republic, 47 (or 67%) out of 70 thought that it had had.

In the question on religion (Q.41), some of the respondents who considered that religion had had a direct or indirect negative effect on the development of science in Turkey, gave reasons which touch on the methodological prerequisites we are discussing. Six respondents, for example, held that "religion has produced a dogmatic way of thinking, made people conservative and unreceptive to new ideas". Another respondent said, "Religion does not encourage doubt, whereas science requires it", while one of the six above added, "Religion has encouraged (blind) memorization". On the other hand, such statements must be weighed against those of two respondents who believed that "the Islamic religion fully supports the positive sciences".

One indirect effect of not questioning what is taught and of regarding the teacher or lecturer's word as authoritative is that he may resent being queried or challenged. His very conception of the role of a lecturer may cultivate in him an attitude of not being open to learning from others. Although in the survey no attempt was made to assess the existence or non-existence of such attitudes, the following comments made quite spontaneously by two of the respondents illustrated that they had been observed:

Docent A: Our professors are ashamed of being shown up in front of foreign professors, and so they don't benefit as much as they could. We need to
get rid of this mentality.

Also,

Docent B: A peculiar kind of chauvinism was displayed by Turkish scientists until the 1960's.

Interviewer: Don't scientists in every country display some kind of chauvinism?

Docent B: The old Turkish kind was different. Scientists in other countries display chauvinism by trying to get their country to produce the best science; in Turkey, it was thought that we had no need of better science - we were doing quite all right, thank you.

Question 38 was designed to test those characteristics that the respondent felt belonged to an outstanding scientist. To avoid a cliché-type of answer, the respondent was first asked to name the scientist he most admired whom he also knew personally. He was then asked to give at least three characteristics which in his opinion made the scientist a "good" scientist. 57 of the 75 scientists in the sample answered, each one giving between two and six characteristics. Presumably the characteristics mentioned were ones which were not obvious in other more "ordinary" scientists. Since 43 of the 54 scientists most admired were non-Turks (3 respondents gave characteristics but refused to commit themselves to writing the name of the scientist they most admired), it would not be amiss to hypothesize that the characteristics they mentioned were to some degree lacking in the Turkish scientific milieu, or at least in that part of it with which they were acquainted. "Humility" and "readiness to listen to others" gained 6 mentions, "openness to new ideas" 3, and "readiness to criticize his own work" 1. "Possession of a creative mind" was mentioned by 7 scientists; although this is perhaps an innate ability, it can be blunted by a socialization process which discourages creativity such as the educational system.

To summarize, therefore, it seems that there are certain traits in the Turkish educational system which a majority of the scientists interviewed thought would be counter-productive to the training of good research scientists. Tendencies toward memorization and a blind acceptance of what the teacher or lecturer says are two examples of this which in general would seem to socialize students into being closed to the possibility of alternative explanations and into being unwilling to doubt results and theories.
It might be asked how this is different from the type of socialization that scientists in other countries receive, if, as T.S. Kuhn claims, most of them are trained to accept the current paradigm—especially during periods of "normal science". (13) Answers to this question can only be conjecture. However, in most countries where scientific research is of a high quality, the educational systems have deliberately moved away from the rewarding of pure recall; a greater proportion of teachers in such countries probably applaud original thinking and even the "awkward" question. Also, in the society at large, there is probably more individualistic action and thinking. Authority of all kinds has been under attack for many years. Thus, although as Kuhn claims, scientists may not question the current paradigm on a deep level, they usually only accept evidence which meets fairly exacting requirements, and arguments from it which are rather rigorous. A scepticism is encouraged, but on a "local" scale. Also, when the current paradigm comes under duress, there is always the possibility of achieving international scientific recognition by scepticism of a more revolutionary nature.

5.9.3. Appertaining to the norm(s) of the scientific community

In Chapter 2 (pp. 95-6) the norm of the scientific community was expressed as follows: "The quality of research work which is performed and published by any research worker(s) and which lies within the limits of the existing scientific and technical consensus of a sub-discipline or of a potentially related sub-discipline is rewarded by scientific recognition in various ways". That recognition by other scientists is highly important to a research scientist was discussed in Chapter 2 (p. 92 above).

Scientific recognition consists of a whole range of items. At one end is acceptance of research articles for publication in well-known scientific journals and the citation of work by other scientists. Then come invitations to speak at international conferences, referee articles and edit books, together with the obtaining of research grants. This is followed by membership of scientific societies. At the far end of the range are prizes and medals, chief of which are the Nobel prizes.

However, the acquisition of the higher forms of scientific recognition hinges on the publication of research articles in reputable scientific journals. This depends on a) work being of quality, which involves a
combination of originality and technical excellence, and b) work being
plausible, that is within the limits of the existing scientific and
technical consensus of the sub-discipline or potentially related sub-
discipline. Referees of reputable journals, who are usually among the most
respected scientists in the field, look searchingly at a potential
publication to see if it fits before they allow it to be published.

5.9.3.1. The extent to which Turkish scientists conform internationally

In the survey, an attempt was made to assess to what extent Turkish
experimental research scientists produce work which is recognized by the
international scientific community and to what extent they are rewarded by
its recognition.

Numbers of foreign publications and numbers of International Congresses
attended seemed to offer two indicators of "international scientific-ness", while
numbers of publications cited seemed to give an indicator of the
extent of scientific recognition. However, there are difficulties with
numbers of foreign publications. The main problem is that it is not clear
where the experimental work on which the publication is written was
performed. A question to this effect might have been included in the
questionnaire, but it would have been difficult for a respondent to answer
this for each of his foreign publications, especially for those published
some years previously. In the course of the survey, several scientists
mentioned in asides that most work published by Turkish scientists in
foreign journals had been performed abroad and then written up afterwards
in Turkey.

A similar problem exists with citation counts. Most of the highly cited
work by Turkish scientists is by Turks resident abroad, or by Turks who have
performed work while visiting western laboratories for short periods. As
was mentioned earlier (p.14), Birgül, Gürey and İnönü found only two papers
based on experimental research work performed in Turkey which received more
than nine citations in the period 1961-71. For this reason, the use of
citation counts as a measure of international scientific recognition was
abandoned.

While recognising the limitations of the data, I decided to obtain the
numbers of foreign publications of the respondents. They would provide an
indicator - albeit a rough one - of the degree to which Turkish experimental
scientists conformed to internationally accepted standards of quality. Numbers of foreign publications ranged from 0 to 50 (0.32):

TABLE 5.4

<table>
<thead>
<tr>
<th>Foreign publications</th>
<th>Writers by academic rank</th>
<th>Writers (total)</th>
<th>Percentage of writers</th>
<th>Foreign pubs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>11 1 2</td>
<td>14</td>
<td>19.2</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>5 4 1</td>
<td>10</td>
<td>13.7</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>3 3 2</td>
<td>8</td>
<td>11.0</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>2 3 1</td>
<td>11</td>
<td>15.1</td>
<td>33</td>
</tr>
<tr>
<td>4</td>
<td>2 1 1</td>
<td>5</td>
<td>6.8</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>- 2 1</td>
<td>3</td>
<td>4.1</td>
<td>15</td>
</tr>
<tr>
<td>6</td>
<td>1 - 1</td>
<td>2</td>
<td>2.7</td>
<td>12</td>
</tr>
<tr>
<td>7</td>
<td>- 1 1</td>
<td>4</td>
<td>5.5</td>
<td>28</td>
</tr>
<tr>
<td>8</td>
<td>- 2 2</td>
<td>4</td>
<td>5.5</td>
<td>32</td>
</tr>
<tr>
<td>9</td>
<td>- 1 1</td>
<td>1</td>
<td>1.4</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td>2 4 -</td>
<td>6</td>
<td>8.2</td>
<td>60</td>
</tr>
<tr>
<td>11</td>
<td>- 1 -</td>
<td>1</td>
<td>1.4</td>
<td>11</td>
</tr>
<tr>
<td>12</td>
<td>- - 2</td>
<td>2</td>
<td>2.7</td>
<td>24</td>
</tr>
<tr>
<td>28</td>
<td>- - 1</td>
<td>1</td>
<td>1.4</td>
<td>28</td>
</tr>
<tr>
<td>50</td>
<td>- - 1</td>
<td>1</td>
<td>1.4</td>
<td>50</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td><strong>31 23 19</strong></td>
<td><strong>73</strong></td>
<td><strong>100.0</strong></td>
<td><strong>348</strong></td>
</tr>
</tbody>
</table>

Figures were checked where possible. Only one serious discrepancy was found between the stated and the actual number of foreign publications. One professor claimed to have 30 but in fact only had 5. However, he may have included publications unconnected with scientific research. The mean for 73 respondents was 4.8 publications. Excluding the two exceptional producers, who had spent 7 and 9 years abroad respectively, the mean for all respondents was 3.8 publications. The mean for professors was 8.7, for docents was 5.0, and for Ph.D.s 2.7 publications. The number of professors and docents with few or no foreign publications was surprisingly high. When the non-publishers were excluded, the mean for all ranks rose to 5.9 publications.

In contrast, Halsey and Trow found that the mean for 1,404 British academics doing research in all disciplines was approximately 9 articles. For natural scientists, the following results were obtained:
Over half the natural scientists had published 10 or more articles.

Blume and Sinclair found that the average number of publications by British chemists of different rank over a five year period was somewhat higher than this.(16)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Average papers published</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professor</td>
<td>30.8</td>
</tr>
<tr>
<td>Reader</td>
<td>24.6</td>
</tr>
<tr>
<td>Senior Lecturer</td>
<td>15.3</td>
</tr>
<tr>
<td>Lecturer</td>
<td>13.0</td>
</tr>
</tbody>
</table>

Blume and Sinclair also found considerable variation amongst the various sub-disciplines of chemistry:(17)

<table>
<thead>
<tr>
<th>Research area</th>
<th>Average papers published</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theoretical chemistry</td>
<td>13.4</td>
</tr>
<tr>
<td>Physical</td>
<td>14.6</td>
</tr>
<tr>
<td>Organic</td>
<td>16.9</td>
</tr>
<tr>
<td>Inorganic</td>
<td>17.9</td>
</tr>
<tr>
<td>Physical-organic chemistry</td>
<td>17.4</td>
</tr>
<tr>
<td>Physical-inorganic</td>
<td>18.5</td>
</tr>
<tr>
<td>Analytical</td>
<td>26.4</td>
</tr>
<tr>
<td>Biochemistry</td>
<td>16.5</td>
</tr>
</tbody>
</table>

These figures are much higher than those for the Turkish scientists interviewed, but then British chemists have advantages of equipment, language.
literature and supplies.

More comparable to the Turkish situation in terms of facilities available is the Spanish one. Blasco found that Spanish researchers who do produce publish an average of 8.7 articles per author in a foreign language.\(^{(18)}\) This, he claimed, was equivalent to almost one article every two years, or 0.46 article per year.

The results for Spain are similar to those found for India by Ahmad and Gupta.\(^{(19)}\) Excluding non-publishers, they found an average of 6.1 publications for the 21-30 age group, 14.5 publications for the 31-45 age group and 31.1 publications for the 46-65 age group. On average, 30 per cent of this total was made up of foreign publications, which gives 9.3 foreign publications for the 46-65 age group.

The Turkish average of foreign publications then, is somewhat lower than that for Spain or India, and a great deal lower than that for Britain.

Some Turkish scientists who had never been abroad or who had been abroad only for short periods nevertheless did manage to satisfy the referees of some foreign publications, as the following table shows (0. 26):

<table>
<thead>
<tr>
<th>TABLE 5.6</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Foreign publications produced</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>by this No. of scientists who had never been outside Turkey:</td>
<td></td>
<td>8</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>by this No. of scientists who had been outside Turkey for 3 weeks - 6 months:</td>
<td></td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

The high producers were members of teams of scientists in different countries who took data on astrophysics, for example, and then sent it abroad for analysis. However, 5 of the scientists interviewed seemed to be wholly responsible for 15 pieces of experimental research performed inside Turkey which were published in foreign journals.

As for attendance at International Congresses and papers read at them (0.68), the following distribution was obtained, for 73 respondents:
TABLE 5.9

<table>
<thead>
<tr>
<th>International Congresses attended in the (sub-)discipline</th>
<th>Scientists who attended</th>
<th>Total I.C.'s attended</th>
<th>Total papers read at I.C.'s</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>25</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>11</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>24</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>27</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>20</td>
<td>?</td>
</tr>
<tr>
<td>12</td>
<td>3</td>
<td>36</td>
<td>14+</td>
</tr>
<tr>
<td>15</td>
<td>2</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>13</td>
<td>1</td>
<td>18</td>
<td>10</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td><strong>73</strong></td>
<td><strong>208</strong></td>
<td><strong>97+</strong></td>
</tr>
</tbody>
</table>

The mean number of International Congresses attended by 73 respondents was approximately 3. Only about 100 papers were read at the 208 Congresses attended.

The attendance and numbers of papers read at International Congresses, and the numbers of foreign publications by Turkish experimental researchers suggest that in general they do not produce enough quality work to gain them international recognition. Several respondents spoke of the difficulties of performing original work inside Turkey. 7 respondents spoke of the limitations of equipment which precluded the possibility of doing a wider spread of experiments. One respondent to Q.36a wrote of the difficulty of finding original topics to work on because of the limited possibilities which exist for Turkish scientists to attend international conferences. Other factors mentioned which could inhibit original and creative thinking were the educational system (Q.39c and Q.69) and, according to one respondent (to Q.43a.4), "a tradition of not wanting to take risks".

However, even if a Turkish research scientist has a creative turn of mind and the necessary cognitive and manipulative skills to keep up with an
ever-changing consensus in the sub-discipline, he has to decide whether the possibility of wider recognition within the international scientific community is worth the trouble involved in performing original scientific research in Turkey. The survey suggests that within Turkey most scientists do not: they either try to do their research work abroad where the facilities are much better, or they opt to perform research which will not usually be recognized by the international community of scientists.

5.9.3.2. The extent to which Turkish scientists conform inside Turkey

The next step was to attempt to determine the extent to which the norm of the wider international scientific community was followed within the local Turkish scientific community. Was quality work rewarded by scientific recognition? First of all, what was the quality of research work published in local scientific journals?

In Q.56, respondents were asked if they thought there was any difference between the quality of research papers published in Turkey and that of research papers published in the West. Only 4 of the 70 scientists who were asked thought that publications inside Turkey were of the same standard; the remaining 66 considered that publications were of a higher standard outside Turkey. 36 (or 54%) of these attributed this to the lack of development of a proper referee system in Turkey. "They publish what you send them", "A high standard is not expected" and "People here are tolerant of poor work so as to encourage young researchers especially" were typical comments. 5 respondents felt some papers were accepted or turned away for personal reasons. Others said, "The referees here don't dare speak their minds" and "People here get their friends to publish their work and their friends don't criticize it at all". Several scientists on the publishing committees for faculty journals reported that which papers were published often depended on which were first in the queue, unless a particular scientist had a docent-ship or professorial examination in the near future, in which case his paper would be given priority.

On the other hand, some respondents felt that the matter was largely one of competition. 28 (or 42%) said that Turkish scientists sent their best work abroad so as to reach a wider audience. Other respondents pointed to generally lower standards of research in Turkey (4), lack of qualified people in the sub-speciality to act as referees (5), lack of a research
tradition (3) and 'atmosphere' (3), and fewer possibilities to do a wider
spread of experiments - which would result in more original work (7).

Research papers sent to reputable scientific journals are usually checked
by referees to see whether the work they report is not too similar to work
already published. In a question which on two occasions brought the
expostulation "But that would be unscientific!", scientists were asked if
they knew of any cases of plagiarism in research papers written by Turks.
To alleviate the delicate nature of the question, the item was preceded
by a statement, as follows (Q.55); "In almost every country, including
countries in the West, a few scientists take other people's research and
present it as their own work. Do you know of any examples of this in
Turkey?"

Only 11 of the 64 scientists asked said that they did. They were then
asked how many cases they knew about, and whether or not they or other
researchers had exposed these. 5 scientists knew of one case (each),
5 knew of 2 cases (each), and one knew of 3 cases. Originally, to ensure
that respondents would not be giving the same case, the question, "How many
cases do you know about in your faculty alone?" was to have been put.
However, in the pilot interviews, it became obvious that respondents found
this a highly sensitive question and were not willing to divulge cases too
near to home. The question was thus put in a more general way "How many
cases do you personally know about?"

Only one case had been exposed - by another Turk. When 4 of the other 10
respondents were asked why they had not exposed the case(s) they knew about,
the following answers were given:

"It is against our culture to do so" (2 respondents),
"I did not want to cause a fuss or spoil relationships."
"I don't know!"

One respondent who said he did not know of one case of plagiarism said that
the penalty for it was very severe, involving the loss of one's job. Two
older respondents said they felt it had been more common 30 years ago.
A few others said, "This is sometimes done when writing books in Turkish!"
Yet another respondent gave the following response: "I have never seen a
case of this. However, what is often done, especially by Ph.D. students,
is to repeat a piece of already-published research but to make small
modifications by using a different compound or element, for example." The
same point was raised in Q.56b. One respondent felt that the reason publications in the West were of a higher standard than those in Turkey was that in Turkey, scientists tended to modify research that had already been published in the West; thus, because of its lack of originality, such research could only be published in Turkish research journals.

Direct plagiarism, then, does not seem to be very common in Turkey. However, some unoriginal research is performed and then is often published in local scientific journals. One ramification of the lack of originality of some articles published in local journals is that publication in such journals is not regarded as a form of great scientific recognition. Greater recognition is obtained by the acquisition of academic titles: (i) Doktor, (ii) Doçent and (iii) Profesör. The question arises, therefore, whether such recognition, that is the awarding of these titles, is given on the basis of merit or on factors other than merit. One of the requirements for obtaining each of these titles is a thesis based on a piece of original research. These are evaluated by juries consisting of (i) the research supervisor and up to four other professors or doçents; (20) (ii) five professors in related fields selected from academics throughout Turkey by the Universities Commission; (21) and (iii) five professors selected by the faculty council of the faculty at which the professorship is being offered. (22) In the survey, therefore, respondents were asked about the effectiveness of the evaluation of such juries (Q.53): "Some Turkish scientists complain that their scientific papers and theses are not evaluated properly, especially by juries. In your opinion, are they right or wrong?" The results for 75 respondents were as follows:

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>They are right sometimes:</td>
<td>29 (39%)</td>
<td></td>
</tr>
<tr>
<td>They are right occasionally:</td>
<td>34 (45%)</td>
<td></td>
</tr>
<tr>
<td>They are wrong:</td>
<td>10 (13%)</td>
<td></td>
</tr>
<tr>
<td>I don't know:</td>
<td>2 (3%)</td>
<td></td>
</tr>
</tbody>
</table>

84% of those interviewed, therefore, considered that occasionally, at least, wrong evaluations of papers and theses took place. Of the 10 respondents who answered "wrong", 5 were professors (i.e. members of juries), 2 were doçents and 3 were Ph.D.'s.

Respondents were then asked if they personally knew of any theses which in their opinion should not have been passed by the jury but which in fact
were passed. The results were as follows, for 68 respondents:

TABLE 5.11

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>37</td>
<td>(54%)</td>
</tr>
<tr>
<td>No</td>
<td>18</td>
<td>(26%)</td>
</tr>
<tr>
<td>I've only heard rumours of such</td>
<td>12</td>
<td>(18%)</td>
</tr>
</tbody>
</table>

One respondent also spoke of the opposite case, that is of a thesis which in his opinion should have been passed but was not.

Setting aside those who had only heard rumours, we find that over half the respondents had a personal knowledge of a mis-evaluation of theses. Since this was rather a delicate subject, scientists might have been tempted to cover-up mis-evaluations, and so the true figure may have been a little higher.

Those who had answered "Yes" were then asked how many cases they knew about. As 2 of the 37 were not asked this question because of lack of time, the answers given by 35 respondents were as follows:

TABLE 5.12

<table>
<thead>
<tr>
<th>No. of cases known</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>5</th>
<th>12</th>
<th>'Lots'</th>
<th>'A few'</th>
</tr>
</thead>
<tbody>
<tr>
<td>by this No. of respondents</td>
<td>7</td>
<td>11</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>3</td>
</tr>
</tbody>
</table>

Some respondents may have been referring to the same instances and so the total number of cases could well be lower than these figures suggest. Most of these 35 respondents were loth to explain why in the cases they had cited the theses had been passed. Some spoke of "conniving" and "intrigues", while others gave answers such as "It was felt he had done the best he could with the facilities available in Turkey", and "We passed him because he had obviously made an effort and we are short of university staff for the new universities".

It was felt that respondents might feel freer to speak their minds when given a more general question rather than being tied to specific instances. In Q.53a, therefore, respondents were asked to mark which factors they thought played a part in the evaluation of a research scientist's work. As before,
the respondents had to mark each suggested factor as important, of some importance, or of no importance at all. 67 respondents out of a possible 71 marked at least three factors. The results are given below, with the percentages of respondents for that question marked in parentheses:

TABLE 5.13

<table>
<thead>
<tr>
<th></th>
<th>i.</th>
<th>s.i.</th>
<th>i.+</th>
<th>n.i.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The writer of the research thesis having worked under the supervision of a particular scientist</td>
<td>38</td>
<td>20</td>
<td>58</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>(57)</td>
<td>(30)</td>
<td>(87)</td>
<td>(13)</td>
</tr>
<tr>
<td>2. The writer's professor influencing the jury</td>
<td>22</td>
<td>32</td>
<td>54</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>(34)</td>
<td>(50)</td>
<td>(84)</td>
<td>(16)</td>
</tr>
<tr>
<td>3. The writer having tried several times before to get his work approved</td>
<td>18</td>
<td>25</td>
<td>43</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>(29)</td>
<td>(40)</td>
<td>(69)</td>
<td>(31)</td>
</tr>
<tr>
<td>4. The writer being a graduate of a particular university or academy</td>
<td>13</td>
<td>28</td>
<td>41</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>(19)</td>
<td>(42)</td>
<td>(61)</td>
<td>(39)</td>
</tr>
<tr>
<td>5. The writer being a member of a non-political clique</td>
<td>7</td>
<td>17</td>
<td>24</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>(11)</td>
<td>(26)</td>
<td>(36)</td>
<td>(64)</td>
</tr>
<tr>
<td>6. Other</td>
<td>7</td>
<td>-</td>
<td>7</td>
<td>-</td>
</tr>
<tr>
<td>7. The writer having right or left-wing political views</td>
<td>4</td>
<td>17</td>
<td>21</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>(6)</td>
<td>(26)</td>
<td>(32)</td>
<td>(68)</td>
</tr>
<tr>
<td>8. The writer being of rural rather than urban origins</td>
<td>0</td>
<td>8</td>
<td>8</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>(12)</td>
<td>(12)</td>
<td>(88)</td>
<td></td>
</tr>
</tbody>
</table>

i. = important, s.i. = of some importance, n.i. = not important at all

In the opinion of the majority of the respondents, direct or indirect influence of the supervisor of the writer of the research thesis was paramount, followed by a desire to have mercy on someone who had tried hard.

It might be argued that Ph.D.'s were in no position to give an opinion, since they are almost never involved in the evaluation process. On the other hand, it was thought that they might be less inhibited to speak their minds since they were younger. To check on this, a cross-tabulation was made against academic title. When Ph.D.'s were omitted, the only significant changes were that a lower percentage of professors and docents gave importance to the writer's professor influencing the jury, and a slightly lower percentage to the writer's trying several times previously to get his work approved.
Under "Other", several scientists wrote "The lack of qualified specialists in the sub-discipline". This does seem to be a real problem in Turkey, in that the scientific community is spread rather thinly over various areas of physics and chemistry. Thus to gather together five knowledgeable professors to pass judgement on a docentship thesis is almost impossible. The survey indicated, therefore, that at least in a limited number of cases, factors other than merit have played a part in the evaluation of research work in physics, chemistry and biochemistry in Turkey, especially when there have not been enough qualified jurors in the sub-discipline. Conducient III, then, does not seem to be very well established amongst the local community of Turkish scientists.

Evaluation on the basis of particularistic factors is avoided in many other countries by calling in an outside examiner even at the Ph.D. level. Because of the larger size of the scientific community, it is generally possible to find an examiner qualified to evaluate a thesis in this way. The same applies to those countries where the docent system still exists. Where it does not, promotion is often given on the basis of publications in reputable journals, a reasonable indication of merit, since such publications first have to be reviewed by distinguished scientists in the sub-discipline — who may live a continent away.

5.9.4 Appertaining to cognitive and manipulative skills relevant to experimental research

In considering the acquisition of cognitive and manipulative skills relevant to experimental research, it is necessary to take into account the innate ability of those acquiring the skills.

The interviews brought several factors related to this to the surface. In the questions on folkways and mores (Q.43), and on religion (Q.41), several respondents mentioned that the practice in country areas of not sending girls to secular schools for economic or religious reasons, was depriving the nation of potential scientific researchers. Some girls with great innate ability (i.e. intelligence) were not being allowed by their families even to start down the road towards the research laboratory.

In the question on deficiencies in the educational system (Q.40) under "Other", 2 respondents drew attention to the plight of students in poor
areas of Turkey getting worse teachers than students in more prosperous areas, or even not getting any teachers at all in certain subjects because in general few educated people want to live in such areas, "far from civilization". Thus, potential research scientists, the respondents suggested, may have adopted a dislike for science either because a love for and interest in science was not communicated to them by good science teachers somewhere in the educational system, or else because they were not taught sufficiently well to be able to obtain high grades in science subjects in the nationwide university entrance examination.

Such things are beyond the control of students in poorer areas. However, there are other more fortunate students in different areas who, although they are able to choose a subject of study at university which could lead them into a basic science research laboratory, deliberately choose otherwise. In Chapter 4 (Section 4.3.16), I explained that this was a result of socio-economic pressures.

During the course of the interviews, the low quality of the intake, particularly in physics and chemistry, was a frequent source of complaint. One physics professor described the situation as follows: "Our biggest problem is the low quality of the incoming students. Of the 80 Freshmen we accepted last year, only one had marked physics as his first choice in the university entrance exams. The average was sixth choice, and for some it was twelfth choice. This is a socio-economic problem that we don't know how to deal with!" Another professor said: "Of the 200 students in my lectures last year, only 4 or 5 of them really wanted to study physics."

A further diversion from the road to the research laboratory seems to occur just before or after the decision has been made to take up a career as a research scientist. This point was brought out by a Ph.D. at a modern English-medium university: "In general, young people in Turkey today don't want to go in for experimental research because it is too difficult. There are too many problems involved in obtaining and maintaining equipment. It is far easier to sit down at a desk and do theoretical work."

Additional encouragement to do theoretical rather than experimental research has come through the influence of Profs. Feza Gürsey and Erdal İnönü, who helped to set up 'schools' of theoretical physics at Middle East Technical University and at Bosphorus University. In the spring of 1978, the result
was the following division between those doing theoretical and those doing experimental research in physics at these two universities:

TABLE 5.14

<table>
<thead>
<tr>
<th></th>
<th>METU</th>
<th>B.U.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physicists engaged in theoretical research</td>
<td>11 (38%)</td>
<td>10 (77%)</td>
</tr>
<tr>
<td>Physicists engaged in experimental research</td>
<td>18 (62%)</td>
<td>3 (23%)</td>
</tr>
</tbody>
</table>

As Prof. İnönü has observed, the majority of Turkish physicists who have been heavily cited in other countries have been theoreticians. This may lend support to our thesis that some of the most able research scientists do not go into experimental research. However, it may simply reflect the difficulties that Turkish experimental researchers face in the course of their work, although this seems unlikely, since Prof. İnönü points out that most of the heavily-cited work was done outside Turkey, where presumably experimentalists and theoreticians would be on more or less equal terms.

The net result of all these factors is that the proportion of people of very high innate ability who end up in a career as experimental research scientists is not as high as it would be if socio-economic factors were not to prevail to such a great extent.

Bearing in mind then, that the "intake" to experimental basic science is not of as high ability as some would wish, let us now consider the processes of acquiring the relevant cognitive and manipulative skills.

5.9.4.1. Cognitive skill acquisition

Acquiring a deep knowledge of subjects relevant to research is mainly a function of educational systems. During the interviews, the respondents were asked for their views on different aspects of the Turkish educational system. One question (Q.39) concerned secondary school curricula. As the modern science curricula had only recently been introduced, respondents were asked about the classical curricula. All except one of the 70 respondents who answered the question felt that the classical school science curriculum had had a negative effect upon the training of good research scientists. 52 (or 74%) considered that one of its faults was an encouragemen
of rote-learning. 42 (or 60%) of the respondents felt that another of its shortcomings was its engendering of an uncritical acceptance of exactly what the teacher said. A third negative factor was that the curriculum did not develop the student's creative ability, held by 63 (or 90%) of the respondents. Also, 65 (or 93%) of the respondents felt that the old curriculum did not encourage the performance of experimental work. 37 (or 53%) faulted it for not arousing an interest in the natural sciences amongst students, a view with which 33 respondents disagreed.

A further question elicited the opinions of the scientists vis-à-vis other aspects of the secondary school system. The following were seen as hindrances to the training of good research scientists, again for 70 respondents (Q.40): the quality of teachers not being high enough, by 41 respondents (59%); the teachers being inadequately trained, by 56 respondents (81%); and the classrooms being overcrowded, by 66 respondents (94%). Other problems mentioned under "Other" included lack of teachers (3 respondents), not enough good books (2), the low pay of teachers which leads to a poor quality intake (2), and schools in poor areas having worse teachers than schools in more prosperous areas because good teachers do not want to go to such areas (2). Teachers were blamed for being too bookish (2 respondents), and for not keeping up with the latest technological developments (1). Parents and teachers were considered culpable for not encouraging students to do research (3), while the educational system as a whole was blamed for not instilling into the minds of students the idea that research is useful and relevant (2).

In Q.69, against the factor "The educational system does not stimulate creativity", the following responses were given (see above, Table 5.3, p.317): Important = 38(55%), Of some importance = 22(32%), Of no importance = 9(13%)
The responses showed that 3 respondents have changed their minds as compared with responses to the question concerning creativity asked in the interview (Q.39). Also, 22 of the remaining 60 signified that in their opinion it is not the most important of factors.

Cognitive acquisition was mentioned by several respondents in other questions. In Q.38 on the "admired scientist", 13 (or 23%) of the 57 respondents wrote, "Possession of a good background knowledge/scientific training", from which we again hypothesize that such is lacking in the average scientist in the local milieu. In the same question, other
characteristics mentioned which probably result from a good training were: having systematic and rational methods of working (5 mentions), being careful in research (4), being empirically-minded (2), possessing a knowledge of areas outside one's own field (2 mentions), and having a grasp of a variety of physics problems (1).

Also, in Q. 52 concerning advantages of western scientists over Turkish ones, 6 out of 60 respondents gave this response "Throughout their education, they have a better chance of developing academically", whilst one respondent wrote "They are used to working on their own in their educational systems".

In Q. 59, with regard to the real reasons why Turkish research scientists do not produce more good scientific research, 9 (or 18%) out of 51 respondents suggested "The lack of a good basic training". One of these 9 added that some professors seem unable to train and encourage research scientists. Yet another scientist wrote: "There is a knowledge-gap between us and our western counterparts, and so it is easier to concentrate on teaching rather than have all the bother involved with keeping up with the latest research."

In Q. 60, 12 (or 20%) out of 61 respondents felt that one of the reasons why foreign professors working in Turkey published more research papers than their Turkish counterparts was that they were "better trained". Another 2 wrote, "They know the problem more deeply."

These responses reinforce the impression that a deficiency in cognitive skill acquisition contributes to lack of more good experimental scientific research in Turkey.

5.9.4.2 Manipulative skill acquisition

Until the advent of the Modern Science Curriculum Project, practical work in middle-schools and lycees was almost non-existent. (see pp. 267 ff. above) Rare were the schools with laboratories and equipment. Another factor was the heavily-loaded curriculum, which, because of the number of examinations which it required, tended to encourage the teachers to stay in their classrooms with their blackboards and chalk. It was not surprising, therefore, that in the survey, the classical science curriculum's failure to encourage experimental work was seen as a hindrance to the production of more good research scientists in Turkey by 93% of the respondents (Q. 39).
In the West, children often acquire manipulative skills by playing with mechanical toys from a very early age. In Turkey, however, it is only in the past few years that such toys have come on the market, and even then only seem to find their way into the hands of upper and upper middle-class children. (25) The question arose whether a lack of opportunity to play with mechanical toys affected an interest in, or an ability to use, scientific apparatus. Respondents to Q.43a were evenly divided as to whether a lack of playing with mechanical toys had in any way affected scientific development in Turkey:

I think so 36 (51%)
I don't think so 34 (49%)

However, a comment by one professor seemed to suggest that an early familiarity with things mechanical was of great benefit in scientific research: "I used to make mechanical toys when I was a boy... That was very good for me... Now I repair a lot of my own equipment, or even make it."

Since most students had had very little or no practical experience before coming up to university, it was hypothesized that they might be reluctant to use experimental apparatus, and that this reluctance might even discourage an able student from going into experimental research. Only 25 (or 35%) of the 72 respondents to Q.63 detected a reluctance amongst students to use apparatus. 14 of these 25 thought such a reluctance might be one factor in deterring students from going into experimental research.

The same point was raised again in Q.69 (Table 5.3). How important a factor did the respondent think reluctance to use experimental apparatus was in hindering the amount of more, good experimental research in Turkey? Responses were as follows, for 69 respondents:

Important = 8 (12%), Of some importance = 35 (51%), Of no importance = 26 (33%)

Several scientists stressed that reluctance was usually only temporary. Others made the point that any reluctance shown was usually on the part of the lecturers, who were rather chary of allowing students to use expensive, and hard-to-replace equipment in case the students broke it.

Q.63b asked whether a reluctance to use apparatus might send a prospective experimental research scientist hurrying in search of another job. In so far as they could decide, most respondents thought that career choice was motivated far more by considerations such as financial advantage. One Ph.D.
who did a lot of laboratory supervision attributed any reluctance to simple lack of desire for the subject, not to inability to familiarize oneself with apparatus: "Our students have an aversion to doing experiments. This may be true all over the world, but here it is worse. The reason? Well, here, most students are studying chemistry just to get a degree. When they graduate, most of them may not even continue with chemistry. Also, whether they get a good or a bad degree will not affect their getting a job. The key thing in getting a job in this country is whether or not you have a friend in the right place - not how good your degree is."

Since the professor - research assistant relationship is rather along the lines of a master-apprentice relationship, the acquisition of highly specialized manipulative skills and research techniques is to some extent a function of the willingness of professors to supervise new assistants. To a certain degree, they are limited by the number of staff the department or chair can employ, though some "star" professors attract assistants who are prepared to work without pay in the hope that eventually a suitable post will become vacant; one professor I interviewed, for example, had two assistants working under her without pay. In contrast, 4 respondents gave "Lack of good research assistants" as one of three reasons why they were inhibited from publishing more research papers (Q.36a). Part of the reason for this may be that the best research students gain TÜBİTAK or NATO scholarships to go abroad, and part that the respondents concerned could not attract good students.

Two questions in the survey were asked of professors about research assistants Q.61a "How many research assistants are you supervising at present?", and Q.62 "How many assistants have you supervised up to now?" With the proviso that some professors may have included all the research assistants in the department under their aegis, even though some of them were more directly supervised by docents, there was a surprising range, even within the same faculty and among professors of approximately the same seniority. The responses for 19 respondents were as follows:
TABLE 5.15

Total No. of research assistants supervised at present and in the past

<table>
<thead>
<tr>
<th>Age range (years)</th>
<th>Chemistry</th>
<th>Physics</th>
<th>Biochemistry</th>
<th>Mean (for age group)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 and below</td>
<td>-</td>
<td>4</td>
<td>4</td>
<td>4.0</td>
</tr>
<tr>
<td>41 - 50</td>
<td>2**, 6*, 15, 21</td>
<td>-</td>
<td>-</td>
<td>11.0</td>
</tr>
<tr>
<td>51 - 60</td>
<td>5*, 7, 15, 20, 24</td>
<td>-</td>
<td>6, 10</td>
<td>12.4</td>
</tr>
<tr>
<td>61 - 70</td>
<td>4, 15</td>
<td>3, 4, 5, 14</td>
<td>-</td>
<td>7.5</td>
</tr>
<tr>
<td>Mean (for field)</td>
<td>12.2</td>
<td>6.0</td>
<td>6.7</td>
<td>9.7</td>
</tr>
</tbody>
</table>

* Two professors of chemistry at METU, and ** one at Hacettepe had supervised understandably low numbers of research assistants, since the graduate programmes at the two universities were fairly recent innovations.

It was significant to find that in the chair of one elderly professor who had supervised few research assistants there were no docents at all.

The higher mean in chemistry perhaps reflects the relative ease of doing original chemistry experiments in Turkey vis-à-vis, say, original physics experiments. Also, the mean of each age-group appears by extrapolation to be rising, such that professors now under 50 will have supervised many more than an average of 12.4 when the majority of them move into the 51-60 age-group; this is probably due to a pressure to train new staff for the nine new universities set up since 1973.

That a number of scientists feel that some professors could take on more research assistants was shown in Q.72 in which respondents were asked to suggest ways of improving the quality and quantity of experimental scientific research in Turkey. 3 of the 71 respondents felt that professors should be made to supervise more research assistants or else lose their jobs.

An important factor in being able to learn new and highly specialized techniques for doing research seems to be the extent to which such techniques...
can actually be seen. One Ph.D. who had been abroad said: "I went to Germany for two months, and in that time learned an awful lot about new equipment and techniques." Also, 4 out of 60 respondents to Q.51 gave "You are able to see the latest research techniques at first hand" as one reason why Turkish scientists who go abroad publish more research papers than those who do not. Though a fair number of scholarships are available for going abroad, competition is keen, and priority is given to those who have not been before. Thus Turkish research scientists appear to be at a disadvantage in comparison with their counterparts in the West, who can visit each other's laboratories with comparative ease.

In the open final question, Q.72, in which respondents were invited to suggest ways of improving the quality and quantity of scientific research in Turkey, many scientists felt that in socialization processes such as the educational system, reforms were needed. 22 (or 31%) out of 71 respondents held that the system should be changed from primary school to lycee with one or more of the following aims: to prevent memorization, to give more people a love for science, to make lessons more relevant to everyday life, and to help people learn languages better.

One docent who had formerly been a teacher at a lycee felt that teachers needed to be given more status: "Until the 1950's, teachers in Turkey had a very high status, but then things changed, and the quality of people wanting to become teachers fell." The reason she gave for this change was echoed in a more general way by another docent: "Governments won't invest in something like education which takes twenty years to bear fruit. They go for things like roads and factories which everyone can see within a few years and which will earn votes. Government should spend a lot more on education in my opinion."

The interviews indicated that a number of young people of high intelligence who live in rural areas cannot or do not even consider a career in experimental scientific research since they are prevented from obtaining a sufficiently good education in science because of socio-economic factors. Other young people of high intelligence who live in educationally more privileged areas and who could go into such a career, however, for the most part opt for more lucrative professions.

Of those who do study physics, chemistry and biochemistry at university,
until the introduction of the Modern Science Curriculum, few had had any practical experience at secondary school level. Also at undergraduate, postgraduate and post-doctoral levels there appears to be a lack of opportunity to acquire technical and manipulative skills necessary for undertaking experimental research. Furthermore, the majority of scientists interviewed in the survey considered that there were deficiencies in the secondary school system which resulted in inefficient transmission of cognitive skills, which in turn had had a negative influence upon the development of experimental scientific research in Turkey (cf. Conduent IV).

As one professor summed it up: "We need better-trained teachers and researchers. The students coming up to university are not properly educated at all. And then we allow half-trained people to graduate. We cannot have national development without properly trained people."

5.9.5 Appertaining to the role conception of, and role expectations from, a research scientist at a university

Earlier (Section 2.3-V above), I suggested that the manner in which a person conceived of his role as a research scientist at a university in Turkey would influence his acting out of that role in various ways: he might have a role conception that was higher than, congruent with, or lower than the formal role expectation as defined by the University Law, and also by the statutes for his particular university. In turn, because role performance is related to a complex of factors in addition to role conception, such as motivation and the extent of role facilities, his role performance might be higher than, congruent with or lower than would be expected from his role conception. The situation is further complicated by informal role expectations both inside and outside Turkey.

5.9.5.1 Formal role expectations

Formal expectations from Turkish academics are described in the University Law, No. 1,750. They are then usually spelled out in more detail in the statute books of individual universities. Article 18 of the law describes the main duties of \( \text{Məretim üveleri} \) (literally, teaching members of staff, i.e. \text{docents} and \text{professores}): \( 26 \)
a) To do research in the university institutions and publish (the results). b) To do teaching and lecturing in the university institutions with
scientific objectivity, to supervise and arrange practicals, and to organize seminars and the preparation of projects.

c) To help in the training of research assistants in the department or chair.

c) To be available to students at least two days a week at definite times to help them and give them guidance where necessary.

d) To perform the duties assigned by the Universities Commission, or the university and faculty administrative bodies; to attend the councils and commission meetings to which he is appointed.

Both a) and c) show that research is definitely expected from "Öğretim üyeleri." The law provides for sanctions against those who do not perform their duties. It requires heads of chairs or departments to write out a report concerning the research and teaching activities of the chair or department by April 1st of every year. (27) This is then discussed by the faculty council and if the activities of that particular chair or department are thought to be sub-standard, a commission is appointed to look into the matter and report back. On the basis of its findings, various disciplinary measures such as temporary or permanent removal of staff from their posts can be taken. However, insofar as the report is a general one, it does not appear to be a very effective means of enforcing conformity to role expectations with regard to individuals. Also, since each chair or department's report comes up for discussion in turn, and since there is at least one member of each chair or department on the faculty council, present and past members of faculty councils stated that these reports are very rarely brought into question because of the fear of reprisals.

That research role conceptions can sometimes be lower than formal role expectations was brought home by the following comment from an older docent interviewed in the survey: "Our first duty is to teach. This is implied in the very name "Öğretim üyesi" (teaching member of staff). I feel, therefore, that my main task is to teach the rising generation." An academic's role conception may differ from official role expectations in another way. The results of Q.50b and Q.50c concerning attitudes towards manual work (see above p.301), although not entirely conclusive, suggest that a Turkish university research scientist may be liable to role conflict. On the one hand, he is an aydın, an intellectual, who is probably thought of by the public as someone who sits at a desk and does not dirty his hands. On the other, he is a research scientist who has to perform experiments in
the laboratory. The net result in certain cases may be that his conception of his experimental research role is adversely affected. Support for this hypothesis came in one of the responses to Q.60, as to why foreign professors working in Turkey publish more research papers than their Turkish counterparts. One respondent wrote: "They do not hold back from working as a technician when the need arises."

On a long-term basis, lack of research will result in a sanction of slow or no promotion. For research assistants at most Turkish universities there is a time limit of six years in which to complete their Ph.D. theses. They then have a further six years in which to obtain their docentships and then are free to remain as docents or else try for a professorship after a further five years (Article 23). To become a docent, only one piece of research, namely the docentship thesis is required. To become a professor, more than one piece of research has to be completed, but no figure is specified in the conditions: "The candidate must show his scientific worth by publications and research work done since gaining his docentship. One of his publications should be put forward as his professorial thesis, or else a thesis should be especially prepared."

In the survey, a question was included as to how many research publications other than the professorial thesis were expected from a professorial candidate in the respondent's discipline (Q.46). Responses varied tremendously, from 2 - 3 to 20 - 25 amongst professors only. The mean for professors, who not only had been candidates themselves, but who had probably sat on professorial juries, was 7 - 8. The number of books and translations was also said to be significant. Respondents from those departments or chairs where research productivity was high tended to give a high figure, and vice versa. It was noticeable that older professors at more classical types of universities gave low figures.

It appears, therefore, that the formal research expectations from academics in most Turkish universities are rather low when compared with the output of their counterparts in the West. That such a state of affairs does not encourage the performance of research was expressed by several respondents. One respondent in Q.69 gave as another factor which may hinder the doing of more, good experimental research in Turkey: "Promotion does not depend on research done, but on a statutory thesis." In Q.72, 8
other respondents expressed the need for a change in the University Law so that those who did not perform research would not be promoted. Two or three scientists felt that instead of the Docentship and professorship exams, 10 publications in reputable journals could be required from a docent candidate, and 20 from a professorial candidate.

5.9.5.2 Informal role expectations

Informal role expectations may be from colleagues in the same chair or department, from fellow scientists inside and outside the country, and from the wider society. Responses to several questions in the survey indicated that there was a considerable difference between informal role expectations in most Turkish universities and those in most western universities. In Q.45, the respondent was asked how many research publications he would expect from a docent who was applying for a job at his university. Most respondents said it would depend on the number of applicants, but they tried to give a rough figure. Responses varied from 0 to 8, with a mean of 3. Thus some respondents did not expect a scientist with at least four years of post-doctoral experience to have published any research at all. Furthermore, the question did not specifically ask numbers of foreign publications but numbers of publications in general. Similarly, in Q.46 mentioned in the previous section, the mean research expectation of respondents from professorial candidates was only 7 - 8 publications, with some respondents giving figures as low as 3 - 4 publications.

In Q.72, there were hints from a few respondents that some research assistants were not performing up to expectations. In particular, one respondent proposed that Ph.D. standards should be made equal at all universities — suggesting that they are not at present. Another respondent suggested that research assistants should be given scholarships, rather than be taken on as full-time employees of the university, because in the latter case there was no real control over them. Another proposal was that assistants should move to another university once they had obtained their Ph.D. "to avoid stagnation", which indicates that the proposer felt that contact with different reference groups was a healthy procedure.

Respondents at more modern universities such as METU and Bosphorus University appeared to have higher research expectations than those at classical universities. This is not surprising, since at METU, for example,
until 1978 a Ph.D. in the basic sciences was only employed as an "asst. professor" after he had published one or two papers in foreign journals. Promotion to "associate professor" only occurred after the candidate had obtained his docentship in the ordinary way and afterwards had satisfied a separate jury at METU that he was worthy of promotion. According to METU scientists interviewed, the jury usually expected 3 - 4 foreign publications since the time a candidate had obtained his Ph.D. degree. The situation at Bosphorus University appeared to be somewhat similar.

Q.47 was designed to test whether the respondent looked up more to a research-oriented academic or to a teaching-oriented one, and Q.48 to test which of the two his colleagues looked up to. The results were as follows:

**TABLE 5.16**

<table>
<thead>
<tr>
<th></th>
<th>res.-oriented academic more</th>
<th>tchg.-oriented academic more</th>
<th>both equally</th>
<th>(Don't know)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of respondents who respect</td>
<td>28 (39%)</td>
<td>16 (22%)</td>
<td>28 (39%)</td>
<td>0</td>
</tr>
<tr>
<td>No. of respondents who think most colleagues in chair/dept. respect</td>
<td>37 (52%)</td>
<td>9 (13%)</td>
<td>23 (32%)</td>
<td>2(3)</td>
</tr>
</tbody>
</table>

Several of those who said they respected both equally made the remark that for a person to be a good teacher, he also had to do research. Others who said they respected a teaching-oriented academic more, or else who said that they respected both equally added the rider that this was because what Turkey needed at present was good educators. A surprisingly high percentage of those interviewed respected an academic who did not give much importance to research either as much as or more than one who did: 61%. On a departmental or chair basis, this percentage dropped to 45%, either because the respondent may not have known which type of academic was more highly respected by his colleagues, or else because in the previous question the respondent was going out of his way to be fair to colleagues who thought that teaching was more relevant to Turkey's needs. Despite the lack of statistical evidence from the results of a similar question asked to academics in Western universities, we may suppose from the "publish or perish" syndrome that a far lower percentage of lecturers in (experimental) basic science in the West would respect teaching-oriented lecturers. (33)

In several questions, respondents touched on "the lack of a research tradition in Turkey". A research tradition appeared to mean a steady progression of
people who think it worthwhile to perform research — for whatever reasons —
and who pass on certain attitudes, concepts, skills, values and expectations
to novitiates. Included amongst such would be the following:

(i) Practice and experience in the technical aspects of research, such
as use of equipment and application of research techniques.
(ii) A high conception of what an experimental research scientist does,
coupled with high expectations thereof.
(iii) A recognition of the need to train experimental research scientists
to as high a level as possible.
(iv) A conception of research as a valuable activity for society.

(ii) will probably result from knowledge of national and international
scientific heroes of the past and present, and contact or communication
with reference groups, with whom frequently there is competition.

In Q.43a, under "Other", 2 respondents wrote "Our society lacks a good
scientific tradition, and so science and society are strangers to each other." This is relevant to (ii) and (iv) above.

That there is more of a research tradition in the West was mentioned by 3
respondents in Q.56b, by 8 respondents in Q.59a, and by 3 respondents in
Q.60 ("foreign professors come from a country where there is a developed
research tradition"). Such a response to Q.60 is particularly significant
since it indicates that a foreign professor even in Turkey has a role
conception of an experimental research scientist which is higher than that of
his Turkish counterparts. In the same Q.60, 16 respondents mentioned that
foreign professors are more used to doing research; this again suggests
that this is a result of higher experimental scientist role conceptions and
expectations in the West, in addition to better role facilities.

One respondent to Q.51 gave as a reason why Turks who go abroad publish more
research papers than those who do not: "Outside Turkey, research is regarded
as a more natural activity", which suggests that a higher role conception
exists abroad. In the same question, 3 respondents wrote: "Turks abroad
work harder because they do not want to be shown up" — indicating again the
existence of a higher role expectation and corresponding conception. Also,
in the same question, the existence abroad of a conception of research as a
valuable activity was seen by this response, given by 2 respondents: "Abroad,
more value is given to research."
A large number of the scientists interviewed also mentioned the "research atmosphere" which they had found abroad but which seemed to be missing in Turkey. When questioned as to what they meant, they spoke of such things as "everyone around you is working hard at research", "you get caught up in the momentum of it all", and "there is far more research planning". All these suggest high (informal) role expectations. "Research atmosphere" was mentioned by 20 (33%) of the respondents in Q.51, by 21 (35%) of the respondents in Q.52, by 15 (29%) out of 50 respondents in Q.59a, and by 11 (or 20%) out of 56 respondents in Q.67. Another respondent in Q.67 remarked,"Abroad, more is expected of you."

Other respondents felt that in Turkey, research was not sufficiently appreciated nor adequately planned. The statement by 2 respondents in Q.59a, "Those who do research are not valued any more than those who don't" indicates that it is possible not to do research and still avoid being penalised. In the same question, another 2 respondents wrote, "There is no 'publish or perish' syndrome here as exists in the West", i.e. that in Turkey, security of tenure and promotion are not affected by the amount of research done—which reveals low role expectations. Furthermore, in the same question, 2 respondents wrote, "In Turkey, promotion is not linked with whether or not we do research", while 6 others wrote,"Research is not appreciated or rewarded financially, or in other ways."

Research planning, especially by more senior members of a chair or department, shows the existence of expectations that others will engage in a definite amount of research in the future. In Q.69, the following responses were given against the factor "There is not enough research planning within the relevant university departments" with respect to the extent of its importance in hindering the performance of more, good experimental research in Turkey:

Important = 41 (61%), Of some importance = 17 (25%), Of no importance = 9 (1

There may be other factors involved in a lack of research planning besides low research expectations, however.

On balance, then, the role expectations of scientists at universities in Turkey appear to be lower than many scientists would wish. Whereas, in the West, greater competition has steadily increased informal role expectations, since the obtaining and tenure of lectureships depends to a large extent on...
numbers of research papers published, in Turkey informal role expectations appear to hover around the formal role expectation level without effective sanctions being applied. It would appear, therefore, that high formal or strongly enforced informal role expectations are necessary for the performance of good experimental scientific activity.

5.9.6 Appertaining to role facilities

In Chapter 2 (Section 2.3-VII), the following role facilities for the performance of experimental scientific research were discussed:

a) Time in which to perform research.
b) Adequate financial subsistence.
c) Equipment and materials with which to perform research.
d) Technicians to repair and maintain equipment.
e) Co-workers.
f) Knowledge of foreign language(s) to follow literature and to communicate with other scientists.
g) Literature (current and past) on the research topic.
h) Opportunities for information exchange.
i) Organization and freedom.
j) Cognitive and manipulative skills (see Section 5.9.4 above)

In the opinion of a large majority of the scientists interviewed, a deficiency in one or more of the above role facilities was the main factor in the lack of more, good experimental research in Turkey. (34)

An early question, Q.36a, asked the scientist interviewed to mark the three factors which most inhibited his publishing more research papers. This followed a question in which respondents were asked if they wished they had published more (72 or 97% of the 74 scientists who replied said that they wished they had done so). In reply to Q.36a, 72 respondents marked 204 responses as follows:

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>N(P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I am unable to obtain supplies and equipment when I need them</td>
<td>64</td>
<td>89</td>
</tr>
<tr>
<td>2. My teaching and administrative duties leave me little time for research</td>
<td>48</td>
<td>67</td>
</tr>
<tr>
<td>3. When equipment goes wrong, a technician comes to repair it only after a long time has elapsed</td>
<td>45</td>
<td>62</td>
</tr>
</tbody>
</table>

339
Table 5.17 (contd.).

<table>
<thead>
<tr>
<th>4. Other reasons</th>
<th>N</th>
<th>N(P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. There is no one else with whom to talk over problems met with during research</td>
<td>16</td>
<td>22</td>
</tr>
<tr>
<td>6. My research is unappreciated by the international scientific community</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>7. My research is unappreciated by the scientific community in Turkey</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>8. I have difficulties in publishing my research</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

\text{N} = \text{Number of respondents who marked this first, second, or third}

\text{N(P)} = \text{N as a percentage of 72 respondents}

Since it is not clear to what extent respondents thought their first choice was more important than their second, I have taken the simple total of mentions for most important, second most important, or third most important for each factor. Among the entries under "Other" were the following: Lack of good research assistants (4 respondents), isolation of Turkish scientists from the rest of the international scientific community (1), problems caused by student politics (2), and lack of research atmosphere (1).

These results may be compared with those for Q.69, regarding those factors which the respondent thought were hindering the performance of more, good experimental research in Turkey (see above, Table 5.3, p.307).

5.9.6.a. Time in which to do research

The most significant difference between the results for the two questions was that lack of time for research dropped from being considered important by 69% of respondents in Q.36a to 46% of respondents in Q.69. This suggests that in Q.36a, respondents were endeavouring to excuse themselves. Nevertheless, several plausible explanations as to why some respondents had little time for research were furnished in reply to later questions, and will be discussed below.

Figures given by respondents in Q.27a and Q.27e for lecturing, supervising practicals and administration may be represented as follows, in hours per week:
TABLE 5.18

<table>
<thead>
<tr>
<th>Lecturing (for 68 resp.'s)</th>
<th>Supervising practicals (for 44 Ph.D.'s and doçents)</th>
<th>Administration (for 74 resp.'s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean:</td>
<td>5.7</td>
<td>4.5</td>
</tr>
<tr>
<td>Range:</td>
<td>2-13</td>
<td>0-20</td>
</tr>
</tbody>
</table>

In Q.27a, the respondent was asked how much time he spent in preparation. This question was not productive in that most respondents said it depended upon whether or not the lecture course had been given before and on the level of the students to whom it was given.

Considerable variations in time spent in teaching, supervising and administration were encountered, even within the same faculty and amongst lecturers of approximately the same seniority. For example, in one faculty, the average number of hours of lectures given per week by two professors in the same field were 4 and 8 respectively, even though neither had administrative responsibilities which took more than four hours a week.

Numbers of students taught were asked in Q.27b. The number of students taught by a particular lecturer ranged from 20 students at Bosphorus University to 1000 students (a total from two different lecture courses) in one department each at METU. Hacettepe Biochemistry, and Ege and METU Physics Departments had very low staff/student ratios, the average number of students per academic being as follows:

TABLE 5.19

<table>
<thead>
<tr>
<th></th>
<th>Hacettepe Biochemistry</th>
<th>METU Physics</th>
<th>Ege Physics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average No. of students per academic</td>
<td>500</td>
<td>430</td>
<td>387</td>
</tr>
<tr>
<td>No. of respondents in dept</td>
<td>3</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>

Large numbers of students apparently affected respondents particularly at examination times when papers had to be marked.

Although some academics appeared to have fairly heavy teaching loads, and other more senior members of staff were involved in many hours of administrative
the average total number of hours spent in teaching, in supervising laboratory practicals, and in meetings or other tasks connected with administration was 14. Figures given by professors for supervising practicals were not included in this, since personal observation showed that while they may have had overall responsibility, they usually delegated the actual supervision to research assistants. Some figures, especially for supervising practicals, were not given; however, the error due to not including these in the total was probably compensated for by the number of hours given by some docents as being spent in supervision, when again personal observation showed that in some cases it was research assistants who actually spent the time in the laboratory.

This average of 14 hours is inflated by slightly more than one hour, since the number of hours spent teaching at other institutions was also included in the total. Such teaching is not obligatory, but some might argue that it is necessary because of the shortage of lecturers at some newer universities and academies. Assuming a 35-hour working week, this leaves approximately 20 hours for other activities including lecture preparation and research. More time is available for research outside the two approximately 14-week semesters of the academic year.

In several questions, respondents insisted that research scientists in Turkey did not have sufficient time for research. In Q.59, 11 (or 22%) of the 51 respondents claimed that this was the main reason why more good research was not done in Turkey. In Q.67, 7 (or 25%) of the 28 respondents who said their research done abroad was better than that done in Turkey attributed this to having had more time to do research. 12 (or 20%) of the 60 respondents in Q.52 mentioned that academics outside Turkey had more time for research than their counterparts inside. Also, in Q.60, 23 (or 38%) of the 61 respondents thought that foreign professors in Turkey published more than their Turkish counterparts because they had more time in which to perform research. One docent made the following comment: "I can only use a tenth of my time for research. I do most of mine in the summer, and haven't been for a holiday for three years as a result."

The reasons given for lack of time were varied, but frequent complaints were too heavy a teaching load, too many students, and having to take on part-time employment at other institutions because of personal financial necessity or because of the shortage of staff at many institutions of higher education.
Such things are understandable in view of the dramatic increase in the number of universities in Turkey since 1973—nine—and in view of the extra numbers of students that the older nine universities have been expected to take, in response to public demand for more university places.

As one docent commented during an interview, "Our greatest complaint is that there are too many students and not enough teachers." 6 respondents saw that this was a result of too many students trying for university places, coupled with public demand for more places for more students; in Q.72, they proposed that in order to better the quality and quantity of scientific research in Turkey, the intake to the universities must be reduced. One typical comment was: "Society must be persuaded to change its belief that everyone who finishes lycée should go to university—something which encourages people to study subjects they are not really interested in, simply because they want to get a degree." In the same Q.72, 7 other respondents agreed that the universities should not take in so many students.

As I mentioned in Chapter 4 (p.280 above), since there is a shortage of staff in certain fields at some of the new universities, docents and professors at older institutions have been invited to give lectures there on a part-time basis. These part-time lectures are both financially rewarding and accompanied by expense allowances and (frequently) air tickets. Several of the scientists interviewed in the sample said that they spent two days a fortnight lecturing or taking seminars at universities often quite far from their own. A number of professors in the sample also taught on a part-time basis at another educational institution in their own university city. A total of 24 (or 32%) of the scientists interviewed were engaged in part-time teaching elsewhere, ranging from one to eight hours a week, the mean being 4.5 hours.

In Q.72, 2 respondents felt that before new universities were opened, they should obtain the necessary full-time staff. Other suggestions in Q.72 were that researchers and lecturers should be divided into two groups (3 respondents), and that researchers should not have to be involved in administration (1).

However, academic staff are not obliged to take on part-time employment. The main incentive seems to be the economic one. Several scientists interviewed in the survey described the necessity of working part-time
"to maintain a decent standard of living" as an important factor in their having little time left for research. One professor said: "I think the main problem with respect to research in Turkey is the economic one. To make ends meet, academic staff take on outside jobs, and this interferes with their research." Another professor made an identical statement.

In Q.60, 2 respondents attributed the greater volume of research done by foreign professors in Turkey over against their Turkish counterparts to their being "better paid" and so not having "the same personal and financial problems". Under "Other" in Q.70, 2 respondents considered that "Too heavy a teaching load", and "Lecturers taking on too heavy a teaching load to make ends meet" respectively were important factors in hindering motivation towards doing good scientific research.

Another reason given for lack of time in which to do research was student politics. Over the past few years, there has been increasing polarisation of students into right-wing and left-wing groups, with frequent clashes between them both on and off campus. Several hundred students have died in the past five years. As a result, university administrators have been forced to take stringent security precautions, including locking up all buildings at night and forbidding even lecturers to stay on inside. As one docent remarked: "Five or six years ago, we used to stay on here in the evenings to do experiments, sometimes until quite late. Now because of the security precautions arising out of clashes between right-wing and left-wing students, we have to vacate the building by about 6 p.m."

Student politics can also be the cause of a certain amount of time being lost in necessary additional administrative procedures. Special staff meetings have to be called, time-tables have to be re-arranged, typed-out and distributed, and hours have to be spent discussing cases of, for example, students who were unable to enter examinations because of (sometimes armed) picket-lines of students of different political persuasions. In fact, during the course of the interviews, one professor was rung up and asked to take action because a stick of dynamite had just been thrown at one of the buildings on campus, while other respondents had to attend special Senate meetings after a grenade had been tossed into a group of students coming out of a lecture, as a result of which 6 students died and 36 were wounded.

On the other hand, boycotts and closures of universities for varying periods
may offer the lecturer an unexpected opportunity to undertake additional research.

Other time-consuming activities mentioned by respondents were the bureaucratic procedures required to import even a simple chemical (e.g. the filling-in of three "pro-forma" invoices), the delays involved in obtaining new equipment or repairing that already installed in the laboratory, and environmental hazards such as the electricity cuts which are a familiar part of Turkish life (in winter, electricity cuts of up to 4 hours per day limit experiments to certain—sometimes awkward—times and play havoc with equipment).

On balance, the survey suggests that in Turkey, the blame put upon lack of time as a hindrance to good research is in many cases undeserved. Although the bureaucracy connected with obtaining supplies and equipment, and student politics, and having to teach large numbers of students must all take up some time, such things do not appear to occupy as many of the hours outside the average 14 hours for teaching, administration and supervising practicals as the output of research might suggest. In Q.59a, 3 respondents wrote: "We lack discipline in the use of time", which may be a somewhat truer analysis of the situation. Perhaps lack of motivation is an even deeper influence.

5.9.6.b Adequate financial subsistence

In Chapter 4 (pp. 275 ff.), I examined why studying physics, chemistry and biochemistry is rather unattractive to most university applicants: it does not give much possibility of obtaining as financially rewarding a job as the study of other subjects does. Thus, the quality of the student intake into physics, chemistry and biochemistry is negatively affected, even though the size of the intake has been increasing steadily because of demand by young people for a university degree of any kind.

However, the situation is relative. A small proportion of students studying physics, chemistry and biochemistry can embark upon an academic career which is financially rewarding by civil service standards, even if it is not anywhere near as rewarding as, for example, law, medicine or the private sector. Although ten years ago, a research assistant was not well paid, since 1973 his monthly salary has been brought more into line with and even above that of middle-level civil servants. Moreover, although great efforts may be required, there is a chance of promotion to doctoral research assistant.
after three or four years, to docent after a further four years, and to professor after a further five years. Monthly salary-scales for April 1978 may be summarized as follows (including fringe benefits): (37)

TABLE 5.20

<table>
<thead>
<tr>
<th>Role</th>
<th>Net monthly salary, approx. (§1 = 25 TL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professor</td>
<td>14,900</td>
</tr>
<tr>
<td>Docent</td>
<td>13,500</td>
</tr>
<tr>
<td>Research assistant with Ph.D.</td>
<td>9,330</td>
</tr>
<tr>
<td>Research assistant without Ph.D.</td>
<td>9,000</td>
</tr>
</tbody>
</table>

These figures are net salaries, after tax and social insurance cuts have reduced gross income by about 35%. Increments for seniority are not included.

These salaries compare favourably with those of middle level and even senior civil servants: (38)

TABLE 5.21

<table>
<thead>
<tr>
<th>Role</th>
<th>Net monthly salary, approx. (§1 = 25 TL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under-Secretary (Müsteğar)</td>
<td>9,980</td>
</tr>
<tr>
<td>Assistant Under-Secretary</td>
<td>9,370</td>
</tr>
<tr>
<td>Head of Ministerial division (Genel müdür)</td>
<td>9,900</td>
</tr>
</tbody>
</table>

In contrast, net salaries in the private sector were very much higher: (39)

TABLE 5.22

<table>
<thead>
<tr>
<th>Role</th>
<th>Net monthly salary, approx. (§1 = 25 TL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doctor in private practice</td>
<td>20,000 - 40,000</td>
</tr>
<tr>
<td>Engineer in private sector</td>
<td>15,000 - 20,000</td>
</tr>
</tbody>
</table>

During the interviews, many respondents expressed dissatisfaction with their salaries, especially when comparing themselves with people of the same age in the private sector who were making up to two - three times as much. It appears that professors and docents have traditionally enjoyed great respect in Turkish society at large, and have been regarded as the highest of the elite. However, now that economic values are being forced upon the society by powerful advertising, especially through television, professors and docents seem to be finding it increasingly difficult to maintain a
standard of living commensurate with that expected from people in their social position. The situation was exacerbated by an inflation rate which reached about 60% in 1978 (see Table 4.33 on p.231).

As has already been mentioned, such socio-economic pressures encourage academic staff to take on part-time teaching jobs at other institutions, which inevitably reduces the amount of time available for undertaking scientific research. The situation is somewhat different when the wife also has a full-time job—as is frequently the case with wives of university lecturers. Another variable would be whether or not the family owned their own house or other property by inheritance. Rents in Istanbul, for example, where three universities are situated, rose by 60% per year on average in the two years up to May, 1978 (see Table 4.33).

The following example by a professor at Istanbul University illustrates the difficulties encountered by at least one potentially bright research scientist: "A very good research scientist we helped to train went to Britain for further studies and did so well that two universities there invited him to stay on as a research fellow. He decided against it and came back to Turkey. We offered him a job, but after unsuccessfully trying to rent a house for a month, he gave up and went to —— (a provincial town). Now we've given him a TÜBİTAK project and we can lend him equipment to continue his experiments. But what is there in ———? He'll teach a few people there, but how much research will he be able to do? We'll have to see."

Everything, of course, turns on the meaning of the term "adequate". Also, so much depends on whether the lecturer concerned is the only wage-earner in the family, whether or not they have to pay rent, the number of children and other dependents, and whether or not they own other property or have other sources of income. Probably in most cases, it could be said that the income of a professor or docent was sufficient for him to maintain himself and his family at a modest level. However, the increasing availability and desirability of more and more consumer goods coupled with a very high rate of inflation means that the temptation to use potential research time for supplementary income is a very real one.

5.9.6.c Equipment and materials with which to perform research

As was shown in the responses to Q.36a and Q.69 at the beginning of this
section, a very high proportion of respondents held that the difficulties involved in obtaining supplies and equipment were responsible for their own research productivity being lower than they desired, and for hindering the performance of more, good experimental/research in Turkey in general. The percentage of respondents in Q.36a was 89% and in Q.69, 84%.

Also, in Q.51, 49 (or 82%) of the 60 respondents felt that one reason why Turkish scientists who went abroad published more research papers than those who did not was because of better equipment and greater ease of obtaining supplies. In Q.52, the same number of respondents gave this as an advantage which western research scientists had over their Turkish counterparts working in Turkey. In Q.67, 20 (or 71%) of the 28 respondents who considered that their research done abroad was better than that done in Turkey attributed this to better equipment and greater availability of supplies. 7 out of 71 respondents (or 10%) in Q.72 felt that the Government should make it easier to import equipment; even though research equipment was exempt from import duty, İşlenmiş Vergisi (Procedural Tax) still had to be paid, which involved a number of bureaucratic processes.

One professor gave the following example of the difficulties he had encountered in importing a certain piece of equipment: "A piece of apparatus I had ordered from abroad lay in Customs for six months, during which time the lazer tube got broken and other parts went rusty. The Ministry of Finance had promised us the foreign exchange, but because it was having a quarrel with the Ministry of Customs, the people there refused to sign the necessary clearance papers. We got the insurance money for the broken lazer tube, but in the meantime the price of new tubes had gone up by $5,000."

A particular difficulty for chemists and biochemists seemed to be the slowness with which even a few grams of certain chemicals were obtained, since nearly all chemicals have to be imported. As one biochemist put it, "In Germany, we could order something one day and it would be in the laboratory the next. Here, it takes at least six months to get even a small quantity of a chemical. And over a period of six months, the direction of one's research can change completely—so it is impossible to plan ahead."

The shortage of foreign exchange in Turkey means that anything which has to be bought abroad can only be ordered after permission has been obtained from the Central Bank—all of which takes time. A former director of the Çekmece
Nuclear Research and Training Centre said that in the early years of the Centre, he overcame this problem by having an account in the U.S.A., with foreign exchange in hand which could be used to buy small but urgently-needed items or materials. In this way, small items could be obtained by research personnel within three weeks.

As regards equipment, several chairs or departments seemed to have quite sophisticated apparatus. During one interview, the telephone rang and the respondent was asked what was to happen about the apparatus they had ordered worth $200,000, now that the Turkish Lira had been devalued by 30%. Lack of co-ordination seemed to be a problem; one respondent remarked that there were at least five mass absorption spectrometers at his university, none of which was in continuous use.

In his reply to Q.72, another respondent considered that it was essential for Turkish scientific administrators to find more efficient ways of choosing scientific equipment, perhaps by visiting other countries. Two or three other respondents mentioned how beneficial visits to laboratories abroad had been in enabling them to select new equipment.

One foreigner who had been teaching and doing research in Turkey for several years made the following remarks: "At the moment there is no access to transferable currency. Few, if any, research programmes can boast really expensive instruments, but in general Turkish institutions are often better equipped than western ones. However, it would be nice to be able to pick up the telephone and obtain first-class technical support..."

Although large quantities of money are allotted to new universities when they are first set up, it appears that little thought is given to the continuing future needs of new equipment and supplies. Hence the later multiplication of red tape, leading to what several respondents described as a feeling of bikanlzik or "fed-up-with-everything-ness" with regard to undertaking research especially after returning from institutions abroad where new supplies and equipment were readily obtained. "The quality of my research has not gone down," said one respondent. "It is just that what took me six months abroad takes me two years in Turkey."

A foreign respondent laid a great deal of the blame for difficulties over equipment and so on at the door of professors abroad who supervised doctoral
students in topics which would be extremely difficult to pursue once these students had returned to Turkey. Such sentiments were echoed by 2 other respondents who said, "We need to start from the bottom by doing research we can undertake with our own equipment."

In Q.72, 4 respondents stated that more co-operation between universities was needed over what equipment to buy, or else a research centre should be set up where people from different universities could go and use the equipment and facilities. In the same question, 7 other respondents felt that more research institutes should be opened, although another respondent was not in favour of this: "I am against the opening of new research institutes. I used to work in one, and the people there thought of themselves as civil servants in Turkey." Apparently such habits included a tendency to sit gossiping with other personnel during working hours, and the avoidance of as much inconvenient work as possible.

In conclusion, it appears that the prerequisite of equipment and materials with which to perform research is somewhat deficient in Turkey, at least with respect to performing research that is anywhere near the forefront of current international scientific research. However, with more co-ordination and long-range planning, including the depositing abroad of foreign currency for purchasing small items required during the course of research, perhaps some of the obstacles could be avoided.

5.9.6.d Technicians to repair and maintain equipment

The lack of technicians to repair equipment was considered important by 45 (or 62%) out of the 72 respondents in Q.36a, and by the same number and percentage in Q.69. In the latter question, another 16 (or 23%) of the respondents held that this was of some importance in hindering the performance of more, good experimental research in Turkey. "More and better technicians and research assistants" was also mentioned by 5 (or 8%) of the 60 respondents in Q.51, and by 7 (or 12%) of the 60 respondents in Q.52. In Q.59a, 1 respondent out of 51 gave as a reason "Lack of trained technicians". Also in Q.67, 1 out of 56 respondents spoke of "the better technicians in laboratories abroad."

Finally, in Q.72, 7 (or 10%) of the 71 respondents saw the need for more trade and technical schools to train up technicians, "especially those who
look after and repair equipment worth $2 million."

The problem, however, is not simply one of more trade schools. Many students who enter such secondary schools do so in order to obtain a white-collar job in the civil service or to make their way eventually to university. An illustration of this is the fact that the name "Secondary Trade School" has, in recent years, been changed to "Secondary Trade Lycee" so that graduates from such schools end up in trades or professions quite different from those for which they were trained at secondary school.

The pull towards university is explicable in terms of the advantage that university graduates have of doing their military service as reserve officers instead of privates, and in terms of financial reward due to starting higher up the civil service scale. However, now that the labour unions in Turkey have become so powerful and have negotiated huge pay increases for their members, there are signs that in some areas a trend towards trade schools as opposed to ordinary lycees may be beginning. (41)

Another point is that because of the overall shortage of qualified technicians to repair television sets and other electrical household equipment, able technicians can make far more money by setting up their own repair workshops than by taking on a job as a technician in a university laboratory. (42)

In conclusion, it appears that the lack of technicians to maintain and repair equipment is a negative factor in the performance of experimental scientific research in Turkey, especially in fields where complex apparatus is necessarily employed.

5.9.6.e Co-workers

During the course of the interviews, several scientists expressed how much they missed other scientists with whom to work on the same research topic. Further discussion revealed that part of the problem lay in scientists' having obtained their Ph.D. degrees at several different universities, including some outside Turkey, at which they were supervised in varying sub-specialities by different supervisors. The 74 respondents from whom the relevant information was obtained studied for their Ph.D. degrees at the following universities (Q.23):
TABLE 5.23

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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>14</td>
<td>7</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>9</td>
<td>9</td>
<td>6</td>
<td>2</td>
</tr>
</tbody>
</table>

U.S.A. = A university in the U.S.A.; GER. = A university in Germany; U.K. = A university in the U.K.; OTI. = A university in another foreign country. The legend for the Turkish universities has been given in previous tables.

Cross-tabulation of university of present employment by university at which Ph.D. degree was obtained showed the following distribution:

TABLE 5.24

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</thead>
<tbody>
<tr>
<td>No. Int.</td>
<td>13</td>
<td>3</td>
<td>8</td>
<td>14</td>
<td>17</td>
<td>7</td>
</tr>
<tr>
<td>No. Univ.</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>8</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

No.Int. = Number of scientists interviewed at this university.
No.Univ. = Number of different universities at which those interviewed obtained their Ph.D. degrees.

Ankara and Istanbul Universities were the best off in terms of the fewest number of different places at which Ph.D. degrees had been obtained; 10 of the 13 interviewed at Ankara University had done the research for their Ph.D. degrees there, and 14 of the 17 interviewed at Istanbul University had done their research at Istanbul. METU academics had the greatest variety of Ph.D. research sites.

Even when scientists have been trained in the same sub-discipline, they may not be able to obtain posts at the same university. Thus, they tend to be spread out across the country. For example, research into aspects of solid state physics is being undertaken at METU, Hacettepe University, Istanbul University, and Karadeniz Technical University. On the other hand, where researchers live in the same city, some measure of co-operation is possible. The "research units" co-ordinated and funded by TÜBİTAK (see p.250 above) encourage this, and some respondents said they had benefited from the intellectual stimulation provided by units such as the Ankara Magnetic Resonance Unit based at Hacettepe University.
Unfortunately, the Turkish University law does not encourage the performance of research in teams. In order to obtain a docentship or professorship, work has to be done on an individual basis. For full professors, however, there is no such limitation, but the survey showed a great variation in the numbers of research assistants supervised by professors of similar seniority (see p. 338 above). Certain professors seemed more willing or more able to attract research assistants. In Q. 60, 4 respondents felt that the reason for the greater research productivity of foreign scientists working in Turkey was that they tended to gather around them helpful research assistants. Another impression gained from the survey was that team-work was hindered in the more classical universities by rigid demarcations between disciplines and by formal academic hierarchies.

5.9.6.f Knowledge of foreign languages to follow the literature, to communicate with other scientists, and to publish abroad

Only 13 of the 75 scientists interviewed in the sample had not been abroad. No figures for the numbers of scientists in the "universe" who had not been abroad were obtainable, and as a bias was introduced into the sample by opting for those who had been outside Turkey, this proportion cannot be said to be representative.

On the other hand, only one docent interviewed had not been abroad. In any case, the title of docent can only be acquired after successfully passing an examination in a foreign language. Thereafter, in order to become a professor, a docent must show his proficiency in a second foreign language. Coupled to such motivating factors is the fact that tuition at METU and Bosphorus University is in the English medium. Hence graduates of these two institutions and especially the academic staff have a very good working knowledge of the language.

Some scientists outside these two institutions did, however, express the feeling that in general the learning of foreign languages by scientists in Turkish required improvement. An older professor expressed it eloquently as follows: "For us, foreign languages are a psychological barrier. We can't communicate properly with scientists abroad. When they write to us, we don't reply. Also, writing papers and keeping up with the current literature is a real chore. This prevents us from keeping abreast of what's going on in the scientific world, and we become isolated from the rest of
the international scientific community."

A respondent in Q.36a wrote of 'language problems making publishing difficult. In Q.51, 6 respondents (or 10%) felt that Turks who did research abroad found it easier to publish their research because of knowing the (foreign) language better. Also, 6 respondents (or 10%) in Q.52 considered that most western scientists were at an advantage over their Turkish counterparts in knowing a language widely used in the scientific world. 2 respondents in Q.59 saw the difficulty of Turkish scientists having to learn foreign languages as one reason why their research output was lower than expected. In Q.60, 6 (or 10%) out of 61 respondents felt that the greater research output of foreign professors working in Turkey was due to their knowledge of a foreign language—which both enabled them to follow the current literature, and to publish more easily.

Finally, in Q.72, 4 respondents spoke of "the need for Turkish scientists to learn foreign languages better", while another respondent wanted "basic texts" to be translated into Turkish.

To what extent are Turkish scientists deficient in the learning of one or more foreign languages? A great deal appears to depend upon the institution where they are employed, with the more classical universities of Istanbul and Ankara giving less emphasis to foreign language proficiency. On the other hand, certain individuals even at these universities were obviously extremely proficient in German, French or English by virtue of having acquired a degree in the medium of one of these languages. Without giving a language examination to all the scientists in our "universe", it would be impossible to give an accurate proportion. However, the fact that some of the scientists interviewed mentioned the subject without prompting suggests that this particular prerequisite is deficient in some cases.

5.9.6.g Literature on the research topic

Subscribing to foreign research journals involves the transfer of hard currency, which, as has already been mentioned, is a problem affecting every aspect of life in Turkey. Universities such as METU, Hacettepe, and Bosphorus which were set up with the help of foreign aid, or else were modelled on western universities, from the outset have been able to obtain
journals with relative ease. For example, the approximate number of periodicals (not only in the natural sciences, however) subscribed to by the central libraries at these universities in 1977-78 was as follows:

![Table 5.25](image)

In contrast, other universities have faculty or even chair libraries instead of one central library. One respondent complained bitterly about the waste of resources this entailed, especially when the same journal was subscribed to by more than one chair at the same university. This situation does not obtain for most journals in physics, chemistry or biochemistry in Ankara, since there are no chair libraries in these fields. Figures for the universities in Istanbul are not available. However, perhaps some idea of the overlapping of libraries may be seen in the field of medicine; nine chair libraries in the Faculty of Medicine at Ankara University had at least some back-numbers of the weekly *Deutsche Medizinische Wochenschrift*, although only one appeared to be continuing to subscribe to it.

Where articles required are not available at the local University, the TÜRKOK scheme for obtaining photocopies within a month (see above, p.253) is available. The scheme is relatively cheap, but it does depend on access to abstracts of research articles.

Many of the scientists interviewed clearly understood the need to keep up with current literature and generally to be au fait with the latest developments in the field. For example, in Q.38 on the most admired scientist, 9 (or 16%) of the 57 respondents mentioned "the ability to keep on top of the subject", while another 10 (or 17%) wrote of "the ability to keep abreast of current developments". In Q.51, 15 (or 25%) of the 60 respondents considered that abroad it was easier to follow the current literature, another 2 felt that it was possible to find out the latest
developments quicker (via, for example, preprints), and 2 others thought that it was easier to see new directions for research. Another 4 respondents wrote "You are closer to the latest developments there", which implies close following of the current literature, and possibly attendance at conferences and congresses. Similar views by nearly equal numbers of respondents were expressed in Q.52. 9 of the 61 respondents (or 15%) in Q.60 considered that "foreign professors working in Turkey are more in touch with recent developments (than are their Turkish counterparts)."

Strangely enough, in view of the number of mentions in Q.51, no scientist who thought that his research done outside Turkey was better than that done inside attributed this to a greater ease of following the current literature, which casts doubt upon the influence of the latter upon research output, especially in view of the TÜRDOK scheme for obtaining photocopies of articles with relative speed. It appears, therefore, that for some respondents difficulties in following the current literature may be more of an excuse than a reality.

Responses to the item "There is a lack of access to current research literature" in Q.69 (Table 5.3), were as follows, for 70 respondents:

<table>
<thead>
<tr>
<th>Important</th>
<th>Of some importance</th>
<th>Of no importance at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>37 (53%)</td>
<td>19 (27%)</td>
<td>14 (20%)</td>
</tr>
</tbody>
</table>

The high percentage of those who did not consider this item important at all probably reflects the contrasting facilities available to scientists at different universities. This is borne out by the following cross-tabulation:

**TABLE 5.26**

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Important</td>
<td>2</td>
<td>6</td>
<td>5</td>
<td>0</td>
<td>10</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>(18%)</td>
<td>(43%)</td>
<td>(46%)</td>
<td>(59%)</td>
<td>(86%)</td>
<td>(100%)</td>
<td></td>
</tr>
<tr>
<td>Of some importance</td>
<td>4</td>
<td>6</td>
<td>3</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(36%)</td>
<td>(43%)</td>
<td>(27%)</td>
<td>(50%)</td>
<td>(29%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Of no importance at all</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(46%)</td>
<td>(14%)</td>
<td>(27%)</td>
<td>(50%)</td>
<td>(12%)</td>
<td>(14%)</td>
<td></td>
</tr>
</tbody>
</table>

Another explanation suggested by TÜRDOK officials, may be that not all scientists are aware of the facilities available for obtaining photocopies of articles, or else that they may not have access to the relevant abstracts.
Finally, in Q.72, 5 respondents suggested that a library or "documenta
centre" be set up in each university city, so that resources of differ
cent heads and faculties could be pooled and co-ordinated. One respon
dent even suggested that this could be done on a national scale, with the centres
linked by computer. Another respondent simply asked that "research
periodicals come quickly to each university".

Some of the respondents at least were obviously unaware of the TÜBİTAK scheme,
or else were not bothering to utilise it. Also, the scheme does require a
knowledge of the current abstracts if articles are to be obtained without
too great a lapse of time, and apparently some abstracts are not readily
available in every university.

5.9.6.h Opportunities for information exchange

In Q.36a, 16 (or 22%) of the 72 respondents marked "There is no one else
with whom to talk over problems met with during research" as one of three
factors most inhibiting their research productivity. Also, in Q.51,
15 (or 25%) of the 60 respondents mentioned that "In the West, there are
more people to talk to about research problems and the latest developments," a point mentioned by 21 (or 35%) of the respondents in Q.52. Again, in Q.51,
4 other respondents wrote "There are more people to talk to who have a greater
knowledge of the subject", whilst another respondent spoke of "a social
atmosphere in laboratories abroad conducive to doing research", which seems
to suggest a greater readiness for exchange of ideas.

2 respondents in Q.56b gave "In the West, there is more communication
between scientists" as a reason why research publications there are of a
higher standard than those in Turkey. In Q.60, 22 (or 36%) of the 61
respondents held that foreign professors' being more closely in touch with the
necessary stimulating environment outside Turkey (than their Turkish
counterparts are) helped increase their research productivity. Another
respondent wrote, "They are able to go to scientific congresses and
conferences more often." In Q.67, 5 of the 28 respondents who thought
that the quality of their research done abroad was higher than that done
in Turkey attributed this to there being more people to talk over research
problems with.

In Q.71, 47 of the 72 respondents considered TÜBİTAK's activities inadequate.
13 (or 28%) of those 47 thought that TÜBİTAK could improve communication between scientists by publishing a regular bulletin of research news (9 respondents), by holding Congresses for small groups more often (2), by publishing a journal in each of the sub-disciplines instead of each faculty publishing its own (1), and by supporting publishing more (1). 4 (or 6.7%) of the 71 respondents in Q.72 felt that more money should be made available for scientists from different universities to get together more often, "which would exert peer pressure". Another respondent spoke of the need for "more links with other countries", while under "Other" in Q.36a, one respondent wrote of the isolation of Turkish scientists from the international scientific community.

The survey suggests that because the numbers of Turkish scientists working in the same sub-discipline are small, and also because they are scattered across the country with only limited opportunities to exchange ideas, their research productivity is negatively affected. Since direct-dial telephoning only became a possibility in Turkey in 1978—and even then only in certain areas—scientists have not become used to utilizing this means of communication.

5.9.6.i Organization and freedom

We have already touched on certain aspects of the co-ordination of research facilities. Some respondents felt a need for greater co-operation in, for example, the buying of expensive apparatus by different departments of the same university. Others felt that better communication between scientists working in the same field would lead to more co-operation.

Organization and co-ordination of research activities may be achieved on three different levels: (i) within a university chair or department, (ii) between different chairs or departments of the same university, and (iii) between chairs and departments of different universities. The first of these was mentioned by several respondents in Q.51 and Q.52. Comparing research laboratories abroad with those in Turkey, 8 (or 13%) of the 60 respondents in Q.51 considered that laboratories abroad were better organized. In Q.51, 5 (or 8%) of the respondents held that the research team's being already established, and the goal clearly defined were advantages gained by Turkish scientists going abroad to do research.

Then in Q.69, the item "There is a lack of research planning within
university departments" was considered important by 61% of the respondents and of some importance by 25%, with 13% considering it of no importance at all. In Q.72, one respondent strongly advocated the abolition of the chair system "because one man can influence everything for the bad". Another respondent thought that universities should be broken down into smaller administrative units, while another respondent felt that in general, more long-range planning was required.

The second level of organization and co-ordination, that between different chairs or departments of the same university, was thought by several respondents to be in need of improvement, especially with regard to the buying of equipment. Also, in Q.67, one of the 28 respondents who held that his research abroad was better than that done in Turkey gave as the reason: "Outside Turkey, there is more co-operation between scientists; for example, you can ask another scientist to do a test for you, and he will do so readily and quickly."

The third level of co-ordination, that between chairs and departments at different universities, was only briefly touched on in the survey. We have already discussed some of the suggestions by respondents for TÜBİTAK to improve communications between scientists. 4 (or 8%) of the 47 scientists in Q.71 who thought TÜBİTAK's activities were inadequate held that TÜBİTAK should co-ordinate research more. 3 others considered that TÜBİTAK had no real science policy. Also, in Q.72, 9 (or 13%) of the 71 respondents considered that there must be a nation-wide science policy defined by TÜBİTAK and geared to the needs of the country, which suggests that they felt a need for greater co-ordination. In the same question, 8 (or 11%) of the respondents said, "More co-ordination is needed between universities—they do not know what each other is doing."

However, interviews with officials in the Science Policy Unit and in other departments of TÜBİTAK showed how difficult it is to co-ordinate research between the universities. "We go to the university departments and ask for their research programmes for the coming year," said one TÜBİTAK official, "and they never co-operate. In fact, sometimes they even imply that we are meddling with their autonomy." The whole question of university autonomy is an extremely vexed one. Article 120 of the 1961 Turkish Constitution, stated: "Universities are academically and administratively autonomous public corporate bodies. Universities are administered and
supervised by administrative bodies composed of qualified members of the academic staff elected by the academic staff". However, after the student troubles leading up to the government crisis of March 12th, 1971, the words "academically and administratively" were dropped, and a clause "under the supervision and inspection of the State" was added. In spite of this addendum, almost the only way in which a university department's activities can be influenced from outside the university is by the Turkish Parliament raising or lowering its budget.

The overall impression given by the survey was that a large proportion of the scientists interviewed considered that research planning within relevant university departments was inadequate. However, not surprisingly, cross-tabulation by academic title for item 10 in Q.69 showed that professors (in several cases, themselves heads of departments) tended to minimise the importance of such research planning:

| Table 5.27 |
|-----|-----|-----|-----|
|     | i   | s.i.| i+s.i. | n.i. |
| Professor | 8 (42%) | 6 (32%) | 14 (74%) | 5 (26%) |
| Doçent    | 13 (69%) | 5 (26%) | 18 (95%) | 1 (5%) |
| Ph.D.     | 20 (69%) | 6 (21%) | 26 (90%) | 3 (10%) |
| All academics | 41 (61%) | 17 (26%) | 58 (87%) | 9 (13%) |

5.9.6.j Cognitive and manipulative skills

These have already been discussed in section IV above.

Knowledge of certain research techniques is obviously a factor in the range of experiments a scientist can perform. Such knowledge may be gained by following current literature or by visits to other laboratories, and so this factor cannot be taken in isolation.

As the lines between even sub-disciplines become more and more blurred, and as the need to look at research problems from different angles becomes greater, it would appear that knowledge of fields adjacent to the research
area would be an advantage. Two respondents in Q.38 gave this as a characteristic of the scientists they admired.

5.9.7. Appertaining to psychological characteristics

5.9.7.a General role-relevant characteristics

5.9.7.a.1 Intelligence

Earlier, in section IV above, we discussed how socio-economic pressures force able students away from studying basic science at university level. Students who obtain high marks in the nation-wide university entrance examination opt for subjects which will eventually bring great economic rewards, such as medicine and civil engineering. The result is that the average intake into physics, chemistry and biochemistry is of lower ability than the intake into the most sought-after fields.

We also noted how in some areas, girls are not encouraged to continue with their education, and that boys and girls at schools in rural areas tend to be at a disadvantage compared with their counterparts in urban areas because the best teachers tend to migrate towards the towns and cities. Such factors, we suggested, may be discouraging some potentially bright research scientists from entering university at all, or from gaining the necessary marks in the university entrance examination to be able to study science.

5.9.7.a.2 Creativity

Two questions in the survey directly touched on the topic of creativity. In Q.39c, 90% of the 70 respondents considered that "Not developing the student's creative ability" was a factor in the classical science curriculum which had hindered the production of good experimental research scientists. The question does assume that some students have a creative ability which can be either suppressed or developed by environmental factors.

Also, in Q.69, respondents were asked for their opinions as to how creativity not being encouraged by the educational system hindered the performance of more, good experimental research in Turkey. Responses for 69 respondents were as follows: Important: 38(55%), Of some importance: 22(32%), Of no importance at all: 9(361
Over half the number of respondents considered that this item was significantly important.

In the same Q.69, another item involving creativity, "There is a lack of initiative to overcome problems encountered during research" was marked as follows, for 69 respondents:

**Important:** 28 (41%),  **Of some importance:** 29 (42%),  **Of no importance at all:** 12 (17%)

This item must also involve motivation, and possibly other factors.

In Q.38, 7 (or 12%) of the 57 respondents gave "He possesses a creative mind" as one of the characteristics which made the scientist they admired a good one.

5.9.7.a.3 Curiosity

Although curiosity may be innate to a certain extent, it can be suppressed or not directed towards the natural world.

In the question which asked which customs or mores the respondent considered had been inimical to the development of science in Turkey (Q.43), two respondents gave under "Other": "The suppressing of children's curiosity. We tell them not to busy themselves with adult affairs". In a question on religion (Q.41), one respondent said he felt religion suppressed curiosity. Also, in Q.38 on the characteristics of the "admired scientist", two respondents mentioned "curiosity about his topic".

The same point was also made in Q.59a. The scientists were asked whether they thought that those research workers in Turkey who explained their lack of good research by physical/environmental problems, such as difficulties in obtaining supplies and equipment, were making excuses or not. 4 (or 5%) of the 75 respondents held that they were; 50 (or 67%) considered that they were excusing themselves, at least to some extent, while 21 (or 28%) thought that they were not excusing themselves at all. Q.59a then asked (those who were in the first two categories) what they felt was the real reason for the excuse-makers' lack of good research work. Of the 51 respondents to this question, 3 felt that lack of curiosity was the real reason (one respondent added that this was a result of the educational system).

Devotion to science for its own sake may be considered under "Curiosity".

In the survey, devotion to science for its own sake was touched on at one or two points. In Q.39c, respondents were asked whether they considered that
the classical science curriculum had hindered the development of experimental scientific research in Turkey by not arousing in the student a love for science. Of the 70 scientists who responded to the question, 37 (or 53%) thought that it had, whilst 33 (or 47%) disagreed. In view of the rather boring nature of the old curriculum, this result is rather surprising. However, since all the respondents presumably had some sort of affection for science despite having been taught the old curriculum, perhaps they were not the most qualified people to answer the question.

In Q.38 about the "admired scientist", the following characteristics were mentioned by several of the 57 respondents: "industriousness" (15 respondents), "persistence in research" (12), and "wholehearted devotion to science/research" (6) - a total of 33 mentions. The first of these was mentioned with respect to one Turkish scientist, the second with respect to 3, and the third with respect to none. This indicates that persistence is probably necessary for doing experimental research in Turkey, but that hard work (in research, not in teaching) and wholehearted devotion to scientific research may be somewhat lacking. A statement from a foreigner who had spent twelve years working in Turkey tends to support this conclusion: "We don't have any scientists in this country like you find in the West, for example, who are real hard drivers, whose work is their life".

How is a devotion to science, to solving "puzzles" about the natural world inculcated? An attempt was made in Q.29 and Q.30 to ascertain why respondents had chosen to embark upon a career as a research scientist, and to discover who had most influenced their choice. Q.29 asked what the respondents had found attractive in becoming a university lecturer. Unfortunately the question was not a good one in that lecturers both teach and do research; and more importantly, respondents seemed to find it difficult to pin-point the reason for their career-choice, or else were reluctant to say what it was. Q.30 was more successful. For 38 (or 54%) of the 70 respondents it was their own decision to become a university lecturer; for 20 (or 29%) it was a lecturer at university; for 4 (or 6%) it was a teacher at high-school; and 5 (or 7%) it was their parents. Thus, 24 (or 34%) of the sample had been encouraged to become university lecturers by former teachers. Assuming that the latter had done so because they thought that their pupils would be "successful" in research and had even detected in them a love for the subject, we may postulate that interest and enthusiasm for scientific endeavour is often communicated and aroused by teachers of the subject. A comment by an
older professor bears this out: "My lycee teacher specially set up a lab: 
(in the school building), which was a very unusual thing during the late 1920's. But that was how I first got my love for chemistry. It was through 
the influence of my teacher." Presumably, some of those respondents who 
registered the decision as their own had also decided to go into scientific research because of a love for the subject instilled in them by a teacher at 
an earlier stage, even though the teacher may not have played a direct part 
in the final decision-making process. This assumption was supported by the 
answers to Q.28.

In Q.28, the question was asked, "When did you decide to become a research scientist?" Responses were given as follows:

<table>
<thead>
<tr>
<th></th>
<th>Respondents</th>
<th>% of 75 respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>In primary school:</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>At lycee:</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td>While an undergraduate:</td>
<td>23</td>
<td>31</td>
</tr>
<tr>
<td>After graduating:</td>
<td>38</td>
<td>51</td>
</tr>
</tbody>
</table>

The interesting point for our present discussion is that 14 respondents (or 19%) decided on a research career before going to university - again suggesting the influence of teachers in instilling a love for the subject.

Further hints about lack of devotion to the pursuit of science for its own sake (though as we saw above, such devotion does exist amongst some of the scientists interviewed) came from the "Other" section of Q.69, as to factors which the respondent felt were inimical to the performance of more, good experimental research in Turkey. One Ph.D. wrote "Those who don't do research set a bad example to other scientists. Without realizing it, they spread laziness around like a plague." One professor wrote, "The invention of various excuses for laziness." Such comments infer the existence of the antithesis of wholehearted devotion to science on the part of some scientists.

However, it would be simplistic to think that hard work and working discipline are the end results of a pure devotion to science alone. They may be fuelled by a complex mixture of incentives, including rewards and recognition. Another consideration, mentioned by several respondents in their answers to
various questions, is that in Turkey there are a number of economic and social problems which tend to distract the research worker from a single-minded devotion to the pursuit of scientific knowledge. Furthermore, in basic scientific research, it is difficult to see the connection between the performance of scientific research (including dedication to such) and the great issues of the "wider society", such as how the country is to develop industrially and economically.

5.9.7.b Self-confidence and self-discipline

The Coles' research on highly-productive American scientists indicates the importance of research scientists finding encouragement early in their careers. Success then breeds success.

Several respondents in the survey on Turkish scientists expressed a feeling of inferiority when comparing themselves with scientists in the West. For example, in Q.59a, 2 respondents spoke of their discouragement when comparing themselves with their counterparts in the West with all the research facilities. Another respondent made the following remarks: "We tend to have an inferiority complex vis-à-vis science in the West. This tends to lower our morale and discourages us from working as we should. Also, our professors and docents don't train us as they ought to."

In Q.38, 2 respondents spoke of self-confidence as one of the characteristics which made the scientist they admired a good one. Also, in Q.60, 5 of the 61 respondents held that one reason for the greater research output of foreign professors working in Turkey was their greater self-confidence.

In Q.67, one of the 28 respondents who considered that his research abroad was better than that done in Turkey attributed this to his supervisor taking a great interest in him and his work, or in other words, encouraging him. This theme of encouragement was taken up by a respondent to Q.36a, who under "Other difficulties encountered in doing research in Turkey" wrote "Not enough encouragement is given to researchers by university administrators. I believe in the need for successful researchers to be encouraged and rewarded somehow!" An older respondent described the effect of early stimulus in his academic life in this way: "I went to France to study and won a prize for coming first in the Honours List. This made a tremendous impression upon me, and has wedded me to science all my life."
The need for research scientists to be encouraged was also mentioned by respondents in Q.72. 7 of the 71 respondents thought that there should be more rewards available for good research, for example from foundations inside and outside Turkey. 2 other respondents felt that people needed to feel that their research was appreciated; one of them said, "Abroad, young scientists are encouraged a great deal by their professors, and this stimulates them to do more research."

The survey indicated, therefore, that some Turkish scientists at least feel a lack of self-confidence while they are engaged in research activity.

As for self-discipline, particularly as regards discipline in order to undertake more and better research work, it is probably obtained by socialization processes such as formal education, and contact with reference groups. Maintaining such a discipline would seem to depend on motivation.

In Q.60, 12 of the 51 scientists who suggested reasons as to why foreign professors working in Turkey are more research-productive than their Turkish counterparts gave: "They have a greater working discipline."

"Lack of discipline in the use of time" was mentioned by 3 out of 51 respondents in Q.59a concerning the real reason for the lack of good experimental research in Turkey (one respondent added: "We prefer chatting with our friends to doing research").

That a working discipline is sometimes hindered by cultural mores was expressed in the following comment by a respondent under "Other" in Q.43a: "It is rather difficult here to shut oneself away to do an experiment. In Turkey, it is unthinkable to turn away unexpected guests, even when they interrupt our work." As the obtaining of a rendez-vous beforehand is a rather infrequent occurrence in Turkey in the writer's experience, unexpected guests are a fairly common aspect of the social scene. The result appears to be frequent interruptions of work. This may reflect the greater importance given to personal relationships in the wider society in Turkey than in that in the West.

Another example of the lack of willingness to turn people away or to ensure that they only come at certain times occurred during an interview with a docent who had never been outside Turkey (and so would not have had as much of an opportunity as others would have done of seeing working-discipline..."
He stated that he had no intention of going abroad, and that he was determined to show that research could be done in Turkey. During the interview, five people came in. One research assistant wanted to ask about a reagent that had run out in the laboratory; three students came in at separate times to ask when their exam papers were going to be marked; someone else came to have an official paper signed; and another person came in to collect some papers. At no time did he ask anyone to come back at another time when he was not so busy. "As you can see", he said, when there was a rare moment between interruptions, "research in Turkey cannot be done under these conditions." And yet the thought came to mind, "What if there had been greater forethought and planning, and people knew not to disturb him when he was busy?" Those who came to his room could hardly have been counted as "guests".

Such an incident seems to bear out the statement of another respondent, also in Q.43a, who wrote "Personal relations are more important than merit in our country."  

5.9.7.c Ability to work with other scientists

It would seem dangerous to generalize about the ability of people of any nationality to work with one another. However, some scientists interviewed in the survey considered that in general Turkish scientists do not co-operate well with one another. Co-operation with other scientists may involve working closely with them in a team situation, or else exchanging ideas and information in writing or by word of mouth at conferences, seminars and visits to other research laboratories.

In Q.38 about the admired scientist, 6 of the 57 respondents mentioned "ability to work well with others", while another 5 mentioned "ability to secure good contacts throughout the scientific world". Another 4 identified "having a good research team to work with" (which would obviously involve good co-operation with others), while a further respondent mentioned "Has a desire for scientific exchange with other scientists".

In Q.51, as one reason why Turkish scientists who went abroad published more research papers than their counterparts who did not, 6 out of 52 respondents gave: "People work more in teams abroad, which encourages you to work better." Another 5 mentioned the encouragement of being caught up in the momentum of
team activity (and thus indirectly pointing out its deficiency in Turkey) thus: "Your problem is already clearly defined, the research team already established." Another respondent spoke of "a social atmosphere in labs abroad conducive to doing research". In Q.52, which asked what advantages research scientists in the West had over their counterparts in Turkey, more teamwork was mentioned by 7 out of 52 respondents, while 3 others mentioned "better personal relationships".

In Q.59a concerning the real reason why there was a lack of good research work in Turkey (after taking into account all the environmental - physical problems), 4 of the 51 respondents spoke of "lack of co-operation"; for example, some research workers refused to let other scientists working on different topics use their equipment for short periods. 2 respondents talked of people doing research in the same sub-discipline being spread out across the country instead of being in the same research team; however, this could be because of lack of a suitable post coming up at the right place at the right time. One docent spoke directly of inability to work with others in teams, as the following conversation illustrates:

Docent: "We do not work well in research teams."
Interviewer: "But as foreigners, we always think of social groups in Turkey as being much more cohesive than those in most Western European countries."
Docent: "Yes, people do have an emotional attachment to one another in our society. But in a research team, mental allegiance and discipline is required. This is lacking in Turkey, and so people branch out on their own and do not work well in teams."

Lack of co-operation amongst research scientists in Turkey was considered an important item by a high proportion of the 70 respondents in Q.69. Responses were as follows:

Important: 45(64%), Of some importance: 21(30%), Of no importance at all:4(6%

The "important" figure could be increased by one, since one respondent (a Ph.D marked "Inability of scientists to work together" under 'Other'; presumably he felt that "lack of co-operation" was not strong enough.

A docent wrote in similar vein under 'Other' in Q.70, which asked respondents' views as to which factors they considered important or of some importance in lowering motivation towards doing experimental research. He wrote, "Importance is given to individual rather than team work."
An example of lack of co-operation amongst research scientists was given by a Ph.D., as follows:

"There is a real lack of co-ordination between 'chairs' at our universities. Perhaps this stems from a lack of planning when they were first set up. However, another important reason is simply egoism. We dislike having to go to someone else for help, and so each chair buys its own (expensive) equipment, often duplicating that in other chairs. For example, in our university, there are 5 or 6 mass absorption spectrometers. And instead of a central library, each chair or department has its own library, often containing the same books. We need to use our resources in a more rational way. The old way of thinking is gradually changing, however."

In considering co-operation with other scientists, it is important to distinguish between reluctance to do so and inability to do so stemming from physical and financial hindrances. A possible reason for such reluctance is suggested by a comment made in response to Q.59a, "We are not achievement-oriented in Turkey." Presumably if the achievement were of prime importance, scientists would be more willing to subordinate their personal desires to realize it. The irony of such a situation is that in this era of Big Science, it is only by working in teams or in an atmosphere of real co-operation with other scientists that a scientist achieves recognition and status on an international scale.

5.9.7.d Motivating factors

Motivation towards engaging in research activity is probably a resultant of different factors, varying in extent with each individual. In different cases it may be affected by conducents Ie, If, Ig, III, IV, V, VI, VII, VIII, VIIIb and VIIIc.

Two direct questions about motivation were asked in the survey. In Q.69, half of the 68 respondents saw the item "There is little motivation to do research" as an important factor in hindering the performance of more, good experimental research in Turkey:

Important: 34(50%), Of some importance: 25(37%), Of no importance at all: 9(13%) The figure in the third column seems surprisingly high at first sight, especially since the formal role expectations for research by Turkish academics are so low. However, to what extent these 9 responses are
dependable is somewhat questionable in the light of the same respondents' responses to Q.70, in which respondents were asked to mark which items they thought lowered motivation towards engaging in experimental scientific research in Turkey. 7 of the above 9 respondents marked at least one item "Important", while one of the other 2 marked four items "Of some importance", and the other marked one item "Of some importance". For this reason, the responses of these 9 respondents have been included in the results of Q.70, which are displayed in the table below:

**TABLE 5.29**

<table>
<thead>
<tr>
<th></th>
<th>i.</th>
<th>s.i.</th>
<th>i+s.i.</th>
<th>n.i.</th>
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</thead>
<tbody>
<tr>
<td>1. In Turkey there is not much demand for research from outside the universities:</td>
<td>49</td>
<td>15</td>
<td>64</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>(73)</td>
<td>(23)</td>
<td>(96)</td>
<td>(4)</td>
</tr>
<tr>
<td>2. The present university system allows a person to obtain promotion without doing much research:</td>
<td>42</td>
<td>21</td>
<td>63</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>(62)</td>
<td>(31)</td>
<td>(93)</td>
<td>(7)</td>
</tr>
<tr>
<td>3. In the Turkish academic world, those who do research have no more status than those who do not:</td>
<td>20</td>
<td>28</td>
<td>48</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>(29)</td>
<td>(41)</td>
<td>(70)</td>
<td>(30)</td>
</tr>
<tr>
<td>4. The head of the chair/department does not encourage the performance of research:</td>
<td>21</td>
<td>21</td>
<td>42</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>(31)</td>
<td>(31)</td>
<td>(62)</td>
<td>(38)</td>
</tr>
<tr>
<td>5. Other</td>
<td>10</td>
<td>3</td>
<td>13</td>
<td>—</td>
</tr>
<tr>
<td>6. The results of research are not appreciated by the international community of scientists:</td>
<td>6</td>
<td>13</td>
<td>19</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>(9)</td>
<td>(19)</td>
<td>(28)</td>
<td>(72)</td>
</tr>
</tbody>
</table>

i = importance, s.i. = of some importance, n.i. = of no importance at all. Rounded-off percentages are given in parentheses.

These results suggest that Turkish scientists would be more motivated to perform research if they felt the results of their research could be utilised in the wider society. From personal observation, educated Turks tend to have a very deep desire for national economic development and yet many of the scientists interviewed could not see how their research could contribute towards this end. (50) One Ph.D. put it this way: "We don't have enough good applied scientists. My research is too abstract. It makes me sad to think that my research is not really relevant to the needs of Turkey." A docent spoke in much the same vein: "Here in Turkey everyone does their own thing. No one thinks how it is going to benefit the country. I only do research that I think can be done with the facilities that are available,
not research that I think might be useful for Turkey. So some organisation like TÜBİTAK should give directions as to what research is to be done inside and outside Turkey by Turkish research scientists - perhaps by means of a magazine or newsheet."

In Q.71, 6 (or 13%) of the 47 respondents who found TÜBİTAK's activities inadequate felt that it should support projects "more relevant to Turkey's needs". In Q.72, one respondent suggested that "TÜBİTAK should arrange research projects that will be useful to Turkey, for example by looking at the import quotas for chemicals". However, these responses appear to conflict with the complaints of TÜBİTAK officials (see p.250) that scientists were unwilling to take on mission-oriented projects.

In the same Q.72, several suggestions were made as to how scientific activity could be made "more relevant to the needs of the country". Moreover, 9 (or 13%) of the 71 respondents wanted a science policy "geared to the needs of the country". 4 other respondents considered that more money should be allotted to researchers "who will meet Turkey's needs, e.g. that of energy". 9 other respondents felt that industry should be made to co-operate more with the universities "at present, it doesn't think we can help at all". However, in this question and in Q.70, the facilities and even the financial rewards which industry could provide may have been in the minds of some of the respondents.

The results of Q.70 show that the low research requirements for promotion in the Turkish university world discourage academics from doing research. 70% of the respondents also felt that a further discouragement was the lack of other forms of scientific recognition for those who did research. Another discouraging factor, according to over 60% of the respondents, was lack of stimulus from the head of the chair or department (however, the large number who discredited this suggestion indicates how much this depends on individual heads). Lack of appreciation of research results by the international community of scientists was considered of no importance at all by 72% of the respondents. However, the item assumes that the research scientist concerned considers that his research is worthy of international recognition; but for various reasons it has not attained such recognition; perhaps an attempt at publishing it in a reputable journal has been unsuccessful. Considering the degree of respect for the referee system of reputable journals outside Turkey, it would be natural to find only a small number of scientists still sticking to their guns once their research paper had been
turned down. Also, most scientists would agree that international recognition is obtained by a steady output of high quality research papers, and that lack of such recognition was due either to lack of numbers, or to lack of quality of research papers, to account for both of which various reasons would be found.

In an earlier question, lack of international scientific recognition was cited by some respondents in the survey as a factor operating to discourage them from performing research. In Q.36a, 7 of the 72 respondents marked the item "The international scientific community does not appreciate the research work I do" as one of the three most important reasons why they did not publish more research papers (2 other respondents marked the item "Other Turkish scientists do not appreciate the work I do").

Similar results were reported by Blasco from his survey of Spanish scientists. Thus Spanish researchers feel themselves to be alienated from society because they do not seem to fulfil a social need. 89% of Blasco's sample thought that "the middle-class Spanish citizen does not care about the amount, volume or quality of scientific research done in Spain". Also, 48% of the sample considered that the government was not really interested in science, while a further 30% thought that it was only "somewhat interested".

In Spain, too, there is not much demand for research from either the public or the private sector. As a result, Spanish scientists would like to see research objectives brought more into line with national economic objectives. 51% of those questioned believe that the main objective of scientific research should be to fulfil domestic demands such as "the acquisition of our own technology".

According to Blasco's study two consequences follow from the lack of practical function of researchers in Spanish society. First, the small amount of research they perform does not usually affect society. Second, whether researchers publish or not is of little importance. Thus 66% of those questioned were "very little" or "not at all" satisfied with their social position. Hence "in the face of the unsupportive climate which surrounds their purely scientific labours, Spanish researchers feel increasingly motivated to seek the power and prestige which society denies them, elsewhere. Thus, it is not surprising that they are willing, in greater and greater numbers, to fulfil a teaching function." Most prefer
jobs at universities to purely research jobs at government research centres. Others combine a scientific with a political career. As in the Turkish case, Spanish society "neither demands nor rewards the services of scientific researchers".

With several of the Turkish scientists interviewed, I sensed that morale was low. This was especially the case with those who had done excellent research work abroad, but had then found it impossible to produce work at the same rate on their return to Turkey. A number of scientists spoke of a "bikinlik" or "fed-up-with-everything-ness" which arises as a result of the multitude of bureaucratic and technical problems which are met with in Turkey during the course of the average research project. Because of the prevalence of this feeling one professor felt that he would only take on research assistants who would be prepared to see a project through to its conclusion despite all the trials and tribulations involved: "In our department, we prefer to take on staff who have been trained almost entirely inside Turkey. People who have done their Ph.D.'s abroad come back completely spoilt, expecting their research to carry on as smoothly as it did outside Turkey. They soon become demoralised and in the end may opt out of doing research altogether."

We shall now consider the results of a survey conducted amongst a rather different group of Turks.

5.10 Survey Amongst Turkish Lawyers

After the data which had been collected in the survey among Turkish scientists had been analyzed, the question arose as to whether those Turks who had become research scientists were typical of educated Turks or not. Did other educated Turks who had decided not to become scientists regard scientific research activity as a worthwhile occupation? If so, would they encourage members of their own families, for example, to take up scientific research as a career?
I decided, therefore, to interview a small sample of a professional group who had no professional links with scientific activities, namely lawyers, in May 1979. Although the sample was small, the near-unanimity of the respondents on various topics confirmed my own personal observations about such things as reasons for career choice.

5.10.1 The lawyers interviewed

Sixteen lawyers resident in Ankara were interviewed in Turkish in interviews which lasted approximately one hour each. The lawyers interviewed ranged in age from 25 to 69 and in political viewpoint from extreme left to right-of-centre. Half of those interviewed belonged to an elite group of barristers; two of them were former Members of Parliament, and three of them were former judges. Most of the others did a combination of court cases and work which in Britain would normally have been done by solicitors. All except one of the lawyers interviewed was engaged in private practice. 13 of them were male and 3 were female. They had practised law for between one and 31 years, with a mean of 17 years. In common with all other avukats in Turkey, they had the mandatory degree in law, as well as experience of court procedures.

5.10.2 Why the respondents had entered the legal profession

6 respondents said that their becoming lawyers was pure coincidence. They had wanted to study a subject other than law at university, but had been unable to obtain sufficiently high marks to do so. Nevertheless, they all stated that afterwards they had not regretted becoming lawyers. 9 respondents mentioned that an important factor in their studying law was that the Faculties of Law at Istanbul and Ankara Universities did not require compulsory attendance at lectures, which enabled them to study and work at the same time.

2 respondents had been encouraged to study law by their parents, while a further 3 had done so because one or both of their parents were lawyers and so they had been brought up "in an atmosphere of law". 2 respondents spoke of a love for universal justice drawing them into the legal profession, while one spoke of a desire to help other people. Yet another spoke of an interest in social phenomena.
None of the respondents spoke of the attractive income of those in the legal profession, nor of the job security involved - even though the absence of these was given by 10 respondents as a reason for not encouraging their children to become research scientists.

At least 4 respondents spoke in the following vein: "As you know, entering a profession in Turkey is not really a matter of choice, it's a question of where you can get in."

5.10.3 Whether or not the respondent would encourage his child to become a research scientist

A question asked early on in the interview was as follows: "As you know, the Science Lycee was set up with the aim of increasing the number of Turkey's scientists in the fields of physics and chemistry. If your son or your daughter were in his/her final year at the Science Lycee, which university department would you advise him/her to go into?" The responses were as follows:

TABLE 5.30

<table>
<thead>
<tr>
<th>Field</th>
<th>Nr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medicine or engineering</td>
<td>12</td>
</tr>
<tr>
<td>Law</td>
<td>2</td>
</tr>
<tr>
<td>Physics or chemistry</td>
<td>1</td>
</tr>
<tr>
<td>No clear response</td>
<td>1</td>
</tr>
</tbody>
</table>

Nr = mentioned by this number of respondents

I then asked the 14 respondents who had not said physics or chemistry for the reasons for their responses. Replies were as follows:

TABLE 5.31

<table>
<thead>
<tr>
<th>Reason</th>
<th>Nr</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) There is more money in the field I would advise</td>
<td>10</td>
</tr>
<tr>
<td>(ii) In the field I would advise, it would be far easier to obtain a job than in physics or chemistry</td>
<td>10</td>
</tr>
<tr>
<td>(iii) In the field I would advise (medicine), he/she could serve other people</td>
<td>3</td>
</tr>
</tbody>
</table>
Table 5.31 (contd.).

(iv) If he/she were to do research, it would almost certainly have to be at a university. An academic career requires a lot of hard work and time to reach the top of the tree (i.e. become a professor), and for much of the time you are subject to the caprices of your superiors

(v) In the field I would advise, he/she would not have to work in a part of the country he/she didn't want to

(vi) Nearly everyone would like a doctor in the family

(vii) In the field I would advise, he/she could best help the class struggle in Turkey

(viii) The field I would advise leads on to one of the most respected professions in Turkey (medicine)

Nr= mentioned by this number of respondents

As for the respondent who replied "physics or chemistry", I reminded him that there was not as much money in those fields in Turkey, as in, say medicine or engineering. He answered as follows: "Money is not important at all. The most important thing is to serve others. The aim of a physicist is to serve others, isn't it?"

I reminded the other respondents that a great deal of money had gone into setting up the Science Lycee, and that because it was a boarding school, tax-payers' money was being used to pay for the free board of the 300 students, for its good quality laboratory equipment and for the salaries of the specially selected teachers. Despite its original aim of providing research physicists and chemists, in 1978 only one of the 100 Science Lycee graduates had opted to study physics or chemistry at university. But in other countries, I went on, some bright students preferred to pursue a scientific research career rather than other, more lucrative careers. Why was it that in Turkey where Atatürk had given so much importance to science, it had not been possible to inculcate a love for science which over-rode materialistic considerations?

This was, of course, a highly provocative question, which elicited some very interesting responses, a selection of which are reproduced below:
"The first priority of every human being is to be happy, and earning (plenty of) money helps you to be happy."

"Everyone wants to get rich as quickly as possible. Our country is destitute of moral and spiritual values."

"Conditions in Turkey push people into making money. After Atatürk's time, idealism began to disappear in Turkey. Now everyone is in a mad scramble to make a living."

"In the early 1950's, ideals began to crumble as everyone came under economic pressure. Great importance was given to material things. More places of entertainment opened. Now everyone wants to own a flat and a car. In such a situation, no one wants to go into physics and chemistry, where there is not much money and not much chance of getting a job."

"There's a tremendous social pressure at work. We don't seem to be able to transmit a love for science. Our kids all want a colourful life and becoming a university lecturer seems far too dull. Also, in the university world, the chances of getting rich are extremely small. As everyone wants to get rich, they choose professions which are far more lucrative."

"All of us love money. In Turkey, to go into the university world you have to be an idealist."

"We are brought up to respect ideals, but then the socio-economic pressures of Turkey force us into professions in which we can earn a lot of money."

I pointed out that a graduate of the Science Lyceé had a very good chance of becoming a physics or chemistry research assistant at a university because at the Science Lyceé only 100 entrants are selected from thousands of applicants each year in a very competitive examination; also, in the University Entrance Examination, Science Lyceé graduates always obtain high enough marks to enter the university department of their choice, which confirms that Science Lyceé graduates are both able and highly trained. Furthermore, a research assistant in physics or chemistry now earns as much as a civil servant in one of the highest civil service grades. Some respondents replied as follows: "To reach the top of the academic profession takes at least half a life-time of hard work. It's too much trouble. No-one wants to work that hard for so little a reward."

"My wife is a university lecturer, and so I know something about the university world. At each step of the ladder in order to become a Ph.D., docent, or professor, a thesis has to be prepared and an awful lot of effort exerted. No-one wants to work that hard. Also, the chair system tends to wreck everything. The research assistants have to try to please their
professors' every whim. And in any case, it's difficult to become a research assistant. You have to take an exam, but a lot depends on the professor. If you are not well in with him, he won't take you on. So there's a certain lack of job security even for a Science Lycee graduate starting out in physics or chemistry."

"It's hard to do research in Turkey. And then when you know how difficult it is to keep up a decent standard of living here, it's not surprising that Science Lycee graduates put their own interests before those of the country. They can earn far more in professions such as engineering and medicine."  

5.10.4 Should academics concentrate on teaching or on research?

This question was asked in an attempt to ascertain the role-expectations of the lawyers from an academic. The results were as follows:

<table>
<thead>
<tr>
<th>TABLE 5.32</th>
<th>Nr</th>
</tr>
</thead>
<tbody>
<tr>
<td>On research:</td>
<td></td>
</tr>
<tr>
<td>I can't decide between the two - academics should do both:</td>
<td>8</td>
</tr>
<tr>
<td>On teaching:</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>

Nr = mentioned by this number of respondents

Although not entirely conclusive, the results showed that a high proportion of the lawyers interviewed considered that research was an important part of an academic's job.

5.10.5 Respondents' views on research for the sake of science as opposed to more applied research

It soon became clear that most of the respondents were unaware of any distinction between pure and applied research. I tried to explain that 'research for the sake of science' was usually done with no immediate practical application in mind, whereas applied research was directed towards solving a particular practical problem. Responses were evenly divided, with 8 respondents in favour of research for the sake of science being performed in Turkey and 7 against (one respondent gave no clear answer). When I suggested that some people considered basic research a luxury for
a country like Turkey, the group of 8 respondents strongly disagreed. (My impression was that their reaction was provoked by chauvinistic sentiments). One respondent who had formerly been a lecturer in a law faculty said: "Scientific research is never a luxury. In time, applications can always be found for research. The private sector should set up a fund to finance basic research." Another respondent said: "To generate confidence in ourselves, we need to train up our own scientists (by implication, through basic research).

Some suggestions for increasing the quality and quantity of (basic) scientific research in Turkey included reforming the educational system, setting up new research institutes, the state's taking an increased interest in research and development and in particular helping to obtain necessary equipment and supplies.

Those respondents who were not in favour of basic research in Turkey felt that research should be directed towards discovering alternative sources of energy, solving problems in the agricultural sector and towards solving other problems associated with the present economic crisis. One respondent considered that the "usefulness" of a research project should be the criterion for its support. Another respondent expressed a desire to see the setting-up of heavy industry in Turkey. "We need to learn to use our own resources," he said. When I reminded him of the difficulties of such a large undertaking, he said that it was all worth it if Turkey was to attain a position of national self-reliance as a result.

I also asked the respondents if they thought that those doing research in physics and chemistry would contribute to Turkey's national development. The unanimous response was "Yes". However, again there appeared to be confusion over what research physicists and chemists in Turkey actually did. When I followed up with the question: "What kind of contribution can they make?" most of the respondents spoke of helping industry or other applied research. Perhaps the question should have been phrased so as to refer more clearly to basic research.

5.10.6 More money for scientific research or more new schools?

I tried to ascertain the extent to which the lawyers regarded scientific research as a priority in Turkey. In the light of the fact that like every country, Turkey had only a limited budget, were the respondents in favour of giving research scientists the money they wanted for more equipment and supplies, or would they rather see that money used to build more primary and middle-schools? Responses were as follows:
I am in favour of opening more schools: 6
I am in favour of supporting more research: 5
I don't think we should have to choose between them: 5
I prefer not to choose: 5

As reasons for their choice, those in favour of opening more schools made such comments as: "Everyone should have the right to an education", "It's necessary to raise the level of the lower classes", "It's imperative to raise the cultural level of the people by giving everyone the opportunity to have a general education", and "For the price of a 10,000 lira piece of equipment, we can give ten people an education".

On the other hand, those in favour of putting money towards research said such things as: "If research is being done, the other aspects of education will take care of themselves", "Quality is important - what's the use of a whole lot of half-educated people?", "We've got too many university graduates out of work as it is; if we increase the number of schools, we're going to have even more educated people unemployed", and "These days nearly everyone sees the importance of giving their children an education, and they are prepared to make sacrifices to do so. But research is beneficial to the state".

In the course of a discussion on education, one of the respondents fired off a salvo against memorization in the Turkish educational system: "In our country, the educational system is based upon memorization. This can't create science. This memorization is due to the way teachers give their lessons and to the lack of facilities for students to do experiments by themselves. Under these conditions, a student does not learn to express himself nor to think for himself."

5.10.7 *Do scientific topics get enough exposure in the media?*

15 out of the 16 respondents thought that scientific subjects in general were inadequately represented in the media. Some of the suggestions included more frequent discussions on topics of scientific interest, programmes on television which would be both educational and interesting and for TÜBİTAK (the Scientific and Research Council of Turkey) to make its activities more widely known. There was a general consensus for the need to arouse a greater public interest in science and scientific activities.

5.10.8 *Tentative conclusions from the lawyers survey*

As mentioned in the introductory remarks on the survey amongst lawyers, the small size of the sample makes any conclusions rather subjective. Nevertheless the following general impressions were given:
1. Among the lawyers interviewed, there was strong verbal support for experimental scientific research in Turkey, even though not many of the sample were clear as to what this involved. Half of those interviewed were in favour of basic scientific research being performed in Turkey while the other half were more in favour of applied research. All of those interviewed considered that research physicists and chemists had a part to play in Turkey's economic development, but some respondents could not describe what that might be. This strong professed support for science was probably influenced by the pro-science ideology within Kemalism. (56)

2. While strong lip-service was paid to scientific research, none of the lawyers interviewed except one was in favour of his or her child taking up a scientific research career if the child had the ability to go into more lucrative professions, or, in one case, into a profession (law) which would best serve the respondent's political interests. The presence of a strong social pressure to obtain well-paying jobs rather than accept material disadvantage for the sake of "ideals" was mentioned again and again. In contrast, 56% of the 55 scientists questioned in the first survey who had children said that they would like their children to become research scientists if they had the ability, while a further 29% wanted to leave choice of career to the child (Q.21).

The interviews among lawyers emphasized how important economic considerations are in career choice in Turkey. Thus 9 of the 16 lawyers interviewed mentioned that one reason why they had chosen to study law at university was that there had been no obligation to attend lectures, which had enabled them to support themselves while studying. Also, although academics receive good pay in comparison to most civil servants, people in other professions such as engineering, medicine and (in many cases) law can make large amounts of money very quickly. Compared to civil servants, academics are quite well off, but compared to the "high fliers" they are not. On the other hand, from the academic scientists' point of view there is a certain degree of security in their job, as well as its intrinsic interest.

3. Several of the lawyers interviewed (5) felt that if a choice had to be made between money for research and money for new schools, research should take priority (This compared with 6 respondents who took the opposite view). This seems to suggest that at least some educated people in Turkey place a high value on scientific research.
4. Although on the part of most young Turks there is an enormous desire to obtain a university degree and consequently the universities are constantly under pressure to admit more students, which in turn increases the teaching load of academics, 8 out of the 16 lawyers interviewed expected academics to concentrate on research rather than on teaching, while a further 6 thought academics should divide their attention equally between them.

5. There was almost a complete consensus that more should be done to popularize and stimulate an interest in science by using the mass media.

5.11 Overall Conclusions from the Two Surveys

1. Before embarking upon the survey of Turkish scientists, I had expected to find a deficiency among them of conceptual and attitudinal conducents due to negative socio-cultural influences. However, the results of the survey indicated that the influence of the latter was rather minimal. The only significant deficiency appeared to be with conducent I1h (and similarly, with conducent I1g), and that only in certain cases and only because of difficulties of communicating with other scientists in the sub-discipline. Negative socio-cultural influences appeared to affect the scientists mostly at the level of motivation. Conceptual conducents were found to be extremely difficult to perceive, however.

2. The impression given by the scientists interviewed was that conducents I1e and I1f (scepticism) were not encouraged by the educational system. The main inhibiting factor appeared to be the prevalence of rote-memory even at undergraduate level. Where the scientists interviewed had strong links with the international scientific community - mainly through having studied or worked abroad - they seemed to have acquired some degree of individual and evaluative scepticism. However, within the local scientific community, it appeared that particularistic factors sometimes entered into the evaluation of research theses. This was partly due to the small size of the Turkish scientific community, as a result of which it was frequently impossible to find sufficient numbers of scientists qualified to evaluate a piece of research within a particular and narrow specialization. The small size of the scientific community may also have been a factor in personal relationships.
being more important than merit, in some cases at least.

3. It is not easy for Turkish scientists to obtain international scientific recognition unless they have spent several years abroad. The practical problems involved in performing research in Turkey and the problems of communicating with peers in the sub-discipline make it difficult to produce a steady stream of good quality research papers. On a local level, scientific recognition is achieved mainly by climbing the three rungs of the academic ladder, which it is possible to do without performing a great deal of research. Obtaining academic titles also results in greater recognition in the wider society. Other forms of local scientific recognition, such as publishing in local journals, are insignificant because of the low quality of the articles published. Thus conducent III seemed to be present only to a limited extent within the local scientific community.

4. There was a general consensus that the educational system tended to suppress curiosity and did not encourage students to apply their knowledge to new situations (although it is possible that this may change with the advent of the Modern Science Curriculum). However, a more important factor affecting the cognitive and manipulative skills of those opting to study physics, chemistry and biochemistry at university was the quality of the intake. Even though the Science Lycee was originally set up to train 100 students per year to go on to do research in basic sciences, nearly all the 100 students who graduate each year with a good basic scientific training choose not to go into a research career because the financial rewards in other professions are so much greater. Some of the scientists interviewed did appear to be different from the lawyers interviewed in wanting to encourage their children to go into scientific research, even though it would mean a lower income than might be possible.

At the postgraduate level, many scientists mentioned the absence of a research tradition, implying that there was a break in the transmission of cognitive and manipulative research skills (conducent IV). Transmission of new skills and techniques appeared to be affected by lack of contact with other peers in the sub-discipline. Moreover, some professors were failing to train new research personnel.

5/6. Formal research expectations are low since they are determined by a university law which has to apply to all areas of knowledge. Informal
role expectations vary from university to university and even from department to department, but everywhere they seemed to be lower than in the West, as evinced by the frequent reference to the absence of a research atmosphere in Turkey. There appear to be few sanctions for not doing much research and few rewards for doing more than expected. In spite of the lawyers' affirmations to the contrary, the teaching role of the academics interviewed appeared to be their primary role in the eyes of the wider society, which expects universities to take on more and more students whether or not the staff is available to teach them and to do research. Idealistic role-conceptions formed outside Turkey are abandoned soon after difficulties with supplies and equipment are experienced upon return to Turkey. Thus conducents V and VI appeared to be deficient compared with more advanced scientific countries.

7. As I had expected, role-facilities (conducent VII) seemed to play an important part in research output, although they varied from department to department and two-thirds of the respondents admitted that in their opinion other factors were also involved in low research productivity in Turkey. Rather than a deficiency in larger pieces of equipment, lack of essential small items and supplies seemed to affect research performance. Such difficulties might be overcome by better co-ordination and planning, including the setting-up of a fund outside Turkey which would be used expressly for small, urgently-needed items.

At the same time, the provision of supplies and equipment and the stability of the research infrastructure such as electricity and power supplies appeared to be strongly dependent upon the wider socio-economic and political milieu. The same was also true for money for subsistence and (the related) time available for research, the availability of trained technicians, access to current literature, and opportunities for information exchange with other scientists.

One surprising result was the small degree of co-operation which appears to exist among Turkish scientists. Not only are scientists in the same sub-discipline scattered across the country, but the system of promotion by examination seems to encourage a tendency to do research on an individual rather than on a team basis. Also, firm demarcation lines between disciplines, exacerbated by the chair system of university administration, discourage inter-disciplinary co-operation. However, at least for
Turkish physicists, the situation seems to be changing. They appear to be gaining more camaraderie through the journal and the expanding activities of the (Turkish) Physics Society.

8. Motivation to do research of an internationally recognised quality seemed to be easily blunted by the practical problems involved. For those who had seen the facilities of scientists in the West, it was discouraging to return to the recurring problems of research in Turkey. Also, low formal and informal role expectations do nothing to stimulate scientists to engage in research. Moreover, that the wider society in general and industry in particular does not recognise that Turkish scientists can be utilized in R and D was an especially discouraging factor to nearly all the respondents.
CHAPTER 6: COMPARISON OF TURKISH SCIENCE WITH SCIENCE IN OTHER SELECTED COUNTRIES

This thesis has focused upon Turkish scientists in a university context. Strictly speaking, therefore, any comparisons made with scientists in other countries should compare scientists in similar contexts. Unfortunately, strictly comparable data is not available, except perhaps in the case of Spain. Nevertheless, some general observations can still be made about science in other countries vis-à-vis science in Turkey. We begin with the Spanish case.

6.1 Science in Spain

Spain is a country whose scientific productivity is not commensurate with its recent fairly rapid economic development. One indicator of such development is the consumption of electricity. De Solla Price and Gürsey have plotted the logarithm of the number of scientific authors against the logarithm of electrical consumption and have found that Spain has a low science / high development position. This becomes even more evident when logs of scientific authors per capita and kilowatt-hours of electricity per capita are plotted. However, Spain is experiencing a high growth rate in numbers of publishing scientists. Thus while in 1967 it was 30th in the world with 277 publishing scientists, in 1976 it was 22nd in the world with 2,064. This compared with 59 publishing scientists for Turkey in 1967 and 206 in 1976, which gave it 41st place in both cases. When growth rates over the period are considered as a function of the size of the scientific community, Spain comes top of all the nations of the world. This may be partly due to more Spanish journals being included in the Science Citation Index data; by 1975 the total was 5. At the same time, that 5 Spanish science journals were thought worthy of inclusion in the SCI shows that their standard must have been high.

A survey undertaken by Blasco among Spanish research scientists and published in 1976 allows opportunity to make comparison with the results of the survey among Turkish scientists. In the early 1970s, Spain had 12 state universities, 3 autonomous universities and 4 under private auspices, with a total student population of 157,000 in higher education. Blasco obtained responses from 597 Spanish researchers from government, university and private industry research institutions working in the fields of mathematics, physics, biology, chemistry and pharmacy. He also performed a separate survey involving 2,000 interviews among non-scientist Spaniards. Blasco reported quite similar results to those obtained in
the Turkish survey.

Some characteristics of Spanish science were the low pay of the staff, a lack of basic materials for the daily functioning of the research laboratories, few or no service contracts of research centres with private industries, large and scattered areas of research, and almost no research by industry. These all characterize Turkish science as well. The salary range of the Spanish researchers was €269 to €4,386 per month compared with the €540 to €900 per month of the Turkish researchers; the upper limit is clearly much higher in the Spanish case, while the lower limit may include those of semi-technician status.

Like the Turkish scientists surveyed, Spanish scientists were generally dissatisfied with their social status. Thus 66% were "very little" or "not at all" satisfied with their social position. For one thing, their pay was too low. This encouraged some scientists to take on auxiliary jobs to augment their salaries. For another, the researchers felt themselves to be alienated from society since they apparently do not fill a social need. Thus 89% thought that "the middle-class Spanish citizen does not care about the amount, volume or quality of the scientific research done in Spain". As for the government, almost half the researchers (48%) considered that it was not really interested in scientific research either, while a further 30% felt that it was only "somewhat interested". 51% of those interviewed wanted research objectives to become more relevant to the needs of society. Thus 11% suggested "collaborating on the needs pointed out by our economic development!", 18% "acquiring our own technology", and 9% "helping with the needs of domestic industry".

In common with Turkish engineers, Spanish engineers generally enjoy a high prestige among the Spanish middle classes. Very few engineers in Spain have chosen a research career. Only 37% of the scientists surveyed would advise their son or the son of their closest friend to enter a scientific research career compared to 37% who would advise him to seek a career in private industry. In the strictly non-comparable question in the Turkish survey, 56% of those asked wanted their child to become a research scientist.

In both countries, although researchers are not rewarded by society, they are not expected to do much research. In Spain, "For both the government and the society it is enough to know that some scientific research centres
exist and that they have buildings and an organisation where 'something is being done'... The researchers are required to do little. No one is really interested in whether they publish or not. Only the personal commitment of some of them impels them to maintain their own standards and productivity... The present situation... produces an enormous amount of tension in almost everyone."(8)

Neither Spanish society nor Turkish society demands much from its researchers. Instead, it expects its scientists to be educators. Scientists who see that little social status is to be gained from high research productivity turn to other roles which can gain them power and prestige. Thus many Spanish scientists prefer university posts to those in government research centres, while others combine a scientific with a political career. Thus Turkish scientists tend to perform the minimum amount of research work necessary to obtain success in the academic hierarchy. Thus in both countries university professors allow themselves to take on too much teaching and become involved in much bureaucracy and internal politics.

In such a context, it is no surprise that particularistic factors affect promotion. Almost half of Blasco's sample mentioned extra-professional factors as being decisive in professional success. The following factors were identified as ensuring a researcher's fast success: acquaintance with influential people (54.7%), ability to get alone (18.1%), being a "good mixer" (16.1%) and good luck (14.2%). In the Turkish case, particularistic factors were mentioned by 57% of the scientists interviewed as being important in the evaluation of research theses.(9) "Good luck" was mentioned by a few respondents spontaneously but did not figure as highly as in the Spanish case.

Blasco also investigated the question of religion versus science in the Spanish context. 83% of Spanish researchers saw no conflict between religion and science; only 10% thought some problems still existed. In Turkey, scientists were asked whether they thought religion had had a negative influence upon the development of science in the country; 57% thought it had not. Blasco found that the most productive Spanish scientists tended to be indifferent towards religion, although some religious scientists were very productive. He concludes, "So we cannot actually say that in the case of Spain religious fanaticism is a serious obstacle to the development of scientific research... The causes [of the poor situation of science in Spain] are more complex and affect believers..."
and non-believers equally". The same could be said of Turkey since 1923 but not before that.

In general, Spanish research scientists do not appear to be motivated by any deep personal desire to advance the cause of science. When asked what the motivating factor was of their colleagues in doing research, \(36\%\) replied "advancement in authority and rank within the institution", \(30\%\) "desire for their knowledge to be made use of" and \(20\%\) "desire to earn a good salary". Although this question was not asked in the Turkish survey, the sentiments of the Spanish responses ring true for there too.

Another similarity between scientists in Spain and Turkey was an enormous mount of frustration. \(80.4\%\) of Spanish researchers declared that they had seriously thought of abandoning their present employment in scientific research. Of those employed at universities in Spain, \(44\%\) wanted to emigrate. Of those who had visited foreign research centres and who had had the opportunity to stay abroad (59.4% of the sample), \(70\%\) thought they would have become more productive had they gone abroad; \(41\%\) thought they would have benefitted economically; \(34\%\) thought they would have had better equipment and a better general scientific environment; and \(32\%\) thought they would have had "improved scientific and intellectual work conditions". Thus not surprisingly Blasco deduced that the greatest single factor affecting research productivity was spending time in research centres abroad. However the Spanish scientists tended to go abroad for shorter periods than their Turkish counterparts. Half of the 55.3% who had been abroad to study or to work stayed for only 3 - 6 months, mostly to learn new techniques.

Thus there are close similarities between the Spanish and the Turkish scientific research communities. In both cases there are few demands on research scientists, but also few rewards. Pay is thought to be low and social status likewise. Neither Turk nor Spaniard feels he fulfils a social need as a researcher. He has the impression that no one is really interested in what he does. No one is interested in the level of scientific productivity. For most of the rest of society it is enough to know that there are buildings and an organisation where something is being done.

The main requirement of both societies is that its children be educated. Since by and large research objectives are irrelevant to the needs of each country, there is little opportunity for ordinary citizens to appreciate...
the worth of the research being done by its scientists.

In both cases, a small proportion of researchers struggle on in their efforts to perform first class research. Their motivation is not sharpened by the observation that promotion is not by scientific merit alone. Both scientific communities experience tremendous frustration at their comparatively low pay and poor facilities. Such frustration becomes all the more acute when visits are made to countries where scientists have very good pay, high social status and superb facilities.

Unfortunately, Blasco did not deal with the question of why Spain has enjoyed such a high growth rate recently in numbers of scientific publications. Perhaps this was a consequence of the general loosening-up which came in the last years of Franco's life. It may have been that more resources were diverted to scientific research in the universities or the research institutes or both. If that were so, it would contrast with the situation in Turkey in which over the same period support for science in real terms only increased after 1972 while foreign exchange for the purchase of essential supplies and equipment became increasingly scarce.

6.2 Science in Israel

In 1976 Israel came fifteenth in the world in numbers of publishing scientists with a total of 3,537. When the numbers of publishing scientists are plotted against the number of kilowatt-hours of electricity consumed, Israel occupies a highly anomalous position compared to the main trend, a position which may be described as having high science in relation to low development. When scientific authors per capita are plotted against kilowatt-hours of electricity per capita, Israel still occupies an anomalous position and comes top of all the nations of the world.

The high productivity of Israeli science is attributable to several factors. Israel is a nation with few natural resources surrounded by hostile nations. It has therefore been keen to develop its own defences and armaments and to utilize science and technology in so doing. Science has also been seen as a national resource which could lead to a better society and increased economic independence. Also in earlier days when Israel was less isolated from the other countries of the world, scientific and technical assistance was regarded as one method by which Israel could gain friends for herself. Moreover Israeli science has benefited from the persecution of Jewish
scientists in Europe and from immigration for more normal reasons. Scientists who have emigrated to Israel have often had strong links with scientific institutions in their countries of origin, and these links have been maintained and strengthened over the years. Israel has also been the recipient of large sums of money which have been sent by Jews outside Israel to build up the universities. As a result, the seven Israeli universities are extremely well equipped for research. An overriding factor in Israeli science had been the powerful Zionist ideology that the land can and should be developed and restored. This has reinforced the traditional Jewish reverence towards learning and the desire to educate one's children.(16)

By contrast, in Turkey the mass of the people have only recently come to see the value of secular education, and then only for economic reasons. A secular education has not been seen as having value in itself but as leading to a good job. Also, Turkey has never had groups of highly educated and professionally trained personnel such as emigrated to Israel from Central and Western Europe and from America in the 1930s and after 1949. Moreover, Turkish scientists have tended to remain isolated from the world scientific community, except perhaps in the 1960s and early 1970s. Also in the Turkish case, education and even research have been the means for obtaining academic and professional credentials rather than as ends in themselves. This has been reflected in the comparatively poor support which has been given to research facilities and research personnel.

Traditionally, Israeli science has been strong in the basic sciences. The Directory of Scientific and Technical Associations and Institutes in Israel does, however, list 52 industrial R and D laboratories besides 68 other institutes, stations and research laboratories. (17) One of the latter is the "Yissum" Research Development Company which was set up in 1964 "to encourage applied research at the Hebrew University of Jerusalem, promote its industrial utilization and exploit Hebrew University patents". Another organisation, the Authority for Research and Development of the Hebrew University of Jerusalem, initiates and coordinates research projects carried out at the University, arranges research contracts with government, private and public agencies, and obtains and maintains interdepartmental equipment and facilities.

When the State of Israel was established in 1948, three academic institutions were in existence at which 2,000 students were taught by an academic staff
of 300. In 1973, after 25 years, 50,000 students were being taught by 7,600 academic staff in seven institutions. (18) The number of students in higher education rose from 1,700 students per million of the population to 17,000 per million. The seven institutions of higher education are the Hebrew University of Jerusalem, the Technion or Israel Institute of Technology, the Weizmann Institute of Science, Tel Aviv University, Bar-Ilan University, the University of Haifa and Ben-Gurion University in the Negev. For research purposes, the Weizmann Institute is perhaps the most renowned. In 1973, it had 600 masters and doctoral students and about 470 full-time scientists in a staff of over 2,000. The Institute attracts as many as a hundred foreign scientists a year to work in its laboratories for varying periods of time. It is also the venue for international scientific conferences, including the Rehovot Conferences. Several science-based industries have been set up near the Institute, while the Yeda R and D Company deals with the commercial promotion of some of the more industrially promising research projects developed at the Institute.

Government spending on research concentrated on academic fundamental research in the 1960s. For example, in 1964 the Weizmann Institute had a budget of $7 million while the total expenditure by government and industry on industrial research was about $3.7. The National Council for Research and Development, created in 1959, has tried to change the pattern of research expenditure in three ways. It has organised joint investment by government and industry in specific development projects within plants, as proposed by the companies concerned. Also, it has encouraged the development of an area of technology or basic research which is important to particular sectors of the economy. Third, it has set up centres to develop long range industrial research on a larger scale than would be possible in individual plants. It is hoped that such policies will reverse the adverse technological balance of payments: between 1960 and 1965, Israel sold know-how worth $1 million and bought know-how for $8 million. The Council also encourages research in the agricultural and medical sciences.

Research on defence in Israel has been described as constituting "the largest research establishment in the country". (19) It includes the Research and Planning Department, the Authority for Weapon Development, and Israel Military Industries, which are under the jurisdiction of the Ministry of Defence. Some research is contracted out to various industries, and this has provided impetus to applied research. Its counterpart in Turkey has been heavily dependent on American aid and has only begun to contract out research since the arms embargo which followed the invasion of Cyprus in 1974.
There is great potential for science and technology in Israel. According to one observer, the Israeli people "eagerly adopt innovation" and have "a love of rationality" and "the capacity to plan" which "coexist with great adaptability and a proneness to pragmatic improvisations". Nevertheless they lack faith in research as an activity which will reap economic dividends. If they can obtain this faith, we may expect a more productive marriage of science and technology in Israel.

6.3 Science in Egypt

In numbers of publishing scientists, Egypt came 28th in the world in 1967 with 293 and came 32nd in the world in 1976 with 731. Its growth rate in number of publishing scientists was therefore unexceptional. Its actual publication level corresponds more closely to those of DCs than to those of LDCs, according to Davidson Frame's predictions. When the numbers of publishing scientists per capita are plotted against the number of kilowatt-hours of electricity per capita, Egypt occupies a position corresponding to high science and low development, although to a much lesser extent than Israel does. In 1976, Egypt had three and a half times the number of publishing scientists that Turkey did.

It is somewhat surprising that this should be so, especially since the revolution in Turkey took place 30 years earlier than in Egypt. Both countries have strong Islamic roots, and a similar but burgeoning population. Both countries have enlisted the aid of science in the furtherance of the revolution. Thus the United Arab Republic Charter drawn up in June 1962 read as follows:

"Science is the true weapon of the revolutionary will. The responsibility of the universities and scientific research centres in shaping the future is not less important than the responsibility of the various popular authorities. Without science, popular authorities may inflame the enthusiasm of the people. With science alone can they hope to realise the demands of the people. Therefore, the universities are not ivory towers but rather forerunners discovering a mode of life for the people.

"Our ability to master the various branches of science is the only way left us to compensate for underdevelopment."
If the national struggle reaches our advanced science, it would have a greater opportunity for progress.

"The major economic and social problems confronting our people at present must be solved on a scientific basis ..."

"The scientific research centres are required at this stage of the struggle to develop themselves so that science would be in the service of society. At this stage, science for its (own) sake is a responsibility which our national potentiality cannot shoulder."(24)

Perhaps there were advantages in having a revolution later in time. There was more of an educational system to utilise and there was the example of at least one country, Japan, which had made it to the ranks of the developed countries by means of its own technical and other expertise. Moreover more substantial financial support could be given to science and greater demands made of research scientists.

The first Egyptian state university was founded in 1925 from an amalgamation of most of the existing private colleges. Between then and the late 1960s, 3 more state universities and over 40 institutions of higher education were opened. By 1975 the number of state universities had risen to 10. Enrolment in higher education saw a tenfold increase between 1945 and 1965, to 150,000. In 1975, this number had become 200,000. (25) Support for the universities comes almost entirely from the state. As in Turkey and in many other LDCs, a university education carries a high social status; Egyptian parents will not willingly send their children to a technical or agricultural school, but prefer them to go to academic secondary schools followed by university and a position of importance in the civil service.

Problems in Egyptian universities parallel those in Turkish universities. (26) There is an emphasis on teaching and rote-memorization, with high student-teacher ratios. Academic staff are sometimes removed for political reasons when there is a change of government. Graduates often find difficulty in obtaining jobs, especially in fields associated with their fields of study. Scientific and technological subjects are underemphasized while humanistic, legal and other more "theoretical" studies are given great prominence.

The first body to coordinate and promote science on a national scale was
set up in 1939, when the Fouad I National Research Council was formed. The Council's brief was to "initiate, encourage, control and coordinate all scientific research for the improvement of agriculture, industry, the national economy, public health and defence". It was also responsible for conducting research and for establishing general and applied research institutes. The Council was not very active during the war years and the first director was not appointed until 1947.

The leaders of the 1952 Revolution showed considerable interest in science. A National Research Centre and an Atomic Energy Establishment were founded in 1955, and a Science Council was set up in 1956. The National Research Centre was soon to become a multi-purpose laboratory performing research in chemistry, applied physics, medicine and agriculture. Nothing comparable to this was to appear in Turkey until 1972. In its first year of operation, the NRC instigated 47 research projects and supported 40 other projects at various other Egyptian institutions. Initially the emphasis was on projects in the applied sciences which had some relevance to the national economy. However, this aim does not seem to have been realized, for the 1972 NRC Report admitted that little had been done to create effective links between the NRC units and the productive sectors of the economy. The activities of the NRC are regulated by ten committees whose members come from universities, industry, the civil service and the NRC itself. By 1977, the NRC had a staff of 1,112 research specialists, and an annual budget of over half a million dollars.

Between 1958 and 1960 the Science Council organised the drawing-up of a five-year plan for scientific research for the period 1960-1964. Some 3,000 Egyptian scientists took part in 58 planning conferences at which 117 topics with some bearing on the national economy and on scientific progress were selected. These were examined by 170 experts and reports written on each topic. The reports contained suggestions for research projects, estimates of the cost of such and an indication of the relative priority of each topic. The total budgetary estimate for the plan was about $46 million. In the event, about half of the funds required, or $20 million were given between 1960 and 1964. According to one observer, the plan favoured academic and basic science studies because it had been drawn up by academics, but it was "definitely a landmark in the history of science organisation and policy in the U.A.R.".

In 1961 the Science Council was abolished by President Nasser and replaced
with a Ministry of Scientific Research. This was superseded by a Supreme Council of Scientific Research in 1965. The Ministry of Scientific Research was reinstated in 1968, to be followed in 1971 by an Academy of Scientific Research and Technology, which now exists alongside a State Ministry of Scientific Research and Atomic Energy. So many changes did not assist the execution of the five-year plan. Nevertheless, the percentage of the Gross National Product used for research rose from 0.18% in 1959-60 to 0.48% in 1962-63 and 0.83% in 1973. (30)

Education in general has been fairly vigorously developed since 1952. In 1967, a special drive was made to develop higher education. Over 2,000 students were sent abroad for further studies during the period of the five-year plan. The aim was to fill the gaps in scientific personnel which existed in various scientific sub-disciplines. One unfortunate side-effect of sending students abroad was a brain-drain, which resulted in the departure of 148 Egyptian scientists in ten years. At present the number of students per year sent abroad for graduate work is about 600, together with about 200 postdoctoral trainees who go abroad for periods of six to twelve months. Inside Egypt 200-300 scholarships a year are awarded by the NRC and other research institutions to university graduates, who have to show their abilities over a period of one or two years before they are taken on as assistant researchers.

At the universities there are about 150 departments where scientific research is conducted. Besides these there are about 77 government research institutions of various kinds. Of these, 8 are major research institutions including the NRC and the Atomic Energy Establishment under the jurisdiction of the Academy of Science and Technology. The remainder are research institutes and centres attached to the Ministries of Agriculture, Irrigation, Industry, Public Health, Planning and Social Affairs. There is also a National Scientific Information and Documentation Centre and a Scientific Instrumentation Centre, both under the jurisdiction of the Academy.

The Academy has set about trying to identify some of the main problems facing the realization of national socioeconomic plans, problems to which practical solutions could be found by research efforts. Its 14 specialized Research Councils have studied various research proposals for dealing with such problems and have endorsed 70 of these for 3-5 year periods. About $2.7 million were allocated and spent in 1974 and about $1.8 million were
allocated in 1975. Each project was set up according to a contract made between the Academy and the main research organization in charge. Progress reports had to be regularly submitted and reviewed but the projects were largely free of red tape. While most of the funds were directed to projects related to national development, about 20% of the funds were given to strengthen the science base. (31)

Egypt has thus had a number of advantages over Turkey in the area of science development. First, it has had the National Research Centre since 1956. In Turkey the only comparable research institution is the Marmara Research Institute which was not built until 1972. Second, in Egypt there has been a far greater financial commitment to science than in Turkey. This began with the $20 million given in the first five-year plan in 1960-64, money which was over and above the normal funding to the universities and research institutes. In the early 1970s, the Academy provided funds for specific research projects and for strengthening the science base. In Turkey, outside the universities and government research institutes, funds only became available for additional scientific research after TÜBİTAK had been founded in the mid-1960s. Third, in Egypt there have been far greater efforts to link scientific research with the goals of national development. Although these efforts have not been altogether successful, they have produced some demand for scientific research.

6.4 Science in India

In 1976, the number of Indian scientists who published in journals scanned by WIPIS was 8,120. (32) This gave India the eighth highest number of publishing scientists in the world. India is far ahead of any other LDC. It had nearly nine times as many publishing scientists as its nearest LDC rival, Argentina. India is, therefore, a scientific giant among other LDCs.

The development of science on a large scale in India is a fairly recent phenomenon. (33) By the middle of the nineteenth century, the teaching of western mathematics, physics and geography had spread to most of the Indian colleges. Medical studies were also established in various institutions, which led to some support for chemistry, botany and natural philosophy. Between 1857 and 1902, five new universities were created and almost 100 new colleges. However, there was little accomplished in the way of scientific education and research at the university level. Moreover,
Indians were not welcome in government departments where scientific and technological activities were being performed. Nevertheless, several scientific societies were founded. Later after the turn of the century, important work was done in the science departments of universities by such men as Bose, Raman, Saha, Ramanujan, Ray and Bhabha.

Despite these contributions, by and large the widespread acceptance of Western science was inhibited by three factors: it was geared to the needs of the British rulers, it emphasized the teaching of results rather than creating an appreciation of science as an instrument for intellectual and social transformation, and it was introduced in English. Thus it became associated with the rulers and did not find acceptance with the different strata of the population. On the other hand the widespread use of English in India meant that Indians had access to one of the leading scientific languages of the world and to a strong scientific research tradition.

Following independence in 1947, science in India was given considerable support by Prime Minister Nehru. The result was the creation of an extensive institutional network and a chain of research laboratories, and the expansion of university and technical education. The Science Policy Resolution of 1958 summarized the extent to which the national government put its faith in science. Aim 6 read as follows: "In general, to secure for the people of the country all benefits that can accrue from the acquisition and application of scientific knowledge". Scientific activity in India accelerated after the passing of the Resolution. Thus total expenditure of R and D rose from $36 million in 1958 to about $270 million in 1972, and the number of people engaged in research from about 21,000 to about 100,000 over the same period.

The 1958 Resolution linked national prosperity to the combination of technology, raw materials and capital, with technology - which 'can only grow out of the study of science and its applications' - as the most important. Science was therefore firmly linked with economic development. Steps were then taken to implement this with the setting up of a number of research institutions outside the universities. In Turkey, however, science was far more of an ideology and until quite recently was almost always performed inside the universities. Science in India, then, was encouraged to have more of an applied bent than it was in Turkey.
The Indian government assists the following organisations to engage in scientific research: the Council of Scientific and Industrial Research (CSIR), the Department of Atomic Energy, the Indian Council of Agricultural Research (ICAR), the Indian Council of Medical Research (ICMR) and the Research and Development Organisation of the Ministry of Defence. There are also a number of research institutes attached to various ministries and to public sector agencies.

The CSIR is much larger than its Turkish counterpart. It supervises thirty research institutions, including four regional research laboratories which busy themselves with problems of industrial development in their respective areas. The CSIR laboratories look at problems of an applied or mission-oriented nature. This has resulted in the following over the past 25 years: over 400 processes for industrial application, nearly 10,000 research papers and about 1,200 patents. In contrast, TÜBİTAK has only a couple of fairly recently-opened research institutes and these have yielded few industrial applications. Like TÜBİTAK, the CSIR awards research grants to university departments and research institutions - 627 to various projects and 2,294 to individual scientists in 1969. Since like Turkish industry, Indian industry has few concerns which can afford to maintain their own research departments, the CSIR has established nine cooperative research laboratories associated with various branches of industry.

India has already exploded its first atomic bomb. The Department of Atomic Energy (DAE) is responsible for a number of research centres, including those which work on physics, electronics, space science and biomedicine. Considerable resources are put into the Defence Research and Development Organization which was set up in 1962. This is responsible for 31 R and D establishments, and a documentation centre. The emphasis is on utilizing indigenous materials and products for defence purposes. The Turkish armed forces support only two or three similar establishments at the most.

Research in India is also performed at a number of private research institutions. These receive some assistance from the government in addition to endowments from scientists and philanthropists. There is nothing comparable to this in Turkey. The best-known of these institutes, such as the Tata Institute of Fundamental Research (Bombay) and the Indian Association for the Cultivation of Science (Calcutta) produce very high quality work.

A survey was undertaken recently among 78 scientists working at ten of the
most highly esteemed centres of research in India, including two private institutions. (37) The scientists interviewed were all working in the fields of elementary particle physics, solid state physics, physical metallurgy and materials science. The findings of the survey had some similarities to my own findings among Turkish academic scientists.

Thus, Indian scientists suffer from a sense of isolation from both the international scientific community and from fellow-scientists in India. Because of poor communications and the large number of sub-specialities, there are few people in India with whom problems can be shared. This leads to comments found in the Turkish case, such as "There is no scientific community in this country". Moreover, Indian scientists do not recognise scientific research done within India as much as outsiders do. This is true outside the universities, too. Thus there is no esteem for Indian research by putative users outside the universities and research institutes. When research scientists learn that their work will never be utilized by industry, they respond by opting to do basic research. Indian research scientists also face similar problems with supplies and equipment as their Turkish counterparts do: a shortage of qualified technicians, a thousand difficulties involved in importing spare parts and a lack of the latest equipment. Research choices are therefore limited by what can be done with the equipment available. Also the choice of Ph.D. topic is often decided abroad and then is quite unsuitable for pursuing in India.

Indian scientists also find some tensions over the social usefulness of their work: "Generally, Indian scientists would like to be scientific and useful. They are burdened by a sense that they are neither and they are apprehensive lest in trying to become useful as the various schemes of 'alternative science' have recommended, they will become less scientific." (38) The science planners either give them goals which are too broad such as the elimination of poverty, or so narrow that no research programmes can ever ensue.

Soon after independence, the government of India decided to promote scientific and technological research through the national laboratories of the CSIR and the DAE. This reflected the lack of confidence of the leaders of the new government in the research capacity of the universities. The result has been to isolate the universities further from the main stream of Indian scientific life. Thus despite the more than 70 universities and
1 million undergraduates, the academic sector receives a much smaller proportion of the total R and D funds than it does in most countries with large university populations.

In the Indian universities, there is a tradition of disdain for research. Most Indian academics do little or none. (39) The M.A. and M.Sc. are obtained by examination and not by successful completion of research. Academic scientists who wish to do research usually join one of the research institutes where the pay and facilities are better. Those who stay in the academic world and who try to perform research are faced by many difficulties including lack of finance, government red tape in importing equipment, academic hierarchies which discourage research initiative, and lack of communication or contact with scientists abroad and scientists in India. Thus "few Indian professors produce new works after their first research thesis". (40) Moreover, like their Turkish counterparts, Indian academics have heavy teaching loads, book-bound curricula, pay which is so low that it has to be supplemented, and students whose interest in the topic is blunted by the language barrier and by the prospect of no job in which they can utilize their knowledge. (41) Indian academic research, like Turkish academic research, is almost totally non-applied in its subject-matter.

A survey which included 835 academic scientists in the sample of over 2,000 reported that "In the context of our present economy, the Indian scientist is by and large a very poorly paid professional, especially in comparison with his counterparts in the developed countries of the West" and that "If given a choice, Indian scientists would prefer most to work in a research institute or in a university laboratory in a foreign country". (42)

In looking for the strengths of Indian science, we should not forget a population of 14 times the size of Turkey's, with over 2 million people in higher education alone. Then there are the research institutes, both government and private, which have received considerable financial backing. In contrast, Turkey has only three or possibly four research institutes which are more than testing-stations. This difference is due to the considerable support given to science by Nehru and his colleagues after independence, that is, many years later than the initial comparatively small support given to science by the Turks. Another great advantage the Indians have over the Turks is that English is very widely used and moreover that there are very close links between research centres in India and research centres in Britain and America.
6.5 Science in Japan

The Turks tend to look at Japan with great admiration as a nation which has finally achieved modernization, and which is now beating the industrial and technical giants of the West at their own game. According to Davidson Frame et al., Japan was sixth highest producer of science in 1973, (43) a position affirmed by de Solla Price and Gürsey, (44) and by Kovach, (45) on the basis of *Who is Publishing in Science* data for seven years and ten years respectively.

One reason for the swift development of science in Japan was that after the Meiji Restoration in 1868, there was little resistance to the introduction of "Dutch learning". Even the samurai elite took to modernisation surprisingly well. The Japanese were used to cultural borrowing, and they welcomed new knowledge and ideas, especially when these held out the promise of military superiority. In contrast, the Chinese (and the Ottoman Turks) were convinced of their moral and intellectual superiority. (46) The Japanese also had no religious inhibitions about adopting Western scientific knowledge. Thus secular education developed very quickly; as early as the mid-nineteenth century, 40-50% of Japanese boys were in formal education (10-15% girls), and by 1905, the figure had risen to over 95% (93% girls). (47) Moreover, there was a strong emphasis on the learning of mathematics and science. In the 1870s and 1880s, mathematics and science occupied one third of the primary school curriculum in the first four years, and two-thirds in the second four years. (48) In contrast, in Turkey the percentage enrolment in primary schools had still not exceeded 70% by 1950 (Table 4.15).

Another important difference between the two countries was that Japan was homogeneous culturally and linguistically whereas Turkey was not. Thus the Japanese did not have to expend energy on developing a nation state, whereas the Turks had to occupy themselves with legal, linguistic and other reforms. The Japanese also had an important geographical advantage; they were distant enough from the Western nations to be able to make objective evaluations about what was best for them. Also, during the Second World War, Japanese scientists were forced to break their psychological dependence on Western scientists. (49) The Turks, however, were on the door-step of Europe and had had cultural links - however tenuous - with various European countries for more than two centuries, which made objective evaluation rather more difficult.
Also, there was a quantitative difference between the modes of introduction of science in the two countries. In Japan, foreign teachers were brought in quickly and in large numbers, and a large number of students were sent abroad for higher education. In less than twenty years, most of the foreign teachers had been replaced by Japanese scientists returning from training abroad. The period (the 1870s and 1880s) was particularly propitious for the transmission of science since a few scientists were able to know a great deal about a rather wide field of research. In contrast the Turks brought in fewer foreign teachers over a longer period of time and at a period when science was expanding rapidly in the West and was entering the era of "Big Science". Also, the Japanese did not rely too much on any one nationality, whereas until the 1960s the Turks were strongly under German academic influence, which resulted in the formation of formal academic hierarchies, strict demarcations between disciplines, and the institution of the docentship system.

Another important difference lay in the understanding of the word "science". For the Japanese, "science" and "technology" were really the same word, and so "science" acquired a utilitarian connotation. This was reinforced by their pragmatic view of science, namely that it should be utilized in the national interest, if not purely for economic gain. Hence they had a strong emphasis on physical and applied science. Thus over half the students at Tokyo University until 1920 were studying pure and applied science. In Turkey, however, "science" had a much wider meaning, closer to "scholarship". The Turks were influenced by German ideals of the pursuit of knowledge for its own sake, and natural science and technology were put on a par with other academic disciplines such as language, history and geography. The latter three disciplines were also emphasized because they fitted in with the Kemalist drive to create a modern nation-state which would be independent of the domination of Islam.

Japan also differed from Turkey in being able to recruit large numbers of able people to study science and engineering. When the stipends of the samurai were curtailed by the government, many of them were attracted into academic research since this was more respectable than business or agriculture. Thus, almost all the early graduates of the engineering college were samurai. In early Republican days in Turkey, however, the elite were attracted more into subjects such as law and political science which led to prestigious positions in administration.
Furthermore, there were significant differences in the levels and nature of financial support for research. Initially the Japanese government set up research institutes and other establishments, strongly motivated by military considerations. Later, the private sector took on more and more of the financial burden of research especially from 1959 onwards. The private sector, of course, in a strong position to do so, and was discouraged from over-reliance on one nation or on foreign companies by government prevention of foreign capital and foreign loans. In contrast, Turkish private industry did not become strong until about the 1960s and even then only through foreign capital. Thus many of the large private companies showed no inclination to sponsor research, preferring to pay licence fees on new products offered by the parent company.

While the real strength of Japanese science lies in its ability to produce technological innovation, a large amount of research is also undertaken at Japanese universities. These sponsored the majority of the 15,847 scientists who published scientific papers in 1976. A postgraduate programme developed within twenty years of the Meiji Restoration, in 1884 when the University of Tokyo was renamed the Imperial University. A similar programme was not to appear in Turkey for another 50 years.

The Imperial University was not bound by Western examples of choice of faculties. It had a Faculty of Technology, the former College of Engineering, and a Faculty of Agriculture, the former Higher Agricultural School, in addition to Faculties of Medicine and Science. This system was copied by other universities in later years. In nearly every case, faculties were formed which would benefit industry in some way.

Thus in 1897, the Kyoto Imperial University was established with a Faculty of Science and Technology, and a Department of Civil Engineering. A year later, other departments including those of Applied Science, Electrical Engineering, Mining and Metallurgy were opened. In 1911, Kyushu Imperial University was inaugurated, with Faculties of Medicine and Engineering. Faculties of Agriculture and Science were opened in 1919 and 1939 respectively. Tohoku Imperial University also opened in 1911 with two faculties, those of Science and Agriculture. Osaka Imperial University, established in 1931, had a Faculty of Engineering and Japan's second nuclear laboratory where Dr. Hideki Yukawa, one of Japan's few Nobel prizewinners, was lecturer. Nagoya Imperial University opened in 1939 with faculties of Science and Medicine.
These universities produced graduates who were well able to apply their
knowledge in industry. Moreover, they incorporated various research
institutes where research of an applied nature was performed. As early as
1918, research professors and assistant professors with the same status as
their university counterparts were appointed to undertake research full-time
in the Aeronautical Research Institute attached to Tokyo Imperial University.
In contrast, in Turkey the first faculties offering technical expertise
were not opened until 1944, and the first research institute employing full-
time research professors until 1956.

6.6 Science in Brazil

Between 1967 and 1976, after Spain Brazil had one of the highest growth
rates in the number of scientists who published scientific papers in well-
known scientific journals. By 1976, it had overtaken Argentina and
moved up to 27th position in the world rankings with 1,253 publishing
scientists. This compared with 206 for Turkey. The number of
scientific papers produced by Brazilians increased sixfold between 1967 and
1976. This was mainly due to the creation of new graduate programmes in
the universities and to the far greater allocation of money to research
since 1968.

Thus, while in 1964 there were graduate programmes only at the University
of São Paulo and a few other places for a small number of students, by 1977
there were about 600 graduate programmes at 30 universities and independent
institutions throughout Brazil. One third of these led to doctoral degrees.
The number of undergraduates has also increased sharply: from 212,000 in
1968 to more than one million in 1977 at about 60 universities and 800
separate institutions of higher education. Money spent on research and
development has increased significantly by means of two Basic Plans for
Scientific and Technological Development which allocated $323 million for
R and D in 1973, rising to $824 million in 1977. This compares with less
than $40 million for the total federal resources for science and technology
in 1971. This vast increase in resources has meant that Brazilian research
scientists have for the most part been able to enjoy improved research
facilities and equipment.

Scientific institutions in Brazil are of comparatively recent origin. The
Brazilian Emperor, Pedro II (1840-89) was an enthusiastic supporter of
modern technology, and he brought foreign scientists to the country to found some research institutions such as a mining school and a national observatory. However, with the establishment of the Federative Republic in 1889, these institutions were looked upon with disfavour and new ones started with much more practical goals. The founders of the Republic, like their Turkish counterparts, were much influenced by Comtian positivism which had a pervasive influence in Brazil amongst the educated elite; those who espoused positivism were generally anti-clerical and in favour of science.

Science in Brazil gained public support quite early on when it demonstrated the practical benefits which science could bring. Two bacteriological institutes founded at the turn of the century were instrumental in combating malaria, yellow fever and other contagious diseases. One of these, the Instituto Oswaldo Cruz in Rio de Janeiro acquired an international prestige which lasted for 20 years or more. In 1927, a biological institute was founded which achieved a striking success in identifying and controlling a very destructive blight in the coffee plantations. Medical Schools, one of which was supported by the Rockefeller Foundation, were also successfully established. In contrast, in Turkey indigenous science has never really demonstrated to the public at large its ability to solve practical problems, except perhaps in the field of medical care.

Another feature of Brazilian science has been that it has maintained close contacts with centres of scientific excellence outside the country. An early example was the Instituto Oswaldo Cruz which maintained close links with the Institut Louis Pasteur, where Oswaldo Cruz himself was trained. The University of São Paulo, founded in 1934, set out to attract a staff of well established foreign scientists who were expected to do their own research, train students and set up research laboratories. An outstanding group of mathematicians and physicists was brought over from Italy and two German professors were brought in to the chemistry department. The fruit of this can be seen in the later productivity of this independent and active centre of scientific excellence. Thus out of 988 articles published by Brazilian scientists in internationally recognized journals in 1974, 234 were from the University of São Paulo alone.

The Faculty of Medicine at the University of São Paulo obtained financial support and advice from the Rockefeller Foundation, which encouraged the
introduction of the American model of medical teaching. There was also close cooperation with the John Hopkins University School of Hygiene and Public Health. During the Second World War, the Rockefeller Foundation provided fellowships in physics, chemistry and genetics. After the war, the Technological Institute of Aeronautics was established by the Brazilian Air Force in close cooperation with American institutions along American lines. In the late 1930s a number of Brazilian physicists were sent to Europe and the United States to work with some of the best scientists in the field. European physicists were also encouraged to take up research and teaching posts in Brazil. In 1975, the Federal German Republic signed an agreement with Brazil to assist in its atomic energy programme at a cost of 10 billion dollars over a period of 15 years. There was also an attempt to set up centres of scientific excellence; a joint programme was developed in chemistry between the Brazilian National Research Council and the National Academy of Sciences of the United States. Also, large numbers of Brazilian students were sent abroad to study at foreign scientific institutions. In 1977, for example, the figure was about 2,000 students on government supported scholarships.

In Turkey, although some scientific institutions were set up with outside assistance and although Jewish scientists fleeing from Nazi persecution were given university posts, in general there has not been the same tradition of close cooperation with foreign scientists and with scientific centres outside the country. Such cooperation has been hampered by lack of foreign exchange and communications difficulties.

Although science in Brazil was initially positivistic and anti-clerical in nature, it was not used by the authorities as a weapon against religion as it was in Turkey. There was thus opportunity for science to gain public credence, especially when it was seen to counter contagious diseases. Nevertheless, "Historically, science was not a career normally chosen by the children of the Brazilian upper classes, or the most ambitious of the lower and middle classes. Brazilian scientists, more often than not, came from immigrant and scattered intellectual families". This may have been because, as was the case in Turkey, a scientific career did not offer much economic advantage.

Since early 1970s, there has been a great influx of support for science in Brazil. As early as 1960, the state of São Paulo had allocated 0.5 per cent of all state tax revenues for the support of scientific research projects.
Also, in 1964, Brazil's main investment bank established a National Technological Fund which in its first 10 years provided about 100 million dollars for research and graduate training in engineering, the basic sciences and related fields. The Fund created an ambitious graduate programme in engineering covering 11 fields of specialization. From 1964 to 1977 about 1,000 masters and 25 doctoral degrees were obtained by means of grants funded by the programme. Its own curriculum and research projects were decided in a very flexible way, in contrast to the restrictions encountered in the Brazilian public universities. Foreign professors were invited to Brazil and the best Brazilian students sent abroad for further training. There is no equivalent of the programme in Turkey. In comparison to the $824 million spent on Brazilian R and D in 1977, for Turkish R and D the figure was about $380 million. (65)

The Brazilian Scientific and Technological Development Plans have brought some problems in their wake. One is the greatly increased number of new institutions, commissions and grant-awarding bodies which involve scientists in large amounts of paperwork and considerable delay. Final decisions are often taken by civil servants and politicians, who do not have to justify their decisions in public. The National Research Council (CNPq) is one body which transfers resources to the institutes under it and also allocates research grants to various projects.

Universities in Brazil experienced drastic reforms in 1968. A law was passed which provided for the establishment of central institutes and departments in place of independent professional schools; a common basic course was created; the university entrance examinations were organised on a regional basis; "course credits" replaced the traditional university "years" system; universities had to accept unqualified students if they had places for them; and graduate programmes along North American lines were created. A law was also passed which made academic promotion dependent on the obtaining of a higher degree. The result was that graduate programmes attracted the best teachers, students and good resources, while at undergraduate level there was a flood of unqualified students into the universities and a subsequent deterioration in undergraduate education. Thus although undergraduate courses suffered, the new graduate programmes gave research a considerable boost. This was not the case in Turkey, where new universities were started but little attention was given to graduate programmes until the late 1970s, and even then financial support was not forthcoming except from a few foreign agencies.
A research career is far more attractive in Brazil than in Turkey. The financial support is far greater, which makes for better facilities and supplies. Salaries are high and travel abroad is easy. It is possible to do research instead of teaching and still not miss out on promotion. Brazilian research scientists, like their Turkish counterparts, prefer to do research which is intellectually attractive rather than socially useful.

In the industrial sector, more research is done in Brazil than in Turkey, but Brazil is still heavily dependent upon imported foreign technology. A survey of 454 of the 500 largest firms showed that only 64% did non-routine research activities and of these 67% did adaptation and only 16% creative research leading to new processes. (66) Foreign technology is easy to import because the Brazilian pattern of economic growth has always emphasized the free marketplace. This pattern means that well-developed processes have to be used in order for a firm to survive. At the same time, this does not encourage firms to invest in locally-performed research. A similar situation obtains in Turkey.

6.7 A comparison with science in Turkey

Science development in Turkey could not begin to take place until the Republic had undergone a number of legal, linguistic and other reforms. There was a great deal to do after the War of Independence which had resulted in the death or wounding of thousands of able young men, the devastation of vast tracts of Anatolia and the near-collapse of the economy.

In the early years of the Republic the Turkish elite were attracted into studying subjects such as law and political science rather than natural science because the former led to positions of power and importance within the administration. Thus Turkey did not benefit, as Japan did, from the entry of the elite into science and engineering.

Moreover in Turkey it took a long time and much effort to set up a strong educational infrastructure. There was a resistance to secular education by the mass of the people, which stemmed from religious attitudes. The Japanese had no such resistance and within forty years of the Meiji Restoration 95% of Japanese children were in formal education.
Compared to science in Japan, science in Turkey did not have the advantage of possessing a utilitarian connotation. It was used by the Republicans as an ideological weapon against superstition (which may not have endeared it to the religiously-faithful mass of the populace) and as such had the meaning of "scholarship" or "scientific thinking". There was no real idea of how scientific research could bring benefits to society. It was enough that science should be pursued like any other academic discipline, for its own sake.

Turkey did not have the benefit of a widespread use of a scientific language as India did. Ethnocentrism meant that links with scientists in other countries were not very strong until about the 1950s. Even then close contacts with centres of scientific excellence were not established to the same extent as they were in India, Brazil and Israel.

Also in Brazil, public support for science was encouraged by a demonstration early on of the practical benefits which science could bring. In later years this resulted, for example, in state taxes from the State of São Paulo being diverted into scientific research. In Turkey, there has not been the opportunity to see the benefits of science except perhaps in the field of medicine.

As a NATO country, Turkey has perhaps become over-dependent on American aid and expertise. There is a widespread tradition of calling in an outside "expert" rather than trying to do the job oneself. This has made it difficult to sell the services of Turkish researchers to the military and industrial sectors. These sectors prefer to take the less risky option of obtaining know-how from outside Turkey. By contrast Israeli scientists have managed to prove their worth to Israeli military experts so that research on defence is the largest research establishment in the country.

The Turks have not yet been able to link scientific research with defence. Nor have they been able to link it with economic development. The same is true of the other countries studied except Japan. In that case, not only did the word "science" have a utilitarian connotation, but the Japanese had a pragmatic view that science should be used in the national interest. The other countries have however made some strides to utilising science in the national economic interest. Thus in Israel, there are several organisations which encourage applied research and promote its industrial utilization including the National Council for Research and Development. In Egypt the
Science Council and later the Academy of Science and Technology have linked some research projects to the realization of national socio-economic ends. In India the CSIR has looked at problems of a mission-orientated nature, with hundreds of industrial processes and over a thousand patents resulting. Also, the thirty establishments of the Defence R and D Organisation are attempting to utilize indigenous materials and products. In Brazil, projects associated with the "gasohol" campaign have ensured that some research is devoted to the economic objectives of the country.

Although Turkey set up agricultural and other research institutes from the 1920s onwards, these seem to have produced little or no original research. India, Egypt and Israel appear to have benefitted far more from their full-time research establishments. Also, good Indian scientists are attracted to Indian research institutes because scientists there have higher pay and prestige than scientists at universities.

Turkish science suffers from a shortage of trained technicians. This is because the pay for technicians in the civil service (including the universities) is far lower than for technicians in the private sector. Furthermore there is a traditional disdain for vocational schools in Turkey as there is in Egypt and India. The Japanese seem to have been able to circumvent the problem, perhaps because of the status of artisans.

Turkish scientists were not trained abroad on the scale with which Japanese scientists were trained. A large number of Japanese were sent abroad for higher education at the end of the nineteenth century and within twenty years Japanese teachers had replaced foreign teachers. Moreover this was at a time when a few scientists were able to know a great deal about a wide field of knowledge. The Turkish training effort was hindered by the second World War, was on a much smaller scale than the Japanese one, took place over a longer period of time and began when science in the West was entering the era of "Big Science".

Science in Turkey has not grown as much from within the country, that is endogenously, as has science in Japan or India. At the birth of the Republic, there was only a limited amount of science being done, mainly at the Darülfüünun. Foreign professors were employed there then and also later when it became Istanbul University. Foreign professors were also employed at Ankara University, and the research programmes they set up were not continued for long after they had left. Only in more recent times have
scientists at universities such as METU and Hacettepe gone on to perform their own research once the foreign professors in the various aid projects had left. In contrast science in Japan was exogenous only for a short period in the nineteenth century. Thereafter it became more and more endogenous until the Second World War when Japanese scientists were forced to go it alone completely.

The first modern university was not set up in Turkey until 1933. Academic research in Turkey dates from around that time. Turkey had to be content with far fewer universities than Japan or India or Brazil. Moreover Turkey did not experience the university reforms which Brazil did in 1968, after which graduate programmes along North American lines were set up and a large amount of scientific research was initiated. By contrast, reform at Turkish universities has been slow. The German tradition of formal academic hierarchies and strict demarcations between disciplines dies hard.

As with Spanish, Egyptian and Indian universities, the primary role of the academic in Turkish universities is a Teaching one. Rote memorization, too, is very common. Classes tend to be large and teaching methods formal. Turkish academics who do perform research follow a laisser-faire tradition of choosing their own research topics; "university autonomy" provides a useful shield for such activities. In common with many Egyptian, Spanish, Brazilian and some Indian academic scientist, Turkish scientists do not usually choose research topics which have any relevance to the needs of the country. Perhaps if more research were contracted out, it would have a wider application.

A common feature of countries whose science has experienced growth is an injection of financial support into scientific research. Thus Egyptian science benefitted from the budget of the five-year plan for scientific research in the early 1960s and from the Academy of Science and Technology awards in the early 1970s. Indian science benefitted from the support given it by Prime Minister Nehru which resulted in much greater spending on R and D including the creation of a chain of research laboratories. Brazilian science has been greatly assisted by the National Technological Fund and by the two Basic Plans for Scientific and Technological Development. Japanese science has seen strong government support ever since the turn of the century, and after about 1959 strong support from private industry. Israeli science has benefitted from the endowment of its universities from Jews abroad and from the government support for academic fundamental research in the 1960s. Although the formation of TÜBİTAK in 1963 has led to an additional
annual budget allocation for science of around £12 million, this is not on the same scale as the funding for science in other countries.

The academic researcher in Turkey is not rewarded financially or in other ways. Few demands are made on him. Society is hardly aware of his existence. This is also true of the academic researcher in Spain, Egypt and India. In Brazil, however, salaries are high and travel abroad is easy. The lack of material and social reward for his labours is brought home to the Turkish academic researcher when he is able to visit countries in the West and compare the rewards there for doing science with his own.

Such factors have contributed to the poor showing of Turkish science compared with science in other countries of the world, as described in Chapter I (Section I.5).
CHAPTER 7: CONCLUSIONS AND RAMIFICATIONS

7.1 General Conclusions

The aim of this thesis has been to investigate the Turkish scientific community and to determine to what extent the low research performance of Turkish scientists has been allied to their ideological and socio-economic milieux. To this end a model has been employed which makes the performance of good quality research work in an academic context the resultant of 36 different factors or "conducents". The presence or absence of these factors over a period of fifty years or more has been traced, with special attention being paid to the situation obtaining at present.

My first hypothesis was that the lack of good quality research work by Turkish scientists inside Turkey over the past fifty years and at present is related to the absence or deficiency of some of these conducents. This hypothesis has been largely substantiated.

In the period before scientific research began on any scale, it is possible to link the absence of research with the absence of conduent If. Until society in general and the rulers in particular could see scientific research as a worthwhile activity, they would not provide either the means or the motivation to do so. Few if any gentlemen of Ottoman times engaged in scientific research since there was no social approbation to do so as there was in England, for example from the seventeenth century onwards. In pre-Republican times, it is also possible to note a tendency towards teleological rather than mechanistic explanations, a lack of belief in the uniformity of natural causes, and underlying doubts that the natural world could be understood and controlled by man (conducents Ib, Ic and Ie).

Before 1923, the role of researcher first appeared in the Darülfunun in an entirely academic context. There was no concept of the researcher contributing towards the economic development of the state; the motive for engaging in research was a non-utilitarian one. Also, the primary duty of the academic researcher was considered to be that of teaching undergraduates. The lack of research at that period may be explained, therefore, by a deficiency in motivating factors (conduent VIIIId) stemming from an inability to see the part which scientific research could play in the defence and material prosperity of the Empire (conduent If). Lack of research skills (conduent IV) may have played some part in the dearth of research, since the foreign professors who could have transmitted them did not stay long in Istanbul. Also role facilities were lacking (conducents VIIc, VIIId, VIIg in
particular), although the failure by the government to provide these may be attributed to its inability to recognise the value of science.

With the declaration of the Republic, the official attitude towards science changed dramatically and conducents Ib - Ig were widely disseminated. However, during the first years of the Republic, the government had to deal with the enormous devastation resulting from many years of war, and moreover it was primarily concerned with introducing a great series of social and legal reforms. During this period, the Darülňünün (and the researchers who remained within it) kept itself somewhat aloof from the changes taking place in the rest of the country. There was no demand for research from industry, which tended to be small and too preoccupied with establishing itself to think of such luxuries. Lack of research at that time, therefore, may be correlated with lack of motivation (conducent VIIIId), deficient research skills (conducent IV) and poor role facilities (conducents VIIc, VIIId and VIIg, as before).

It was not until 1933 that the government was able to instigate reform in the Darülňünün, which included the hiring of a number of foreign professors and the provision of better equipment, books and other supplies. It was after that time that original research began to be performed on a more systematic basis. A few other research establishments were also opened, including Istanbul Technical University in 1944. However, even then Turkey still lacked the economic infrastructure which could support research which would be useful in national economic development; and the granting of autonomy to the universities allowed researchers to choose research topics which had no foreseeable application. Moreover, the comparatively low salaries of academics, particularly assistans, did nothing to attract able people into a career in research. Thereafter, it is possible to attribute lack of quality and quantity of scientific research in Turkey to factors which varied somewhat with the individual research institution.

The conducents model is also applicable to the situation of research in Turkey today, where the research effort has grown enormously over the past 30 years, but still lags behind that in scientifically more developed countries where science has grown exponentially and in every sub-discipline.

Since research in Turkey is still concentrated in the universities, it is possible to make some generalizations as to deficient or missing conducents, even though some conducents - particularly role facilities - vary from university to university and from individual to individual. The following
observations refer mainly to basic research, but may be true also for some more applied fields.

Conducent If appears to be deficient, especially in so far as it provides motivation to engage in experimental research. Basic scientific research does not seem to have any relevance to the pressing economic and social problems of the country. Deficiency in conducents Ih and IIg is a natural result of isolation from peers in the sub-discipline, something which also applies to conducents IV, VIIe and VIIh. There are tendencies in the educational system which appear to go against conducents IIe and IIlf, but the effect upon research scientists is not easy to determine. Conducent III is not really established within the local scientific community; recognition on a local scale is still possible without the performance of much research work of quality. Conducent IV appears to be deficient in some cases, mainly because of shortcomings in the educational system and a lack of transmission of research skills. Conducent V was not easy to ascertain, but seems to be linked to conducent VI, which is lacking because of low formal research expectations. As for role-facilities, conducent VIIb appears to be deficient compared to salaries in other professions. This has a significant effect upon the quality of the intake into a research career. Conducent VIIc is deficient more with respect to supplies and spare parts than to basic equipment, while conducent VIIId is deficient particularly outside the three main cities. The small size of the scientific community contributes to a deficiency in conducent VIIe. Conducents VIIf and VIIg are lacking for some scientists, especially those in provincial universities. The organizational aspect of conducent VIIi could be much improved. As for conducent VIIia, intelligence is affected by the poor intake into basic sciences, while the educational system (pre-Modern Science Curriculum) seems to discourage creativity, curiosity and independent thinking in many cases. Conducent VIIId is deficient since it is related so closely to conducents such as If, III, VI, and VIIc - h.

My second hypothesis was that the absence or deficiency of internal factors such as conceptual, attitudinal and motivational conducents is more important a factor in the lack of good quality research work by Turkish scientists inside Turkey than the absence or deficiency of external conducents such as equipment, support personnel and salaries. It has been difficult to draw any firm conclusions about this because of the interrelatedness of the conducents. On the one hand, I was surprised to find that conceptual and attitudinal conducents appeared to be less deficient than I had assumed.
before the field-work began. I had extrapolated from certain societal norms such as the very common everyday expressions of fatalism and the common disdain for any kind of manual labour by upper class and wealthy Turks. However, these appeared to have little influence upon research behaviour. On the other, it soon became apparent that motivation played an extremely important part in research performance. And motivation was not increased by poor expectations and lack of rewards from both the scientific community and the wider society and was easily blunted by lack of supplies and equipment and other "external" deficiencies.

In scientifically developed countries, scientists gain high status and rewards in the scientific community by performing good quality research work. Generally speaking they also have high status in the wider society as scientists. Moreover they are rewarded materially for their labours and in return are expected to produce original research.

In Turkey, by and large this is not the case. Not much research is expected from Turkish scientists. Not much material reward is given to Turkish scientists. No great status or reward is obtained in the scientific community by producing good quality research work. Instead status both in the scientific community and in the wider society is usually gained by obtaining academic titles, which need not involve the performance of a great deal of good quality research. And with each academic title goes somewhat greater material reward (although still low compared to those in other professions). Moreover Turkish scientists do not have high status in the wider society as scientists. The wider society knows little or nothing of what goes on in the way of scientific research. What it does realize is that a docent is more important than an asistan and a profesör more important than a docent. But as to how these titles are achieved it knows very little.

Such a situation lowers motivation to engage in more than the minimum of research necessary to gain academic titles, motivation which is further lowered by the physical difficulties involved in performing research in a country like Turkey. In turn these difficulties provide a rationale for not engaging in research and for keeping the expectations of other scientists low.

Furthermore other motivations to engage in research are lacking. Thus one motivation might be to help provide solutions to pressing economic or social problems. However in Turkey, most academic research is not directed towards
such problems. Even though most academics are intensely keen that Turkey develop economically, they are not able to contribute towards that end.

7.2 The Conducents Model: An Evaluation

The conducents model focuses attention upon an individual scientist or group of scientists in an academic context. One advantage of the model is that it encourages us to consider all the various factors which can affect a scientist in his performance of research. Thus when research performance is poor, it is possible to consider which of the various factors is deficient or missing, and then to consider why this should be. The model is particularly useful for tracing the historical development of scientific institutions over time. Conceptual and attitudinal conducents are especially important in the early stages. Then once the scientific infrastructure has been set up, socio-economic and psychological conducents appear to be more important.

The conducents model has a fairly narrow application. In its totality, it applies only to academic research scientists, although a number of the conducents have a much wider application. Another disadvantage is that some of the conducents are extremely difficult to measure. This is particularly true of most of the conceptual, attitudinal and methodological conducents. Thus in the Turkish case conducents Ia-h, IIa-g, IV and VIIa-d were difficult to ascertain since they referred to factors within the individual research scientist or potential research scientist, and so their extent had to be estimated indirectly. Conducents III, V, VI, and VIIa-j were generally easier to determine because they referred to socio-economic or physical factors external to the individual scientist.

The conducents model then is a fairly rough model which provides a check-list of factors conducive to a scientist performing good quality scientific research. Its usefulness lies in its consideration of almost every factor involved in the performance of research in an academic context.

7.3 Suggestions for Further Research

Several possibilities for further research arise out of this investigation. This first group are more general, the second particular to Turkey and Turkish science. The most obvious possibility would be to apply the conducents model to scientists in different academic institutions in various LDCs. This would be particularly interesting in cases where good quality
scientific research had been undertaken with fairly limited resources. This thesis has shown the importance of motivation and morale in the performance of scientific research and it would be instructive to have an investigation into the factors which affect scientific research morale, especially in LDCs. Another topic which could be fruitfully investigated is the maintaining of research quality in a local situation. In the international scientific arena quality is maintained by the system of referees for scientific journals. Yet many of the topics pursued in that arena are irrelevant for LDCs. How then can quality be upheld when only local issues are being considered? What mechanisms are there for enforcing quality in such a context?

As for issues pertaining to the Turkish situation, it would be interesting to investigate a group of Turkish scientists who had emigrated to the West and who were successfully performing high quality research there. It would be even more profitable to seek out those researchers who have successfully undertaken research entirely in Turkey. What is the secret of their endeavours? What motivates them to produce good research? Another group of Turkish scientists whom it would be worth investigating are those Turkish academic scientists who are engaged in applied research. How much research do they undertake? How much outside consultancy work are they engaged in and to what extent does this affect their research activity within the universities?

The lack of social demand for science in Turkey is mainly due to the fact that Turkish companies prefer to get research done abroad and then read up the results. There are fewer risks involved. And yet the question still remains, why are Turkish scientists and technologists not taken seriously by industry and by the public sector? Why has the military sector been slow to utilize the potential of Turkish scientists? How can Turkish scientists sell their services more aggressively? It would also be instructive to investigate the attitudes towards and conceptions of scientists by ordinary Turks.

From the survey, lack of cooperation among Turkish scientists became evident. The reasons for this would bear closer investigation. Furthermore it would be fruitful to plot the communications networks of Turkish scientists with each other and with scientists outside Turkey. The question could also be asked how Turkish scientists hear of advances in their field: by letter, by
TÜBİTAK's role is a difficult one, and yet the question arises as to why it has not been more successful in promoting original scientific research. Part of the problem lies in the tension between the traditional autonomy of the universities and the desire by outside agencies to influence the course of research. Further investigation may provide a way, round this dilemma.

In 1977, the amount spent on Turkish R and D was about $380 million. This is a not inconsiderable sum and it would be useful to study in detail on what all this money was being spent, as well as the scientific research productivity of some of the recipients.

7.4 Ramifications for LDCs in general

The results of this investigation should be of interest to anyone interested in science development in LDCs, especially in an academic context. The results suggest that the educational system of a country should take upon itself the task of inculcating certain concepts and attitudes, particularly if there are any contextual factors which tend to work against them. These concepts and attitudes are summarised by conducents Ia to Ig. In particular, science must be seen to be not in conflict with other deeply-held beliefs but as capable of yielding knowledge which is 'useful' to society (conduent If). Moreover, the top end of the educational ladder should teach methodological conducents IIa to IIf and cognitive and manipulative skills indicated by conducents IVa to IVc. High conceptions of the work of research scientists should be taught (V), as well as at least one foreign language of scientific importance (VIf). Curiosity and creativity should also be encouraged (VIIIa).

Formal expectations of research performance should be made as high as possible, but backed up by good facilities (VIIa to VIIj). The criterion of research performance should be a certain number of publications in internationally recognised journals. Undergraduates and postgraduates need to be exposed to the conceptual frameworks currently held by other scientists in the sub-discipline (Ih) as well as to the instruments and to the methods and techniques involving these which are currently held to be legitimate by them (IIg). Current research techniques (IVd) should also be taught.
Opportunities for close communications with the international community of scientists should be given. This should include not only access to relevant scientific journals but also the possibility of attending scientific conferences and congresses, as well as that of maintaining close links with centres of scientific excellence. High quality research will be obtained only if the norm of high quality research being rewarded by international scientific recognition (III) is allowed to operate. This will mean that only problems which interest the international community of scientists can be investigated. An alternative mechanism needs to be invented if problems of a more local nature are to be investigated in a way which will produce high quality research results.

The scientists need to be organised in teams without the constricting hierarchy of the "chair" system. Rather the American "department" system is to be followed (VIII). The role of research scientist must be a sought-after one: highly paid and with high social status. Moreover, the successful researcher should be rewarded by promotion and perhaps in other ways (VIIIId). If possible, research should be shown to be contributing towards national development goals. Universities should have units whose sole aim is to sell the results of research to the productive sector, and also to obtain contracts for research.

7.5 Ramifications for Turkish experimental science in particular

Several ramifications for Turkish experimental science arise out of this research. They should be of interest to the Turkish scientific community and to those involved in science policy making in Turkey. The first set may be thought of as operating on a national level:

(i) Research topics must somehow be made more relevant to national needs and aspirations. This will ensure greater motivation. Also successful research along such lines will benefit from the approbation of Turkish society. At the same time, ways need to be found to prevent standards from slipping because research topics are not those favoured by the international community of scientists.

(ii) A foreign currency fund needs to be set up outside Turkey to enable spare parts and supplies to be obtained swiftly. Scientists working on topics of national importance could be given priority access to such a fund.
(iii) Ways need to be found to ensure greater cooperation among Turkish scientists. More attention needs to be paid to the research topics allotted to Ph.D. students both inside and outside Turkey. Ph.D. students should not be allowed to specialize in widely differing sub-disciplines because later this will result in intellectual isolation. The new-found camaraderie among Turkish physicists is an encouraging sign that greater cooperation is beginning to take place.

(iv) There is a need for Turkish society to be better informed about what its scientists are doing and their successes applauded.

(v) The numbers of students being taught should be kept as low as possible, especially since there is little prospect of obtaining science-related jobs after graduation. The pressure on the universities to take more students is a national problem which is exacerbated by the law permitting men with degrees to do their military service as reserve officers instead of as privates. For the sake of the universities, this law must be changed.

(vi) The scientific research career needs to be made into a much more rewarding one financially so that capable youngsters opt to become scientists. This could be done by giving scientists a large number of fringe benefits. On a wider scale the problem of the taxation laws needs to be tackled; the tax burden on civil servants needs to be lifted and placed on the farmers and others with high incomes who at present pay little or no tax.

(vii) Technicians in research laboratories need to be better paid so as to attract more able men to the profession. Technicians also need to be better trained so as to be able to maintain and repair sophisticated and costly equipment.

(viii) Government aid should be given to research undertaken by industry. Perhaps some academic researchers could be seconded to industry on a full-time or part-time basis. The public and private sectors and also the military sector could award more research contracts to academic scientists.

(ix) More use could be made of Turkish scientists resident abroad. They could be encouraged to keep closer links with the Turkish scientific research community and be invited back to speak at congresses and seminars.
Another set of ramifications may be considered to operate on a university level:

(x) Changes are needed in the university law so as to link promotion to publishing in international scientific journals. Numbers of foreign publications could also be publicized. The law should also be changed so as to allow a greater possibility of teamwork; at present it encourages individuals to undertake research.

(xi) Ways need to be found of encouraging young researchers early in their careers and of thereby maintaining high morale.

(xii) Professors who do not train research assistants should be penalized and the situation publicized. Overall there is a need for better postgraduate training inside the country.

(xiii) Universities should be encouraged to abandon the German chair system in favour of the more flexible American departmental system. This would enable greater flexibility and more teamwork and reduce the temptation for heads of chairs to become autocratic.

(xiv) The universities need to undertake an aggressive campaign to sell their usefulness to industry. It might be worth TÜBİTAK setting up a special unit to develop this. On the other hand, it might be worth each university setting up a special unit to promote greater liaison with the public, private and military sectors.


3. Ibid., pp. 168, 182.


5. Ibid., pp. 685-86.

6. Varis, Fatma, Türkiye'de Lisans-Üstü Eğitim : Pozitif Bilimlerin Temel ve Uygulamalarında (Post-Graduate Education in Turkey in the Fields of Basic and Applied Positive Sciences), (Ankara: Ankara Üniversitesi Eğitim Fakültesi Yayınları No. 23, 1972), p. 96-97. Also, 500 out of 540 academic researchers in the social sciences considered that research personnel were not properly trained at Turkish universities.


10. This was said to the author by several of the Turkish scientists he interviewed.

11. Kovach, op. cit., Fig. 2.


13. Ibid., Fig. 6, p. 34.


16. The works referred to in this section are listed in the Bibliography.


18. The Meaning of the Glorious Koran, An Explanatory Translation by M.M. Pickthall (New York: New American Library, n.d.). In Sura 13/3,4 (pp.182-83), Sura 15/19 (p.191), Sura 16/3 (p.195), and Sura 50/7, 38 (pp.370-71), there are verses describing creation ex nihilo.


37. Burtt, op.cit., pp.52-69, 74-82.
44. Ibid., pp.23-4.
46. Butterfield, op.cit., p.32.
47. Burtt, op.cit., pp.56 ff.
53. Ibid., p.49.
Ch. 2 Refs. (contd.)

60. Hooykaas, op. cit., p. 35.
63. Hall, op. cit., p. 115.
72. Ravetz, op. cit., p. 149.
74. Polanyi, Knowing and Being, p. 80.
75. Hooykaas, op. cit., pp. 67-69, although cf. Crombie, op. cit., p. 109, who states that "the idea ... that the purpose of science was to gain power over nature useful to man" was first explicitly expressed in the 13th century.


85. Lloyd, op.cit., p.126.


90. Ibid., pp.105-6, 109-114, 143.


95. Wynne, B., *Sociology of Science - Unit One* (Leeds: SISCON, 1974), pp.31-


Ch. 2 Refs. (contd.).


103. *Pilot Teams Evaluation Conference* (Paris: OECD, 1968), pp.182 ff. gives the case of Turkey, but it is probably not atypical of science in the Middle East in this respect.

104. Hooykaas, *op.cit.*, pp.75-96, upon which much of this section is based.


111. Burkhardt, *op.cit.*


121. Polanyi, M., Personal Knowledge especially Chs. 1 - 6, pp.3-195.


130. Barnes, op.cit., pp.37, 41.


133. Butterfield, H., op.cit., p.89.


138. Hooykaas, *op.cit.*, p.82.
150. The debate is chronicled in (eds.) Lakatos, I., and Musgrave A., *op.cit.* Kuhn, T.S. makes this particular point in his contribution "Logic of Discovery or Psychology of Research", pp.13 ff.


161. Merton, R.K., "The Ambivalence of Scientists" (1963) in *The Soccer*., pp.383-41:


167. 'Scientist Davis' in *The Soccer*., p.114.


177. Zahlan, A.B., "Scientific and Technological Education for Arab Middle Eastern Countries" in *Elements for a Regional Plan for the Application of Science and Technology to Development in Selected Countries of the Middle East* (Beirut: UN Economic and Social Office, 1972).


198. See refs. 163, 165, 186, 187 above, and also Watson, J.D., op. cit.


200. Ibid., p.11.


207. Polanyi, Knowing and Being, p.76.

208. Ibid. pp.53-54.


211. Hagstrom, op. cit., pp.17 and 60 (note 21).


217. This is an adaptation of Mulkay, 1977 op. cit., p.106. I have replaced his "originality" with "quality" so as to cover less original but technically excellent work.


Ch. 2 Refs. (contd.).

221. Ibid., p. 50.


224. This is Basalla's Phase 2 towards obtaining an independent scientific tradition. See Basalla, 1959, op. cit.


234. Ben - David, 1971 op. cit., pp. 139-50. There had been some university appointments in the eighteenth century in Britain, and some people were employed in industry as professional chemists in the nineteenth century. See Russell, C.A., Chemists by Profession, op. cit.


237. Ibid., p.290.


239. Hagstrom, op.cit., pp.18-19. On p.19, referring to note 26 on p.61, Hagstrom questions the efficacy of non-publication for poor work, since some journals do not send papers to referees at all. However, Ziman, 1968 op.cit., p.115 argues that such journals may accept work only from recognized professional scientists who have internalized the standards a referee would try to enforce and who can anticipate most reasonable grounds for criticism.


243. Ravetz, op.cit., p.16.

244. Zahlan considers that in a society which is "in perpetual crisis", it is unrealistic to expect "an ideal system within which the scientist spontaneously finds his equipment, his supplies and his salary". See Zahlan, A.B., "The Acquisition of Scientific and Technological Capabilities by Arab Countries", Bulletin of the Atomic Scientists, Vol. 25, Nov. 1969, pp.7-10. See also Moravcsik, op.cit., p.157.


246. Blume, S.S. and Sinclair, R., Research Environment and Performance in British University Chemistry (London: H.M.S.O., 1973). While some academics spent more than half their time supervising research, 48% of the lecturers and 88% of the professors surveyed spent less than 10% of their time on research.


249. Dedijer estimates the amount as 90%, but the figure may well have gone down since 1962. See Dedijer, S., "Research and the Developing Countries—Problems and Possibilities", Teknik— Vetenskaplig Forskning, Vol.33, 1962, pp.1-20.


254. Ravetz, op.cit., p. 177.

255. For example, in Turkey: University Law, No. 1750, Article 23c, passed on 20 June 1973.


262. Ibid., pp.426-30.


272. See above, p.52.


277. Ibid., p.279.


285. Kizaemon Ariga, cited by Campbell, L., "Science in Japan", *Science*, Vol.143, 21 Feb. 1954, pp.776-82. This might seem to conflict with the comment by Oya Shin'ichi (ref. 190) on the lack of criticism of work done by foreign scientists. However, Shin'ichi states that Japanese scientists were critical of one another's work.


290. Ibid., pp.145-47.


294. Ibid., pp.32, 150.

300. For a review of the evidence see Fisch, op.cit. pp.287-9. In contrast, children in LDC's are unlikely to be socially isolated in their early years because social bonds in the nuclear and extended families are stronger than in most DC's.
301. Ibid., p.290; also, ref. 289 above.

CHAPTER 3

1. Lewis, Bernard, The Emergence of Modern Turkey (1961, Oxford and London: Oxford University Press, second edition 1968), p.13. Most Turks embraced the orthodox Sunni sect. However, there are significant numbers of Alevi, or Shiites, in modern Turkey. No official estimates are available, but in 1978 some sources put the number of Alevi as 7 million out of a total population of 43 million. However, in spite of their numbers, Alevi keep a low profile since they have been persecuted and scattered in days gone by. For the estimate of the Alevi population, see Turkey Almanac 1980 (Ankara: Turkish Daily News, 1980), p.325.
5. Sarton, "Islamic Science", pp.87 ff.
Ch. 3 Refs. (contd.).


11. Ibid., p.191.


27. Hartner, W., "Quand et comment s'est arrêté l'essor de la culture scientifique dans l'Islam?" in Actes du Symposium International (1957), op.cit., p.331.


29. Ibid., pp.413-4.

30. Ibid., pp.422-3, 426, 427 and 428 respectively.

31. Ibid., p.422.


43. Ibid., Sura 45:23-26, p.356.


51. Ibid., pp.251-52.


58. Ibid.


63. Ibid., p.174.


69. Ibid., p.302.


71. Ibid., Sura 2:23, p.35.

72. Ibid., Sura 2:24, p.35 and Sura 3:4, p.62.

73. Ibid., p.43.

74. For a modernist's interpretation of this verse, see Fārūqī, *op.cit.*, p.243, note 17.


77. Ibid., p.25.
Ch. 3 Refs. (contd.).

84. The most scholarly account in English is Lewis, Bernard, *op.cit.*
85. For a description of the reforms, see *ibid.*, pp.56-61 and 74-123.
87. See Mardin, Serif, *op.cit.*
99. Ibid., p.395.
100. Ibid., pp.359-63.


103. Berkes, Development, p.413.
106. Ibid., p.171. However, these figures are not easy to square with those given in ibid., p.221 for the number of primary school teachers in 1923, i.e. 10,102.


120. Artel, Tarik, "Tanzimat'tan Cumhuriyete Kadar Türkiye'de Kimya Tedrisatının Geçirdiği Safhalara Dair Notlar" (Notes on the Stages of Chemistry Education in Turkey from the Tanzimat until the Republic) in Tanzimat (İstanbul: Maarif Matbaası, 1940), pp.504-505.

121. Heyd, op.cit., p.43.


125. Ibid., p.490.

CHAPTER 4


2. Ünaydın, Rüfen Eşref cited in Bozdağ, İsmet, "Atatürk 'ün Fikir Kaynakları-5", Milliyet, 14 November, 1974. Translations into Turkish here and elsewhere in this chapter are by the author.
3. Ibid.


The word used by Mustafa Kemal for "knowledge" was "ilim", which had a rather broad meaning similar to that of "science" in English before about 1800, that is, the systematic study of any academic subject. Religious knowledge was not included, however. The ambiguity may have arisen from translations into Turkish of the German word Wissenschaft. However, in the second part of the quotation (which is not set into the wall referred to), Mustafa Kemal spoke of "ilim ve fen", which would emphasize that the natural sciences were very much on his mind when he made his pronouncement. In order to narrow down the range of "ilim", "mümde ilim", or "positive science" was used, and is still common today as "mümde bilim", (bilim has replaced ilim in the language reform). This generally refers to physics, chemistry, mathematics, astronomy, biology, geology and interdisciplinary variations.

The ambiguity in the term "ilim ve fen" has not been helped by the Turkish language reform, a systematic attempt since the 1930's to replace words of Arabic and Persian origin with "pure" Turkish words, or words borrowed from European languages. Thus, in his anthology of Atatürk's speeches transcribed into modern Turkish (see ref. 10 below), Çağlar has used "bilim ve teknik" for "ilim ve fen", although teknik usually refers to "technology".


10. Çağlar, Behçet Kemal (ed.), Atatürk'ün Şöylevleri (Sayings of Atatürk's), (Ankara: Ankara Üniversitesi Basımevi, 1968), p.86. In this anthology, Atatürk's speeches have been transcribed into modern Turkish.

11. Ibid., p.87. See also Atatürk's speech on the 10th Anniversary of the Republic in which he described positive science as "the torch which the Turkish nation holds in its hand and its head as it walks along the road to civilization and progress", Nabi, op.cit., p.168.

12. Afecinan, Prof., M. Kemal Atatürk'ün Yaziıklarım (My Writings about M. Kemal Atatürk), (İstanbul: Millî Eğitim Basımevi, 1971), p.121.


27. Speech in 1925. See İnönü, İsmet, İsmet İnönü’nün Maarife Ait Direktifleri (İsmet İnönü’s Directives Concerning Education), (İstanbul: Maarif Matbaası, 1939), p.6.

28. Article written for Ülkü magazine on 29 October 1933, the tenth anniversary of the Republic. See İnönü, Maarife Ait, p.20.


30. Speech in 1925. See İnönü, Maarife Ait, p.5.


32. İnönü, Maarife Ait, p.3.

33. See, for example, speeches in 1926, 1928 and 1931 in İnönü, Siyasi, pp.126, 211 and 389.


39. Tevfik, Kâzım, Genç Düşünceler, 1 November 1928. English translation in Levonian, op.cit., p.140. The periodical was subsequently closed and the editor prosecuted, but the fact that he dared to publish the article in the first place reflects the spirit of the time.


42. Çağlar, op.cit., p.76; see also the article on Atatürk in Türk (İnönü) Ansiklopedisi, 4.cilt (Ankara: Millî Eğitim Basımevi, 1950), p.III.

43. Çağlar, op.cit., p.87, in which Çağlar inexplicably translates fen as teknik. The original can be found in Söylev ve Demeçleri, Vol.II op.cit., p.44.

44. Vakit, 8 July 1927, p.1, quoted in Borak, Sadõ and Kocaturk, Utkan, op.cit., p.46.

45. Cumhuriyet, 5 Feb. 1933, quoted in Nabi, op.cit., p.117.


50. Maarif Vekâleti Teblîşler Necmûası, 15 December 1926, No.11, p.61 quoted in ibid., p.279.


58. Başgöz and Wilson, *op.cit.*, pp.85, 162.


60. İnönü, İsmet, *Maarife Ait*, p.21, speech on 19 Nov. 1933 on the anniversary of the foundation of Ankara Halkevi.


62. Karpat, "People's Houses...", from which most of this section is taken. Başgöz, *op.cit.*, p.157 considers that the statistics on members were deliberately inflated by Chairmen anxious to impress.

63. Öztürk, Kazım, *Türkiye Cumhuriyeti Hükümetleri ve Programları* (Governments of the Turkish Republic and their Programmes), (İstanbul: Ak Yayınları, 1958), pp.15, 39-41, 99, 142, 152, 273, 303.

64. Quoted in Ergin, Osman, *Türkiye Maarif Tarihi, Vol.5* (History of Education in Turkey), (İstanbul: Osmanbey Matbaası, 1943), p.1365.


68. Milli Eğitim Hareketleri, p. 11.
72. Ibid., p. 128.
74. Akyüz, Yahya, "Once Öğretmen Güzellendirmek Gerek" (First of All the Teacher must Be Supported), Milliyet, 28 February 1978, p. 2, citing a speech by Hasan Ali Yücel, Minister of Education in 1938.
75. Akyüz, Öğretmenlerin, pp. 284 ff.
76. Ibid., pp. 235-46.
77. Personal observation.
78. The horrors of being posted to a far corner of Turkey are vividly described in "Kadro Dördü" (The Suffering Caused by Staff Appointments), Öğretmen Sesi, 1 October 1936, No. 37-38, p. 34, quoted in Akyüz, Öğretmenlerin, p. 229.
80. Başgöz and Wilson, op.cit., p. 119.
81. Afetinan, Nâzîralar, p. 266.
85. Özinönu, op.cit., pp. 47-49.
88. The information in this section has been culled mainly from Araştırmalar Kurum ve Birimleri Rehberi, Kamu Kesimi (A Guide to Research Establishments and Units in the Public Sector), (Ankara: TÜBİTAK, B.P.U., 1976).

89. Cited in Uysal, Şefik, Yurt Dışında Yetişen İhtisas Gücü (Specialist Manpower Training Abroad), (Ankara: TÜBİTAK, 1974), p.11.

90. Milliyet, 4 January 1931. English translation given in Levonian, op.cit., p.177. Uysal, op.cit., p.34 lists only 4 students sent in 1933, but admits that he could not obtain information for 402 out of the 3,232 students he estimates were sent abroad at government expense up to 1971.


93. İnönü, Erdal, "Temel Bilimlerde Türk Bilim Adamlarının Yaptığı İlk Doktoralar" (The First Doctoral Degrees Obtained by Turkish Scientists in Basic Sciences) in Prof. Dr. Tevfik Okyay Kabakçıoğlu Anısına (Papers in memory of Prof. Dr. Tevfik Okyay Kabakçıoğlu), (İstanbul: Matbaa Teknisyenleri Basımevi, 1974), pp.121-129.

94. İstanbul Üniversitesi Kimya Fakültesi Rehberi (Guide to the Chemistry Faculty of Istanbul University), (İstanbul: İstanbul Üniversitesi Yayınları, 1977), p.13.


96. Ibid., pp.13-14.


98. Malche, Albert, İstanbul Darülfünnunu Hakkında Raporu (İstanbul: Maarif Vekilliği, 1939), also found in Hırş, E., Dünyanın Üniversiteleri ve Türkiye'de Üniversitelerin Gelişimi (Universities of the World and the Development of Universities in Turkey), (İstanbul: Kâğat ve Basım İşleri A.Ş., 1950), Vol.I, pp.229-93.


100. Quoted in ibid., p.39.

101. Ibid., pp.42 ff.

102. İnönü, Erdal, "Temel Bilimlerde...", op.cit.


104. Özdemir, H. İbrahim, The History of Engineering Education in Turkey (İstanbul: İstanbul Technical University, 1965-66), p.13.


110. Quoted in Hirş, op.cit., p.571.


112. See Robinson, op.cit., Ch.5; also Lewis, op.cit., pp.281 ff.

113. Başgöz and Wilson, op.cit., p.46.


117. Ibid., p.115.

118. Başgöz and Wilson, op.cit., p.51.


121. Lewis, op.cit. p.416.


123. Batu, Selâhaddin, "Yeni Yıla Girerken" (Entering the New Year), Varlık, No. 565, 1 Jan. 1962, p.3.

124. İrdelp, Neşat Ömer, Rector of Istanbul University quoted by Bilsel, op.cit., p.39.


131. İnonü, Erdal, "Temel Bilimlerin Eğitiminin ve Kendisinin Evrimi ve Toplum ile İlişkileri" (The Development of the Basic Sciences and of Education in the Basic Sciences, and their Relations with Society), paper read to the Seha Meray Conference at Middle East Technical University, Ankara, on 12 May 1978.


133. Köprülü, M. Fuad, "İlim ve Tenkit" (Science and Criticism), Ülkü, September 1939, 14, pp.11-12.

134. Except where otherwise stated, statistics in this section are taken from Robinson, op.cit., Chs. VI, VII and VIII. Additional material is found in Lewis, op.cit., pp.304 ff., and in Krueger, Anne O., Foreign Trade Regimes and Economic Development: Turkey (New York: Columbia University Press, 1974).

135. Lewis, op.cit., pp.416 ff., where a list of articles on the religious revival by different observers is given.


138. According to Lerner and Robinson, by early 1951, over 1,000 officers and N.C.O.'s were being trained either in the U.S.A. or in Germany. See Lerner and Robinson, op.cit., pp.29-44.


140. Öztürk, Kâzım, op.cit., pp.359, 383, 419.


143. Robinson, op.cit., p.204.


147. Nabi, Yaşar, "Nereye gidiyoruz?" (Where are we going?), Varlık, No. 373, 1 August 1951, p. 3.

148. Nabi, Yaşar, "Gerilige karşı" (Against Reaction), Varlık, 1 February 1951, p. 3.


156. Private communication, Mr. Tahir Göğüş, former Consultant in the Ministry of Agriculture.


159. Ibid.

160. Lerner and Robinson, op. cit., p. 35; MRPT, p. 85.

162. From the Milli Bibliografyası (National Bibliography) for the relevant years.


166. Kaya, op.cit., p.190.

167. Article 6 of Law No. 3803, the English translation of which is given in Stone, op.cit., p.228.


170. MRPT, p.159. Kazamias gives a lower figure: 63.6%. See Kazamias, op.cit., p.273.


172. Milli Eğitim Hareketleri, p.11.

173. MRPT, p.123.


175. MRPT, pp.139, 141.


177. Computed from figures given in RTNCE, p.43 and in Milli Eğitim Hareketleri p.13.

178. Kaya, op.cit., p.121.

179. Figures in this section are computed from statistics given in ibid., pp.154, 159, and 151.

180. RTNCE, pp.52 ff.

181. Ibid., p.21

183. Ibid., p.54; and Education and Research in Italy, Greece and Turkey (Paris: OEEC, n.d. 1959?), p.30.

184. As observed by Kazamias, \textit{op.cit.}, p.128, after field-work in Turkey.


186. Örta Okul Programı: 1951 (The 1951 Middle School Curriculum), (Istanbul Milli Eğitim Basımevi: 1951), pp.20, 159, 173, 183. This was similar to those published in 1949 and 1962.


189. Figures computed from totals given for tertiary education as a whole in \textit{Milli Eğitim Hareketleri}, pp. 59 and 66.

190. From HRPT, p.152.


193. RTNCE, pp.63 ff.


197. \textit{Education and Research in Italy, Greece and Turkey}, p.32.


200. From figures given in Kaya, \textit{op.cit.}, p.265. However, Kodamanölu considers that science students tended to be rather more successful than other students. See Kodamanölu, \textit{op.cit.}, p.77.

201. Summaries in English of the various laws are given in Okyar, \textit{op.cit.}, pp. 234 ff.
202. Ibid.

203. For a discussion of the relationship between scientific productivity and university administrative frameworks, see Ben-David, Joseph, Fundamental Research and the Universities (Paris: OECD., 1968).


205. Turhan, Mümctaz, op.cit. The articles on which the chapters are based are in Istanbul Review between 1954 and 1956.

206. Ibid., pp.45-56, 82.

207. Uysal, op.cit., p.34.


211. Özönü, A. Kemal, Growth in Turkish Positive Basic Sciences, 1933-1966 (Ankara: METU Faculty of Arts and Sciences, 1970). Özönü reports the findings of a questionnaire sent out to 782 scientists in universities and research institutes working in the "basic sciences" i.e. mathematics, physics, astronomy, chemistry, statistics, biology and botany. Biochemistry, physical chemistry and electronics, for example, are curiously grouped together under the same head, namely "interdisciplinary specialities". Although some of the sampling and analysis is questionable, this was the first survey amongst Turkish scientists to obtain a greater than 40% response rate.

212. Milli Eğitim Hareketleri, pp. 69, 78, 87.


Ch. 4 Refe. (contd.).


216. Ibid., p.26,

217. Personal observation. The abbreviated titles Müh. and Y.Müh. often prefix names on letter-heads or on plaques outside offices, and on social occasions people are sometimes introduced with Mühendis preceding their names.


219. Figures calculated by perusing the list of articles given in Ibid. An additional 31 articles are given in Supplement III of İnönü, 1973 op.cit., pp.45-50. Prof. İnönü includes several review articles and chapters in his list because they contain some original material.


222. Ibid., p.15.

223. Ibid., p.34.


228. From figures given in Ibid., p.22. These figures do not square with those of İnönü who in 1971 op.cit. and 1975 op.cit. records 133 physicists and 372 chemists as having published material by 1966. İnönü probably included a greater number of scientists of Turkish origin working abroad (Özinönü does not state how many of his sample were in this category). Nevertheless, Özinönü's figures probably reflect the general pattern of growth.

229. The averages at different science faculties varied. At Istanbul University and Istanbul Technical University, it was about 18 years, at Ankara and Ege Universities, 14 years, and at METU 12 years—a figure which emphasises METU's more dynamic ethos.

231. Özınnü, 1970 op.cit., p.11. He assumes that all 52 "instructors" had Ph.D.'s. It is not clear to what he was referring. If he was referring to METU instructors, then from personal observation very few, if any, of them are likely to have had Ph.D.'s. Without the 52 instructors, the manpower structure would be even more unbalanced.


233. Bisbee, Eleanor, op.cit., p.121. The author taught in Turkey for many years.

234. Nabi, Yaşar, "Biz nelerle uğraşıyoruz" (What We Are Struggling With), Varlık, No.464, 15 October 1957, p.3.


237. Nabi, Yaşar, "Atatürkçülük" (Kemalism), Varlık, No. 455, 1 Nov. 1957, p.3


239. RTNE, p.29.


241. Anday, Melih Cevdet, Yeni Ufuklar, Vol.3, No.16 (32), Jan.1955, p.288. This notion may have come from the Islamic tarikats or sects, in which a guru-type of figure called a mürit (spiritual guide) revealed divine mysteries to ordinary mortals.

242. İnönü, Erdal, "Temel Bilimlerin Eğitiminin ..."


244. Kafesoglu, Ibrahim, "Batı Medeniyet ve Türkler" (Western Civilization and the Turks), İstanbul, Vol.3, No.8, August 1955, p.22.

245. Erginer, Suat, "Doğu-Batı Tezadı" (East-West Contrast), Varlık, No.470, 15 Jan. 1958, p.5, and "Doğu-Batı İkiliği" (East-West Duality), Varlık, No.473, 1 March 1958, p.5. Similar sentiments are expressed in Nabi, Yaşar "Batı'dan ne alacağız" (What We Shall Take from the West), Varlık, No.404, 1 March 1954, p.3.

247. Statistics and some information in this section are taken from: 

- **Statistical Yearbook of Turkey, 1979** (Ankara: State Institute of Statistics, 1979) - SYT; 
- **Turkey OECD Economic Surveys** (Paris: OECD) from 1963 to 1980 - OECDT; 
- **Economic and Social Indicators - Turkey** (Ankara: U.S.A.I.D., 1974) - ESIT; and from **Turkey Almanac 1980**, pp.179 ff - TA. Other information comes from personal observation. In the text, the sources of information for the tables are denoted by the abbreviation SYT, OECDT, ESIT and TA.

248. TA, p.292.
249. OECDT.
250. ESIT, p.54.
251. TA, p.187.
252. TA, p.208.
253. TA, p.203.
254. TA, p.454.

255. Kışmır, Parla, **Scientific and Technological Research Potential of Turkey** (Ankara: State Planning Organization, 1970), p.5 cites three studies made between 1966 and 1969 which reported no research in the private sector. However, a study made in 1964 to assess the research potential of Turkey found several companies who claimed to have spent a total of 4,445 million TL ($493 million) on R and D, of which 3,750 million TL was spent by the Eczacıbaşı company. Officials in the **Uygulayıcılarla İlişkiler Ünitesi** (The Industrial Liaison Unit) of TÜBİTAK, The Scientific and Technical Research Council of Turkey, stated that they knew of no original research being undertaken in the private sector in 1978. The discrepancy appears to arise from expenditures on fairly routine modifications to industrial processes being classed under "R" and "D". The 1964 study was reported in **Türkiye'nin Araştırma Potansiyelini Teşbit Etmek Amacılı Yapılan Envanter Çalışmaları, Hakkında Ön Rapor** (Preliminary Report on the Inventory Efforts Being Made to Determine the Research Potential of Turkey), (Ankara: TÜBİTAK, B.P.U., 2nd edn. Sept. 1966), p.39.

257. SYT, p.217.
258. TA, p.191.
259. TSY, p.360.
260. TA, p.453.
262. TA, p.204.
263. SYT, p.32.
269. Kurucu Meclisi Tutanak Dergisi (Minutes of the Acting Assembly), (Ankara: 1961), p.2. Following the military takeover on 12 September 1980, the Head of State, General Kenan Evren, spoke in a similar vein at the TÜBİTAK prize-giving ceremony on 11 December 1980: "The countries which are advanced in technology and which have realized their industrial development, reached their present advanced level by going along the path indicated by science. The Great Atatürk—who believed that the Turkish nation, which has raised many great men of world calibre throughout history, would put forward great scientists in future—said to his nation that the path to being a prosperous community and taking up a place among advanced nations lay in following the motto: 'Science is the best guide'... We all know that transcending economic bottlenecks, getting rid of dependence on abroad depends largely on our working out our own technology based on science. Working out technology, be it by our own endeavour and creativeness or by means of transfers, definitely requires scientific research. What I request of our valuable scientists is to give priority to research directed towards the solution of the nation's bottlenecks and the needs of the country and to exert efforts for the transfer of the technologies of advanced nations in a way suited to our own conditions, as well as to give momentum to our industry with fresh outlooks. From the viewpoint of scientists and research our country has a considerable potential. However, we cannot claim that we have so far used this potential in the best way. I believe that we should make the most of our scientific potential with better organization and effective co-operation." Reported in The Pulse, A Daily Review of the Turkish Press (Ankara: 12 December 1980).


273. Talas, Cahit, "8. Eğitim Şurası İçin" (For the 8th National Education Convention), Milliyet, 1 October 1970; Nabi, Yaşar, "Çagımıza ters düşenler: VI" (Those who Go Counter to Our Age), Varlık, No. 806, Nov. 1974, p.3; Kaya, op.cit., pp.327-30, 447.

274. Erbakan, Necmettin, İslam ve İlim (Islam and Science), (Ankara: Furkan Yayınları, 3rd edn. 1972), p.26, "I am saying that Muslims have founded what today we call Western science: physics, chemistry, mathematics, astronomy, medicine, history, geography, and even all of the sciences of today"; also in Dünüma Kurulu Onsekizinci Toplantısı, 18 Mayıs 1974 (18th Meeting of the Advisory Council of TÜBİTAK), (Ankara: TÜBİTAK, 1974 p.3, "As we pointed out in our Government Programme, our nation has produced the founders of many of the sciences."
275. İnönü, İsmet, in Öztürk, op. cit., p.537.

276. Demirel, Süleyman, in ibid., p.618.


287. Personal observation. Cf. the remarks on economic nationalism "characterized by a combination of mistrust of foreign entanglements, the motivation to economic self-sufficiency and feelings of national pride" quoted in TA, p.455.

288. The material in this and the following paragraphs is taken from Maybury, Robert H., Technical Assistance and Innovation in Science Education (New York: John Wiley and Sons, 1975), pp.107 ff., and from a private communication from Thomas D. Scott, Program Officer for the Middle East and Africa, Ford Foundation (Dec. 1977).

289. Figures are taken from Mustafaoglu, Ömer, Planlı Dönemde Eğitim Yatırımları (Educational Investment in the Era of the Five-Year Plans), (Ankara: DPT, 1979), pp.46, 50. The figures are rounded off.

290. The information in this section has been culled mainly from Araştırma Kurum ve Birimleri Rehberi, Kamu Kesimi (A Guide to Research Establishments and Units in the Public Sector), (Ankara: TÜBİTAK, B.P.Ü., 1976).

291. Unless otherwise indicated, information in this section is taken from The Scientific and Technical Research Council of Turkey (Ankara: TÜBİTAK, 1975), and the series of Faaliyet Raporu (Annual Reports) from 1965 to 1980.


294. Ibid., p. 2., Article 2.


296. See the introductory remarks to the 1971 Annual Report by the Chairman of the Science Board, Cahit Arf. Faaliyet Raporu (1971), p. IV


299. Cf. Wionczek's report that Science and Technology Policy instruments in Argentina, Mexico and Peru have been progressively dismantled over the past few years. See Wionczek, M.S., "Science and Technology for Development", The Bulletin of the Atomic Scientists, April 1979, pp. 45-48.

300. Türkeli, Some Observations, p. 10. Türkeli comments: "The senior chair professors while emotively objecting to any infringements, real or imagined, upon the freedom of science and university autonomy from without, have totally failed in establishing a viable tradition of freedom of science within their own chairs, where the freedom of science really matters and should exist in its operational context". A private communication from Mr. Taner Yücel of TÜBİTAK supported these sentiments.


305. His somewhat idealistic proposals do not seem to have been applied. For details of his 1972 proposal, see Dedijer, Stevan, Committee on Science Policy of TÜBİTAK: One Proposal for its Terms of Reference, Organization, Work Procedures and Plan of Activities (Ankara: TÜBİTAK, 1972, unpublished memorandum).


311. Calculated from figures given in ibid., p.11.

312. The following exchange rates were used: 1964-69: $1 = 9 TL; 1970-75: $1 = 14 TL; 1976: $1 = 16 TL; 1977: $1 = 17 TL; 1978: $1 = 25 TL; 1979: $1 = 36 TL.


315. The failure of the mission-oriented projects scheme was admitted by the Head of the Science Board in 1977. See "Bilim Kurulu Başkanı Prof. Dr. Kâzım Ergin'in VI. Bilim Kongresi ve Ödül Törenini Açılış Konuşması" (Opening Speech of the VIth Science Congress and the Prizegiving Ceremony by the Head of the Science Board, Prof. Dr. Kâzım Ergin), 1977 Ödül Töreni (Ankara: TÜBİTAK, 1977), p.2.

316. The Scientific and Technical Research Council of Turkey, op.cit., p.11.

317. TÜRDOK's activities are outlined in a booklet in English entitled Welcome to TÜRDOK (Ankara: TÜBİTAK, n.d.).


320. Figures supplied by courtesy of TÜRDOK.


323. Özoglu, op.cit., p.56.

324. Ibid., p.16.


328. Ibid., p.3.

329. See, for example, the programmes of the governments of İsmet İnönü, Suad Hayri Ürgüplü and Süleyman Demirel in Öztürk, op.cit., pp.504, 535, 566, 592 and 616 ff.

330. Calculated from figures in SYT, pp.343-44 and ESIT, p.45.

331. Mustafaoğlu, op.cit., p.4.


337. Ibid., p.100.

338. SYT, p.103; MEH, pp.24, 25, 27.


340. Ibid., p.159.

341. SYT, p.103; MEH, pp.24, 28, 30.

342. They are discussed in detail in Szyliowicz, op.cit., pp.358 ff. and in Kaya, op.cit., pp.212 ff.

343. Ibid., p.171.


346. In 1978 it was estimated that a janitor in a bank, or a municipal dustman earned more money than a newly-qualified teacher. See "Eğitim Raporu" (Education Report), *Hürriyet*, 17 Oct. 1978, p.9.


348. For repeaters, see *ibid.*, p.224; for drop-outs, p.225.


360. Private communication from Yalçın Yalırım, Science Lycee graduate in 1978.


364. Ibid., p.144.


368. The basic introductory text was translated from: Educational Development Centre, Introductory Physical Science (IPS), (New Jersey: Prentice Hall, 1967). The others were translated from: Biological Science Curriculum Study (BSCS), High School Biology: BSCS Green Version (Chicago: Rand McNally, 1953); Chemical Education Material Study (CHEMSTUDY), Chemistry: An Experimental Science (San Francisco: W.H. Freeman, 1963); Physical Science Study Committee (PSSC), Physics (Boston: D.C. Heath, 1960); School Mathematics Study Group (SMSG), Intermediate Mathematics, Parts I and II (New Haven: Yale University Press, 1961).


371. From 1981, the examination will be held in two stages.
Ch. 4 Refs. (contd.).

372. As usual with Turkish statistics, different statistics are given by different sources — partly because of differing definitions. The rounded-off figures here are from Yıldırım, Cemal, "Admission to Higher Education in Turkey" (Ankara: unpublished paper, METU, n.d.), p.3 (until 1972) and from ÜSYM. The figures for university entrants are from Milli Eğitim İstatistikleri: Yükseköğretim 1974-78 (Ankara: Devlet İstatistik Enstitüsü, 1978), p.10, although its totals for entrants to higher education do not tally with the ÜSYM figures. The 4.Ber Yıllık Kalkınma Planı 1979-1983 (4th Five-Year Plan), (Ankara: Devlet Planlama Teşkilatı, 1979) also gives slightly different figures in Table 102 on p.228. The figures from ÜSYM include 2-year and 3-year education institutes, but exclude YAYKUR (the Extended Education Scheme).

373. 4.Ber Yıllık Kalkınma Planı, op.cit., p.459. See also the statement by Necdet Uğur, then Minister of Education, in Milliyet, 22 Sept. 1979. For an earlier reference to the reserve officer factor, see Irmak, Sadi, "Reform Tasarısı" (The Reform Bill), Cumhuriyet, 17.12.68.

374. Personal observation on the basis of discussions with many Turkish young people.

375. The orders of depts./chairs are compiled from cut-off points given in 76 ÜSS Kılavuzu (The University Entrance Examination Guidebooks) (for 1975), 77 ÜSS Kılavuzu (for 1976), 78 ÜSS Kılavuzu (for 1977) and 79 ÜSS Kılavuzu (for 1978), (Ankara: ÜSYM, 1976-79).


377. 76, 77 and 78 ÜSS Kılavuzu.


380. Yıldırım, Cemal, Ortadoğu Teknik Üniversitesi'ne Giriş ve Üniversitede Başarıya Etkileyen Faktörler (Factors Which Influence Entrance to METU and Success While at the University), (Ankara: mimeographed research report, 1972), p.182.

381. One physics graduate who did not have the word "Mühendis" (Engineer) on his diploma wrote to a journal complaining, "Everyone looks at me as a middle-school teacher." See Çağdaş Fizik, No.2, Vol.I, Nov.1976, p.4.


383. SYT, p.50. A study by Özinönu published in 1975 suggested that even in the field of chemical engineering, saturation point had been reached in the public sector at least; nearly two-thirds of the 225 chemical engineers about whom he obtained information were engaged in "Services", "Marketing" or other activities not directly concerned with production. See A. Kemal Özinönu, "Milli Eğitim Düzeninde Üniversite Eğitimi-İstihdam İlişkisi Üzerinde Başı Gözlemeler" (Some Observations on the Relationship in the National Education System Between University Education and Employment [Prospects] ), in V. Bilim Kongresi BAYG Tebliğleri (Ankara: TÜBİTAK, BAYG, 1975), pp.19-27.


389. The laws are conveniently published in Üniversiteler Kanunu ve Üniversite Personel Kanunu ile Üniversiteleri İlgilendiren Diğer Kanunlar, Tüzikler, Yönetmelikler (Ankara: Üniversitelerarası Kuruluş Genel Sekreterliği Yayınları: I, Fon Matbaası, 3rd edn. 1976). The articles relating to METU and Hacettepe, Articles 82 and 83 are found on p.40. Karadeniz Technical University and Erzurum Ataturk University were also exempted from certain provisions of the law (Article 82), but these sections were subsequently annulled by the Constitutional Court.

390. SYT, p.100; M.E.I., Yükseköğretim 1974-78, p.10.

391. Personal observation. Such lecturers have become known as "uçan öğretim üyesleri" or "flying academics".


394. Ünver, R. "Türkiye'de Fizik Mühendisliğinin Gelişimi ve Sorunları" (The Development of Physics Engineering in Turkey and Its Problems), Fizik Mühendisliği, No.1, Vol.1, April 1977, pp.5-7. Ünver reports that 298 Physics Engineers were members of the Turkish Chamber of Engineers in 1977. He calculates that 350 were trained between 1957 and 1977, whereas Nasuhoğlu gives a figure of 413 for Higher Physics Engineers from Ankara University Science Faculty alone. See Nasuhoğlu, Rauf, "Ankara Üniversitesi Fen Fakültesi Fizik Bölümü"(The Physics Dept. of Ankara University Science Faculty), Çağdaş Fizik, No.1, Vol.3, May 1978, pp.21-24.


402. Ibid.; Okyar, op.cit., p.225; Szyliowicz, op.cit., p.341; Sözer, Necde "Universite Reformuna Mini" (Lullaby to University Reform), Aksam, 8-9 April, 1969.


408. Uysal, Şefik, 1974. op.cit., p.34.


414. The problems are discussed at length in Uysal, op.cit., with a summary on pp.112-120.


416. Oğuzkan, Turhan, Yurt Dışında Çalışan Doktoralı Türkler (Turks with a Ph.D. Degree who are Working Abroad), (Ankara: O.D.T.U., 1971), p.15. Cf. Okyar, Osman, "The Medical Brain Drain in Turkey", Hacettepe Bulletin of Social Sciences and Humanities, Vol.1, No.1, June 1969, pp.9-17; Okyar reports that 2,248 Turkish medical physicians were working overseas in 1962-63, 832 of them in Germany and 607 in the U.S.A.


420. For details of the Çekmeköy Centre, see Çekmeköy Nükleer Araştırma ve Eğitim Merkezini Tanıyalım (Acquainting Ourselves with the Çekmeköy Nuclear Research and Training Centre), (Çekmeköy: A.E.K ÇNAM Tanıtımcı Yayınları No.1, 1977).

421. İnönü, Erdal, "İstanbul'da Fiziği Canlandırmak İçin Birşeyler Yapmiyacak Miyiz?" (Aren't We Going to Do Anything to Revive Physics in Istanbul?), Çağdaş Fizik, No.2, Vol.1, November 1976, pp.34-36.


426. Ibid., pp.11-14, 21.

of scientists for 1970 is from MEH, pp.85-89, with a subtraction made for non-scientists in METUFAS, and estimations made for BUBSF (then Robert College) and HUSF. The number of scientists for 1977 is from Milli Eğitim istatistikleri: Yükseköğretim 1974-1978, pp.56-64, with the METUFAS figure calculated from the METU Catalogue, since the one given includes non-scientists.


435. Özinönu, A. Kemal and Tinto, Vincent, "University Organization and Scientific Productivity in Turkey", METU Journal of the Faculty of Architecture, Vol.2, No.1, Spring 1976, pp.123-38. The data used are from Özinönu's 1970 study, in which only 30% of the respondents gave details of their publications.


438. Pilot Teams Evaluation Conference (1968), p.172, henceforth designated as PTEC.

439. Varış, 1972 op.cit., pp.96-97. Also, 500 out of 540 academic researchers in the social sciences considered that research personnel were not properly trained at Turkish universities. See Yurt and Sevil, op.cit., p.110.
440. Birgül, Gürsey and İnönü, 1974 op.cit. Out of 202 articles and books which gained more than 9 citations between 1961 and 1971, only 7 articles—2 in chemistry, 3 in mathematics and 2 in theoretical physics—and 3 proceedings of summer schools were on work actually performed inside Turkey.


442. Varsiş, op.cit., p.77, where she reports that 57% of her 713 respondents considered that their Masters and Ph.D. theses had "no relation to the needs of the country in the spheres of science and technology"; PTEC, p.171; Türkeli, 1971, op.cit., p.11-12 where he states that in 1971, there were 4 chairs of "decorative plants" (landscape gardening) and 8 chairs of history of science, 4 of them in medicine.


447. Stirling, op.cit., p.28.


450. Ibid.


452. A professor at one of the universities in Istanbul told the author that some of the older professors at certain universities had started out as asistans when people of even mediocre ability could become one, because of the very low salary at that time, and so their academic prowess was questionable.

453. PTEC, p.172.
17% of the 150 expatriate Turkish scientists questioned by Öğuzkan put
"The possibility of advancing in my field of specialization" as one of
three reasons which had attracted them to a post outside Turkey;
10% marked "Close contact with large scientific establishments". See
Öğuzkan, op.cit., p.149.

In 1965, of 34 research units who replied to a TÜBİTAK questionnaire,
5 had no laboratory of their own and 20 had no library. See ENR, pp.21,
27-29. Cf. RRI, p.13; BTA, p.23; Second Five-Year Development Plan,

BÖR, p.17 gives a figure of 1.6 technicians to one engineer in 1966.
ENR, p.27.

BÖR, p.23; Second Five-Year Development Plan, p.219.
Second Five-Year Development Plan, p.219; 3.Beg Yıll Kalkınma Planı,
p.685; RRI, p.13; PTEC, p.171; ENR, pp.27-29.


Kaya, op.cit., p.286.

CHAPTER 5

1. This practice no longer became possible after 1979, however, when
academic medics had to choose between their private clinics and full-time
employment at a university.

2. The remarks of a physicist from Karadeniz Technical University in Trabzon
(N.E. Turkey) bear this out: "Our department has only recently begun
effective experimental research work in physics. Having to deal with
problems associated with the infrastructure, equipment and supplies
needed for experimental work—especially in a provincial city—has
caused delays and wasted a great deal of time". See Taner Oskay in
"Türkiye'de Denel Fiziğin Durumu ve Sorunları: Bir Simpozyum" (A
Symposium on The State of Experimental Physics in Turkey and Its Problems)
Çeşçeş Fizik, No.9, May 1980, p.16.

3. METU and Bosphorus University are English-medium and more modern than the
classical Istanbul University, Istanbul Technical University and Ankara
University. Hacettepe and Ege Universities are "mixed" or somewhere
between.

4. Notes on the "universe" and the sample are found in Appendix 1.

5. This compares with a figure of 37.4% female and 62.6% male academics in
basic sciences in 1973-74. See Milli Eğitim İstatistikleri 1972-74
(National Educational Statistics), (Ankara: Devlet İstatistik Enstitüsü,
6. In the early 1960's, Kazamias found that 24% of the lycee students he surveyed still believed in Kismet or fatalism. Also, Başaran found that 19% of the students she interviewed at Ankara University Faculty of Letters believed in Kader, or fate over which they had no control. See Kazamias, A.M., "Potential Elites in Turkey: Exploring the Values and Attitudes of Lyce Youth", Comparative Education Review, Vol.11, No. 1, Feb. 1967, pp.22-37; Başaran, Fatma, "Dil ve Tarih-Coğrafya Fakültesi Öğrencileri Üzerinde Psiko-Sosyal bir Araştırma" (A Socio-Psychological Study of Students at Ankara University Faculty of Letters), in Dil ve Tarih-Coğrafya Fakültesi Cumhuriyetin 50. Yıldönümü Anma Kitabı (Ankara: Ankara Üniversitesi Basimevi, 1974), p.602.

7. Percentages here and elsewhere are rounded off, and so may not add up to 100.

8. An "enlightened religious man" is described by a Turkish professor as a person "who does not simply accept the products of Western science and technology but who encourages his own society to be creative in these areas", amongst other characteristics. See Yavuz, Fehmi, Din, Eğitim ve Topluluğumuz (Religion, Education and Our Society), Ankara: Sevinç Matbaası, 1969), p.100.


10. See Table 5.4 on p.323.

11. According to the responses given to another question (Q.66), only one of the respondents' research papers (a foreigner's) had ever been criticized in a research journal. This agrees with Mulkay and William's observation that scientists seldom undertake a written refutation of another scientist's work because there is little likelihood of achieving recognition thereby. See Chapter 2 ref. 186.


13. See Section 2.3-Ih in Chapter 2.

15. Ibid., p. 297


17. Ibid., p. 24.


20. See, for example, Fakülte Öğretim ve Sinav Yönetmeliği (Faculty Teaching and Examination Regulations) (Ankara: Hacettepe Üniversitesi MŞEF, 1977), p. 9.


22. Ibid., pp. 102-105.

23. Figures supplied by courtesy of the respective Heads of Department.


25. Personal observation.


27. Law No 1750, Article 41 in Ibid., pp. 23-24.

28. There is some question over the length of this period, since Article 30 which deals with research assistants was annulled by the Constitutional Court in a decision published in Resmi Gazete, No. 15431 3 Dec. 1975.

29. Until recently (1978), this has not been the case at METU and Bosphorus University, where Ph.D.'s ("asst. profs."") have been under no official obligation to become docents ("associate professors"). Also the difference in net salary between "asst. prof." and "associate professor" has been fairly marginal.

31. For example, figures given by some older professors at Ankara University, Istanbul University and Istanbul Technical University were as follows, in numbers of papers expected:

<table>
<thead>
<tr>
<th>A.U.</th>
<th>I.U.</th>
<th>I.T.U.</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-5, 7-8, 8-9</td>
<td>3-4, 5-6</td>
<td>3-4</td>
</tr>
</tbody>
</table>


34. Problems involving role facilities for experimental research physicists were discussed at a symposium on 20-21 Dec. 1979 at Bosphorus University. The proceedings are reported in the article entitled "Türkiye'de Denel Fizigin Durumu ve Sorunları: Bir Simpozyum" cited in ref. 2.

35. Since the military coup of 12 September 1980, boycotts have been outlawed, and the level of urban terrorism both on and off campus has been drastically reduced. See reports by David Barchard in The Guardian of, for example, 16 January and 24 February 1981, p. 6.

36. Personal observation of the situation before the coup.

37. Figures supplied by courtesy of the Accounts Department of Ankara University Faculty of Science.

38. Figures supplied by courtesy of the Ministry of Employment, Ankara.

39. Figures obtained from various acquaintances employed in these fields, or from friends of those thus employed.

40. For accounts of the equipment available and research undertaken in various physics departments, see the following articles: Yalçı̇n Çengiz, "Orta-Doğu Teknik Üniversitesi Fizik Bölümünde Yapılan Araştırmalar" (Research Being Undertaken in the METU Physics Department), Çağdaş Fizik, Vol.1, No.2, Nov.1976 pp.24-29; Sanalan, Yalçı̇n and Iğın, Acar, "Hacettepe Üniversitesi Fizik Enstitüsü" (Hacettepe University Physics Institute), Çağdaş Fizik, Vol.2, No.1, May 1977, pp.14-18; Nasuhoğlu, Rauf, "Ankara Üniversitesi Fen Fakültesi Fizik Bölümü",
41. Private communication from Doç. Dr. Mahmut Tezcan, Faculty of Education, Ankara University.

42. Personal observation, based upon discussions with relevant parties.


46. Published in Resmi Gazete, 20 July 1961.

47. Published in Resmi Gazete, 22 September 1971.

48. Cf. Some observations made by Prof. Adnan Sokolluoğlu, Research Director of the Marmara Research Institute, on 1st June 1979:

Prof. A.S.: Our culture doesn't train people's minds. In the family, children are not encouraged to ask questions, and if they do, their questioning is not looked upon favourably.

P.H. Is this still true for urban middle-class families?

Prof. A.S. Yes it is, even though the situation is changing through the influence of television and so on. But even at schools and universities, students are not encouraged to ask questions.

P.H. What is the reason for this?

Prof. A.S. In our culture, it is not considered proper for young people to question older people. Older people do not want to admit that they do not know something and so they continue to foster this taboo. This is also true of teachers, who do not want their students to think they cannot answer a particular question.


50. Cf. the following statement by Prof. Metin Bara, Assistant Dean of the Faculty of Science at Istanbul University: "I am doing research on the action of gravity on plant metabolism, which is the field of my doctorate. I cannot honestly claim that I am doing anything for Turkey but this is
the tradition here. You do not become prominent by working on local problems; in fact, that is a good way of losing respect amongst your colleagues. Prominent Turkish scientists will have nothing to do with local problems", quoted in Sardar, Z., "Science in Turkey: Choosing the Wrong Priorities", Nature, Vol. 282, 13 Dec. 1979, pp. 689-70 (emphasis mine).


53. Only about 875 lawyers are not in private practice. Estimated from ibid.

54. See Chapter 4 ref. 360.

55. This was said rather with tongue in cheek. Compared to doctors, and engineers in the private sector, civil servants do not have a very satisfactory income.

56. See Chapter 4, Sections 4.1.2 and 4.1.3.

CHAPTER 6


2. Ibid., Fig. 5, p.33


4. Ibid., Fig. 2, p. 37


6. Ibid., p. 208

7. Ibid., p. 595

8. Ibid., p. 311

9. Table 5.10 above


11. Ibid., p.504

12. Ibid., p. 301

14. Price and Gürsey, op. cit., Fig. 4, p.32
15. Ibid., Fig. 5, p.33
19. Ibid., p.117
20. Shimshoni, op. cit., p.442
21. Kovach op. cit., Table I, p.34
22. Frame, J. Davidson, "National Economic Resources and the Production of Research in Lesser Developed Countries", Social Studies of Science Vol. 9, 1979, pp 233-46
23. Price and Gürsey, op. cit.,Fig.5, p.33
26. Akrawi, op. cit., pp.343, 352
27. Sabet, op. cit., p.187
29. Sabet, op. cit., p.194
30. Ibid., p.199; for the 1973 figure, see Zahlan, 1980 op. cit., p.81
31. Araoz, op. cit., p.27.
32. Who is Publishing in Science, 1977 Annual, p.9
33. For a history of science in modern India, see Ranganathan, A., "Science in Modern India", Impact of Science on Society, Vol. 9, 1958, pp.210-30
35. Ranganathan, *op. cit.*, p.223

36. Aráoz, *op. cit.*, p.27


43. Frame, *op.cit.*

44. Price and Gürsey, *op. cit.*, p.35. Note: they found that Japan came 21st on a per capita basis.

45. Kovach, *op. cit.*, p.34


50. 2,299 foreign teachers from Britain, France, the U.S.A., Germany, the Netherlands, Italy, Switzerland and China came to Japan between 1868 and 1889; and 550 students were sent abroad between 1868 and 1874. See Government of Japan, *op. cit.*, pp.12,17


52. Nakayama, *op. cit.*, p.203

53. Watanabe, *op. cit.*, p.186

55. Ibid., p. 225 shows the steep increase in expenditure on research by industry over that by university and government.

56. Who is Publishing in Science, 1977 Annual, p. 9


58. Ibid.

59. Kovach, op. cit., Fig. 2, p. 37

60. Who is Publishing in Science, 1977 Annual, p. 9


62. Ibid., p. 559


64. Schwartzman, op. cit., p. 576

65. 1978 Araştırma ve Geliştirme Harcamaları Raporu (Report on 1978 R and D Expenditure), (Ankara: TÜBİTAK, Bilim Politikası Ünitesi, 1979), p. 23. The figure is somewhat inflated since it includes 10% of the salaries of academic scientists whereas the figure for Brazil does not.

Notes on the sample

1. The numbers of scientists interviewed in each faculty/department were as follows, with the total number of scientists engaged in experimental research in the faculty/department in parentheses:

<table>
<thead>
<tr>
<th></th>
<th>Chemistry</th>
<th>Physics</th>
<th>Biochemistry</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.U.</td>
<td>2(6)</td>
<td>1(4)</td>
<td>1(13)</td>
<td>1(3)</td>
</tr>
<tr>
<td>(i)</td>
<td>0(1)</td>
<td>1(4)</td>
<td>1(7)</td>
<td></td>
</tr>
<tr>
<td>(ii)</td>
<td>0(0)</td>
<td>1(2)</td>
<td>1(4)</td>
<td>0(1)*</td>
</tr>
<tr>
<td>(iii)</td>
<td>1(2)</td>
<td>2(7)</td>
<td>2(16)</td>
<td>1(2)</td>
</tr>
<tr>
<td>B.U.</td>
<td>1(2)</td>
<td>2(7)</td>
<td>2(16)</td>
<td>1(2)</td>
</tr>
<tr>
<td>(v)</td>
<td>0(0)</td>
<td>1(2)</td>
<td>1(4)</td>
<td>0(1)*</td>
</tr>
<tr>
<td>E.U.</td>
<td>0(0)</td>
<td>1(2)</td>
<td>1(4)</td>
<td>0(1)*</td>
</tr>
<tr>
<td>(i)</td>
<td>1(2)</td>
<td>2(7)</td>
<td>2(16)</td>
<td>1(2)</td>
</tr>
<tr>
<td>(ii)</td>
<td>0(0)</td>
<td>1(2)</td>
<td>1(4)</td>
<td>0(1)*</td>
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<td>(iii)</td>
<td>0(1)</td>
<td>0(1)</td>
<td>0(3)</td>
<td>0(1)</td>
</tr>
<tr>
<td>H.U.</td>
<td>3(9)</td>
<td>2(16)</td>
<td>1(7)</td>
<td>0(0)</td>
</tr>
<tr>
<td>(i)</td>
<td>1(3)</td>
<td>2(7)</td>
<td>3(23)</td>
<td>1(2)</td>
</tr>
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<td>(iv)</td>
<td>2(3)</td>
<td>2(18)</td>
<td>0(0)</td>
<td>0(0)</td>
</tr>
<tr>
<td>M.E.T.U.</td>
<td>0(0)</td>
<td>1(1)</td>
<td>1(5)</td>
<td>2(6)</td>
</tr>
<tr>
<td>(v)</td>
<td>1(6)</td>
<td>1(8)</td>
<td>0(13)</td>
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<td>2(11)</td>
<td>2(11)</td>
<td>2(16)</td>
<td>1(3)</td>
</tr>
<tr>
<td>I.T.U.</td>
<td>3(9)</td>
<td>0(0)</td>
<td>2(16)</td>
<td>0(3)</td>
</tr>
<tr>
<td>(iv)</td>
<td>0(0)</td>
<td>0(2)</td>
<td>1(7)</td>
<td>0(1)</td>
</tr>
<tr>
<td>(v)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>12(42)</td>
<td>5(17)</td>
<td>4(11)</td>
<td>21(70)</td>
</tr>
</tbody>
</table>

Professors: 13(56) 8(24) 2(9) 23(89)
Dokents: 16(138) 10(62) 5(28) 31(2)
Ph.D.'s: 16(138) 10(62) 5(28) 31(2)
Appendix I (contd.).

*Temporarily in the U.S.A.


(i) = Science Faculty, (ii) = Faculty of Pharmacy, (iii) = Faculty of Medicine, (iv) = Chemistry Faculty, (v) = Faculty of Arts and Sciences, (vi) = Faculty of Basic Sciences, (vii) = Faculty of Engineering and Architecture, (viii) = Çerrahpaşa Faculty of Medicine

2. Only scientists engaged in experimental basic research were included in the "universe". Theoretical physicists and chemists were excluded, as were those working in applied fields such as industrial chemistry. In general, clinical biochemists were also excluded.

3. A slight bias was introduced by opting to interview a) a higher proportion of professors and docents than research assistants, b) a higher proportion of scientists at English medium (METU and BU) and mixed (Hacettepe) Universities than at other more classical universities, and c) a higher proportion of scientists who had studied abroad than were warranted by their proportions in the universe. Hacettepe University Faculty of Pharmacy was not considered for inclusion in the universe since it had only recently been founded.

4. The overall sample by academic title was as follows:

<table>
<thead>
<tr>
<th>Academic title</th>
<th>No. in universe</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professor</td>
<td>70</td>
<td>21</td>
</tr>
<tr>
<td>Docent</td>
<td>89</td>
<td>23</td>
</tr>
<tr>
<td>Ph.D.</td>
<td>228</td>
<td>31</td>
</tr>
<tr>
<td>TOTAL</td>
<td>387</td>
<td>75</td>
</tr>
</tbody>
</table>

The sample by field was as follows:

<table>
<thead>
<tr>
<th>Field</th>
<th>No. in universe</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics</td>
<td>105</td>
<td>23</td>
</tr>
<tr>
<td>Chemistry</td>
<td>232</td>
<td>41</td>
</tr>
<tr>
<td>Biochemistry</td>
<td>50</td>
<td>11</td>
</tr>
<tr>
<td>TOTAL</td>
<td>387</td>
<td>75</td>
</tr>
</tbody>
</table>
APPENDIX 2

N.B. Questions marked with an asterisk* were on the sheet left with the respondent to be filled in and returned after the interview.

English translation of structured interview/questionnaire used among 75 Turkish experimental scientists in March-April 1978

Questionnaire No. --- ---

1a. University, faculty
1b. Dept./Chair

2. Academic title:
   1( ) Doctoral assistant i.e. Ph.D. 2( ) Doçent or Associate Professor
   3( ) Professor

3. Sex: 1( ) Male 2( ) Female

4. Do you have any administrative duties in the faculty? If so, what are they?
   1( ) no 2( ) yes: ______________________________

5. How old are you? ______________________________

6. Where were you born?
   1( ) provincial capital 2( ) town 3( ) village

7. Where did you spend most time in the first twelve years of your life?
   1( ) provincial capital 2( ) town 3( ) village

8. Including yourself, how many brothers and sisters are there in your family?
   ( ) male ( ) female

9. Are you the oldest child in your family? 1( ) yes 2( ) no

10. Besides yourself, do you have any brothers or sisters engaged in academic activity at university?
    1( ) natural sciences 2( ) social sciences

11. Is your father alive? 1( ) yes 2( ) no

12. (if yes) Does he still work? 1( ) yes 2( ) retired

13. What is/was your father's job/profession?
    1( ) agriculture 2( ) industry 3( )business
    4( ) communications 5( ) service profession

14. In the place where your father works/worked, what is/was his status?
    1( ) employee 2( ) employer 3( )self-employed

15. What is/was your father's position/rank in his job/profession now/when he retired? ______________________________

16. What was the last educational institution from which your father graduated?
    1( ) primary 2( ) middle or equivalent
    3( ) lycee or equivalent 4( ) university or other higher education
    5( ) he did not graduate from any school

17. What was the last school your mother graduated from?
    1( ) primary
    2( ) middle or equivalent 3( ) lycee or equivalent
    4( ) university or other higher education 5( ) she did not graduate from any school
Appendix 2 (contd.).

18. What is your marital status?
1( ) never married 2( ) married 3( ) widow(er) 4( ) divorced

19. Do you have any children? If so, how many?
1( ) boy 2( ) girl 3( ) none

Boy/ Age
If still studying Where is Which profession does he/she want to enter? If not studying What is his/her last education? In which subjects?
Girl
he/she study he/she want to enter?

1st
2nd
3rd
etc.

20. Number of children wanting to become research scientists ........

21. If he/she has/had had the ability, do you want/would you have wanted one of your children to become a research scientist? 1( ) yes 2( ) no

If yes
21a. Would you prefer him/her to become a research scientist rather than a doctor or engineer?
1( ) yes 2( ) no

If yes
21b. Why?

If no
21c. Why?

Now I would like to ask a few questions about your own education.

22. Which lycée did you graduate from and when?

Name of institution
Subject(s) of specialisation
Period of educational specialisation of study
Year of graduation
Who supported you?
Internship years

23. Which institute(s) of higher education did you graduate from and when?

First degree
Masters
Doctorate

24. (If respondent is docent or prof.) When did you become a docent and where?

25. (If respondent is prof.) When did you become a professor?

26. What is the total number of years you have studied and/or worked outside Turkey?

27. At the university, are you engaged solely in research or solely in teaching or in both?
1( ) research only 2( ) teaching only 3( ) research and teaching
Appendix 2 (contd.).

if engaged in (some) teaching

27a. On average, how many hours do you lecture per week?
27b. On average, how many students do you lecture to?
27c. Do you have a job at any other educational institution? If so, how many hours do you lecture there?
27d. Approximately how many hours do you spend per week in preparing for lectures and in reading exam. papers?
27e. Approximately how many hours a week do you spend in meetings and other administrative duties?

28. Can you remember at what stage you decided to become a research scientist?
1( ) at primary school 2( ) at middle school 3( ) at lycee
4( ) during higher education 5( ) after graduating
6( ) can't remember

29. What attracted you to this profession?

30. Who encouraged you the most to enter this profession?
1( ) my father 2( ) my mother 3( ) my brother/sister
4( ) my lycee teacher 5( ) my university teacher 6( ) other_______

31. How many research papers have you published in Turkish scientific journals? _____________

32. How many research papers have you published in western scientific journals? _____________

33. Do you have any research papers which you have written but not published?
1( ) yes 2( ) no

If yes
33a. How many?
33b. Why haven't you published it/them?

34. (if not clear from 33b) Have you experienced any difficulty in getting your research work published in Turkey?
1( ) yes 2( ) no

If yes
34a. What difficulties did you experience?

35. Has anyone (else) in your department experienced difficulty in getting his/her research work published?
1( ) yes 2( ) no

If yes
35a. In what way?

*36. Do you wish you could have published more research papers?
1( ) yes 2( ) no

If yes
*36a. What are the three most important factors hindering you from doing more research? Please choose three of the following and write 1, 2, 3 in the brackets alongside in order of importance.

1( ) My teaching and administrative duties leave me little time for research.
Appendix 2 (contd.).

2( ) I cannot obtain the necessary supplies and apparatus when I need them.

3( ) When a piece of apparatus goes wrong, a long time elapses before a technician can come to repair it.

4( ) Other Turkish scientists do not appreciate the research work I do.

5( ) The international scientific community does not appreciate the research work I do.

6( ) I have difficulty in publishing my research work.

7( ) I have no other research scientist to talk over the problems I meet with during my research.

8( ) Other (please explain) _______________________

*37. Which research scientist of your acquaintance do you admire the most?
Name ................... Academic title ..................
Univ. and dept. .................
Nationality ...................

*38. In your opinion, which qualities make him/her a good scientist? (Please write at least three below)
1.
2.
3.

If you don't mind, I would now like to go on to the subject of education.

39. In your opinion, did the classical school science curriculum encourage the production of good experimental research scientists?
1( ) yes 2( ) no 3( ) don't know

If yes
39a. In that case why was the Modern Science Curriculum Development Project begun? _______________________

39b. Wasn't there anything in the classical science curriculum which hindered the production of good experimental research scientists?
1( ) yes 2( ) no

If no
*39c. In the classical school science curriculum, what hindered the production of good experimental research scientists? With which of the following do you agree or disagree?
1( ) It emphasized memorization.
2( ) It encouraged an acceptance of exactly what the teacher said.
3( ) It did not develop the student's creative ability.
4( ) It did not give the student the possibility of doing as much experimental work as might have been desirable.
5( ) It did not awaken in the student an interest in the natural sciences.
6( ) Other (please explain) _______________________

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Appendix 2 (contd.).

*40. Other than the curriculum, what else in the secondary school system hinders/hindered the production of research scientists? With which of the following do you agree or disagree?

\[\begin{align*}
1 & = \text{agree} & 2 & = \text{disagree} \\
1. & ( ) \text{The quality of the teachers is not high.} & 2. & ( ) \text{The teachers are not trained adequately.} \\
3. & ( ) \text{The classrooms are too crowded.} & 4. & ( ) \text{Other (please explain)} \ \\
\end{align*}\]

41. Now may we move on to the subject of religion? In your opinion during the Republican Period in Turkey, has religion directly or indirectly had a negative effect upon the development of science?

\[\begin{align*}
1( ) & = \text{yes} & 2( ) & = \text{no} & 3( ) & = \text{don't know} \\
\end{align*}\]

If yes

41a. How did it affect the development of science? Please explain.

42. Have you ever heard an older member of the family say "studying science makes a person irreligious"?

\[\begin{align*}
1( ) & = \text{yes} & 2( ) & = \text{no} \\
\end{align*}\]

*43. In your opinion during the Republican Period in Turkey have any mores or customs directly or indirectly influenced the development of science in a negative way? With which of the following do you agree or disagree?

\[\begin{align*}
1 & = \text{agree} & 2 & = \text{disagree} \\
1. & ( ) \text{Children's not generally playing with mechanical toys.} & 2. & ( ) \text{Memorized knowledge being permitted and even thought highly of (for this reason, creative ability cannot develop).} \\
3. & ( ) \text{Great importance being given to inter-personal relationships (for this reason a person prefers to spend time with other people rather than do experiments on his own).} & 4. & ( ) \text{Other customs (please state briefly)} \\
\end{align*}\]

44. Do you think that people in this society have a tendency to accept things as they find them?

\[\begin{align*}
1( ) & = \text{yes} & 2( ) & = \text{no} \\
\end{align*}\]

If no

44a. But expressions such as "What can we do?" and "It's not in our hands" are very common in the society, aren't they?

\[\begin{align*}
1( ) & = \text{yes} & 2( ) & = \text{no} \\
\end{align*}\]

If yes

44b. Now let's think of a research worker. While he is doing his research, he is certain to come across a lot of problems. Do you think that this tendency we have just spoken about, i.e. to accept things as they are, consciously or unconsciously affects the desire and zeal of the research worker to solve the problems he meets with in his research? In what way might this tendency affect the desire and zeal of the research worker?

\[\begin{align*}
1( ) & = \text{lessens it greatly} & 2( ) & = \text{lessens it a little} & 3( ) & = \text{does not lessen it at all} & 4( ) & = \text{don't know} \\
\end{align*}\]

45. (If docent or prof.) If a docent wants to get a job in your field at a university, is he expected to publish other research papers than his docentship thesis?

\[\begin{align*}
1( ) & = \text{yes} & 2( ) & = \text{no} & 3( ) & = \text{don't know} \\
\end{align*}\]
Appendix 2 (contd.).

If yes
45a. Approximately how many? _____

46. And how many research papers would a professorial candidate in your field be expected to have published? ___________

( ) don't know

47. University staff are usually involved in both teaching and research. I would now like you to think of two types of academic:
1. ( ) The first is an academic who teaches well but who does not give much importance to research.
2. ( ) The second is an academic who gives a great deal of importance to research but not much to teaching.
Which of these would you respect more? Or
3. ( ) Would you respect them both equally?

48. Which of the following is more respected in your department?
1( ) The academic who teaches well
2( ) The academic who gives a lot of importance to research, or
3( ) They are equally respected

49. Amongst the graduates from your department, which group wants to go on to do a Ph.D.?
1( ) The best students
2( ) A range of students with differing abilities

If 1,
49a. Why do the best students prefer to do research rather than go into the private sector and earn a lot of money?

If 2,
49b. Why do some of the better students prefer to do a job other than research?

50. Amongst the well-educated and rich people in society, are tasks which involve some manual work looked down upon or not?
1( ) not looked down upon
2( ) looked down upon

If 1,
50a. In that case, why don't well-educated and rich people carry even a suitcase?

If 2,
50b. Some experimental research may require the research worker to do some manual work. Do you think the attitude we have just mentioned might be a reason why an able student might choose not to go into a career in experimental research?
1( ) yes
2( ) no

50c. How does the attitude mentioned above affect a scientist's desire to do experimental research?
1( ) It can lessen it greatly.
2( ) It can lessen it to a certain extent.
3( ) It doesn't lessen it at all.

*51. A research project financed by TÜBİTAK (the Scientific Research Council of Turkey) shows that Turkish experimental research scientists who work outside Turkey or who frequently go outside Turkey publish more research papers than their counterparts who stay in Turkey. Why do you think this is so? Please give at least three reasons below, in order of importance.
Appendix 2 (contd.).

*52. What advantages do western research scientists working in the West have over their counterparts in Turkey? If some of the reasons given in Q.51 apply to this question also, please show this by an arrow).

53. Some Turkish scientists complain that their scientific papers and theses are not evaluated properly, especially by juries. In your opinion, are they right or wrong?

1( ) right sometimes 2( ) right occasionally 3( ) wrong 4( ) don't know

If right

*53a. Do the factors below affect the evaluation of a scientist's work? Please show which of them you think is 1) important, 2) of some importance, 3) of no importance at all by putting a mark in the appropriate column.

The writer of the research paper:
1( ) is of rural rather than urban origins
2( ) has right or left-wing political views
3( ) is a graduate of a particular university or academy
4( ) has tried several times already to get his work approved
5( ) is a member of a non-political clique
6( ) has worked under the supervision of a particular scientist
7( ) The writer's professor influences the jury
8( ) Other (please explain)

*53b. Please put the factors you have considered important above in their order of importance by writing their numbers below:
First( ) Second( ) Third( ) Fourth( ) Fifth( )

54. Do you know of any doctoral, docent or professorial theses which were approved by a jury even though in your opinion they were not of a high enough standard?

1( ) yes 2( ) no 3( ) I've only heard rumours of such

If 1,

54a. How many cases do you personally know about?

54b. In your opinion, why was such research work approved?

55. In nearly every country (including western ones) a few research workers have taken the work of other scientists and presented it as their own. Do you know of any cases of this in Turkey?

1( ) yes 2( ) no

If yes

55a. How many do you know?

55b. Did you or anyone else expose the research scientist(s) concerned?

If yes

55c. Who did the exposing?

1( ) You?
2( ) Another Turk?
3( ) A foreigner?

If no

55d. Why didn't you expose him?

56. Do you think there is any difference between the quality of research papers published in Turkey as compared with that of those published in the West?

1( ) yes 2( ) no
Appendix 2 (contd.).

<table>
<thead>
<tr>
<th>If yes</th>
<th>If no</th>
</tr>
</thead>
<tbody>
<tr>
<td>56a. Is the quality of those published in the West better or worse?</td>
<td></td>
</tr>
<tr>
<td>1( ) better</td>
<td>2( ) worse</td>
</tr>
<tr>
<td>56c. In that case why do some Turkish scientists celebrate when their research work is published in foreign journals?</td>
<td></td>
</tr>
<tr>
<td>If yes</td>
<td></td>
</tr>
<tr>
<td>56b. What do you think is the reason for this?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

57. You will probably agree that the thought of a body of scientists who are publicly prepared to criticise his work makes a scientist publish higher quality work.
1( ) yes | 2( ) no | 3( ) don't know |

58. Do you think such a body of scientists exists at present in Turkey?
1( ) yes | 2( ) no | 3( ) in some fields only |

<table>
<thead>
<tr>
<th>If yes</th>
<th>If no</th>
</tr>
</thead>
<tbody>
<tr>
<td>58a. Have you ever criticised the research of a Turkish scientist either at a conference or in a journal?</td>
<td></td>
</tr>
<tr>
<td>1( ) yes</td>
<td>2( ) no</td>
</tr>
<tr>
<td>58c. Haven't you ever seen a research paper worthy of criticism?</td>
<td></td>
</tr>
<tr>
<td>1( ) yes</td>
<td>2( ) no</td>
</tr>
<tr>
<td>58b. How did the person you criticised react to your criticism?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>58d. Wouldn't you agree that in some fields Turkish scientists hold back from criticising each other's work openly?</td>
<td></td>
</tr>
<tr>
<td>1( ) yes</td>
<td>2( ) no</td>
</tr>
</tbody>
</table>

| If no *58e. Below are some reasons why Turkish scientists may hold back from criticising one another. Which of them do you agree or disagree? Please show which of them you think is 1) important, 2) of some importance, or 3) of no importance at all by putting a mark in the appropriate column |
|--------|-------|
| 1( ) Criticalising the work of a more senior scientist is "not done" |
| 2( ) Since the size of the scientific community in Turkey is rather small, scientists tend to know each other well and so refrain from public criticism. |
| 3( ) Because people in Turkey are less individualistic than people in the West, they are not so ready to criticise each other openly. |
| 4( ) There are a number of other institutions in Turkish society which tend to be authoritarian and which tend to discourage doubt and criticism (for example, the family, religious and educational institutions). |
| 5( ) Scientists are afraid of criticising each other openly because they think that such behaviour may adversely affect their chances of promotion in the future. |
| 6( ) Scientists are afraid that the person being criticised may |
Appendix 2 (contd.).

take it as a personal attack upon himself and become offended.

7( ) Other (please explain) ________________________

*58f. Please write below the numbers of the reasons you considered important in their order of importance
First ( ) Second ( ) Third ( ) Fourth ( )

59. Some Turkish research scientists explain their lack of good research work by the following: the difficulties in obtaining materials and supplies; the lack of essential equipment; the frequent electricity cuts; the lack of well-trained laboratory technicians; a lack of time, etc. Others, however, say that each of these is only an excuse. What do you think, I wonder?
1( ) excuse 2( ) partly excuse, partly correct. 3( ) truth in all of them
If excuse
59a. Apart from the above, what do you think are the real reasons for the lack of research work?

*60. The TÜBİTAK research project mentioned before shows that foreign professors working in Turkey publish more research papers than Turkish professors. Can you offer any explanation for this?

With your permission, I would now like to ask you some questions about your students (and assistants).

61. Do you have any Ph.D. students at present?
1( ) yes 2( ) no
If yes
61a. How many __________

62. How many Ph.D. students have you supervised up till now?

63. Have you noticed that your students hesitate to use experimental apparatus?
1( ) yes 2( ) no
If yes
63a. Why is this? Please would you explain

63b. Do you think such a hesitation to use experimental apparatus might hinder a student from choosing a career in scientific research?
1( ) yes 2( ) no 3( ) don't know

I would now like to ask you a few questions about your own research work.

64. Whilst doing research, has one of your students/helpers ever suggested an alternative approach to a research problem than the one you had suggested?
1( ) yes 2( ) no

65. Does a young research worker normally challenge the suggestions of a more senior research worker?
1( ) yes 2( ) no

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Appendix 2 (contd.).

66. Has your research work ever been criticised in a research journal?
   1( ) yes  2( ) no

   If yes
   66a. Was the critic a Turk or a foreigner?
       1( ) Turk  2( ) foreigner

67. (If respondent has studied/worked abroad) While you were abroad, was
    the quality of the research work you did better, the same or worse than
    research work you have done in Turkey?
    1( ) better  2( ) same  3( ) worse

   If better
   67a. Why was it better?

   If worse
   67b. Why was it worse?

68. Have you ever attended an International Congress in your field of
    research?
    1( ) yes  2( ) no

   If yes
   68a. How many times have you attended?

   68b. How many times have you read papers?

*69. Various suggestions have been put forward concerning the factors which
    hinder the doing of more good experimental research in Turkey. Which
    of these do you consider is 1) important, 2) of some importance, and
    3) of no importance at all?

   1( ) There is a lack of access to current research literature.
   2( ) Creativity is not encouraged by the educational system.
   3( ) It is difficult to obtain supplies and equipment.
   4( ) There are not enough trained laboratory technicians.
   5( ) There is a reticence to use experimental apparatus.
   6( ) There is little motivation to do research.
   7( ) An atmosphere in which critical appraisal is encouraged is lacking.
   8( ) There is a lack of initiative to overcome problems encountered
       during research.
   9( ) There is a lack of co-operation amongst research scientists in
       Turkey
   10( ) There is a lack of research planning within the relevant university
         departments.
   11( ) Teaching and administrative duties leave little time for research.
   12( ) Other factor(s) _____________________ 

*69a. Please write below the numbers of the factors you considered
       important in their order of importance.
       First( )  Second( )  Third( )  Fourth( )  Fifth( )

*70. Which of the following lowers motivation towards doing experimental research
    in Turkey? Please show which of them you think is 1) important, 2) of
    some importance, or (3) of no importance at all, by putting a mark in
    the appropriate column.
Appendix 2 (contd.).

1( ) The results of research are not appreciated by the international community of scientists.
2( ) In Turkey, scientists who do experimental research have no higher status than those who do not.
3( ) The present university system allows a person to be promoted without having to do much research.
4( ) Heads of departments do not encourage research.
5( ) In Turkey, there is not much demand for research from outside the universities.
6( ) Other (please explain) ____________________________________________

70a. Please write the numbers above in their order of importance.

First( ) Second( ) Third( ) Fourth( ) Fifth( )

71. Do you consider that TÜBİTAK's activities in the area of scientific research are adequate?
1( ) yes 2( ) no
If no, please explain:

72. As a last question, what would be your suggestions for improving the quality and quantity of scientific research in Turkey? (Under the headings of what should be done by the government, by TÜBİTAK, and by the universities).

Tallies and answers to open-ended questions are given in Appendix 3.
APPENDIX 3

Tallies of answers given in structured interview/questionnaire, and answers given to open-ended questions

In the open-ended questions, answers already given in the main text will be omitted, as will answers expressing similar sentiments to other answers given. Where appropriate, rounded off percentages are given in parentheses. However, in the open-ended questions, numbers in parentheses refer to numbers of respondents. A few respondents were not asked some questions because of lack of time resulting from unexpected interruptions.

Question
1a. METU HU AU EU BU IU LTU EU
    12 14 13 3 18 7 8
    (16) (19) (17) (4) (24) (9) (11)
1b. See Appendix I.
2. Ph.D.: 31(41), docent: 23(31), prof.: 21(28)
3. male: 52(69), female: 23(31)
4. no: 13, yes: 62
7. Istanbul, Ankara or Izmir: 35(47), other p. capital: 17(22), town: 16(21), village 7(9).
8. Total brothers and sisters of this no. of respondents
    0 1 2 3 4 5 6
    5 19 18 13 6 6 5
9. yes: 31(42), no: 43(58)
10. 11 respondents out of 69 had brothers or sisters who were academics in mathematics or a science subject (applied fields included).
11 and 12. were not tallied; they were lead-ins to 13 - 15.
13. Father's occupation (for 67 resp.):
    Civil service administrator: 16(24)
    Teacher: 7(10)
    Private businessman: 16(24)
    Other administrative position: 5(7)
    Farmer/farm worker: 11(16)
    Army officer: 8(12)
    Factory worker: 4(6)
16. Father's education
    29 (39)
    Univ./higher ed.
    17 (23)
    Lycee or equivalent
    8 (11)
    Middle or equivalent
    18 (24)
    Primary
    3 (4)
    no school completed
17. Mother's education
    2 (3)
    Univ./higher ed.
    6 (8)
    Lycee or equivalent
    15 (20)
    Middle or equivalent
    27 (36)
    Primary
    25 (33)
18. never married: 10, married: 64, divorced: 1, widow(er): 0
19. No. of children belonging to this no. of resp's 8(12)
    0 1 2 3 4
    25(38) 29(45) 1(1) 2(3)
20. Too many of those interviewed had children too young for this question to be meaningful; 6 out of 16 wanted to become research scientists.
21. yes: 31(56), no: 8(14), up to the child: 16(29), not asked: 20.
22. In one of 3 largest cities: 37(49), other p. capital: 15(20), foreign language lycee: 13(17), teacher training institute: 8(11), outside Turkey: 2(3)
23. Where first degree obtained:
    AU IU Germany EU METU France USA Other country
    29 22 5 3 3 3 3 3 2 1 1 0
    (39) (29) (7) (4) (4) (4) (4) (3) (1) (1) (0)
24. and 25. For origin of Ph.D. degrees, see Table 5.20.
    Years after commencement to Ph.D.
    (mean: 4.1 years)
    2(3) 2(3)
    (mean: 4.1 years)
    Ph.D. to docentship**
    2(6)* 2(6)*
    (mean: 5.2 years)
    docentship to professorship***
    3(21) 7(50)
    (mean 6.1 years)
Appendix 3 (contd.).

* obtained before the present regulations appertaining to assistans and docents came into force.

** 35 out of 44 docents and profs.

*** 14 out of 21 profs.

26. Years studying or working abroad: 0 3 wks. 1 2 3 4 5 6 7 8 9 10 11 12
No. of respondents: 10 13 14 3 6 5 3 7 4 4 2 1
3 wks. = 3 weeks - 6 months

27. Led into 27a - 27e. See Table 5.15

28. After graduating: 38(51), while undergraduate: 23(31), at lycee: 10(13), at primary school: 4(5)

29. Once respondents had opted for studying phys./chem./biochem., then becoming an academic would be the best way out of becoming a low-ranking civil servant or poorly-paid secondary school teacher. Entry into phys./chem./biochem. was usually because the respondent could not get into medicine or engineering. This was not a good question, therefore, and was subsequently abandoned.


31. Turkish publications: 0 1 2 3 4 5 6 7 8 9 10 12 15 18 20 30 55
by this no. of resp.'s: 5 12 12 6 8 6 4 2 2 3 5 2 1 1 2 1 1
Mean = 5.9

32. See Table 5.4

33. 34 and 35. Questions omitted after being asked to a few respondents since the questionnaire was taking longer than expected.

36. yes: 72(96), no: 2(3)

36a. The following were marked as one of the three most important factors hindering the respondent from doing more research work (for 72 respondents):

<table>
<thead>
<tr>
<th>Item</th>
<th>Marked by these respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 (supplies and equipment)</td>
<td>No. 64 89</td>
</tr>
<tr>
<td>1 (lack of time)</td>
<td>No. 48 67</td>
</tr>
<tr>
<td>3 (absence of technicians)</td>
<td>No. 45 62</td>
</tr>
<tr>
<td>7 (no-one to talk over res. problems with)</td>
<td>No. 16 22</td>
</tr>
<tr>
<td>5 (res. unappreciated by international scientists)</td>
<td>No. 7 10</td>
</tr>
<tr>
<td>4 (resp. unappreciated by Turkish scientists)</td>
<td>No. 2 3</td>
</tr>
<tr>
<td>6 (difficult to publish)</td>
<td>No. 1 1</td>
</tr>
<tr>
<td>8 Other</td>
<td>No. 2 1</td>
</tr>
</tbody>
</table>

Included under "Other" were the following:
Lack of good quality research assistants (4), student troubles (2), electricity cuts put our equipment out of order (1), lack of money to buy high-quality equipment (1), lack of trained technicians (1), lack of time due to having to work elsewhere to maintain living standards (1) and having to give lessons in other branches of chemistry outside my field when I was at the provincial university (from which I transferred a few months ago) (1), no agreement in Turkey on what constitutes quality (1), not enough encouragement is given to researchers by university administrators (1), we are cut off from the rest of the scientific world (1), language problems make publishing difficult (1), research assistants have to work on the topics their professors give them (1), it is difficult to choose a workable research topic (1).

37. Answered by 54 scientists, who gave 43 foreign and 11 Turkish scientists; 3 respondents gave no name, but answered Q.38 nevertheless.

38. This question was designed to test those characteristics the respondent felt belonged to an outstanding scientist. To avoid a cliché-type answer, the respondent was first asked to name an outstanding scientist whom he knew personally. He was then asked to give at least 3 characteristics which in his opinion made the scientist a "good" scientist. In this way, it is
possible to gain an understanding of the concept of a "good scientist" held by the sample of respondents. The question was entirely open, with no clues or hints given.

57 of the 75 respondents answered, each one giving between two and six characteristics. The characteristics may be grouped into various categories. Under one heading may be put what might be termed "natural abilities", such as creative mind (mentioned by 7 scientists), high intelligence (6), ability to perceive productive lines of research (3), self-confidence (2), having drive and energy (2), and "the potential found within him (3)".

Another set of characteristics may be grouped under the heading "personal characteristics". These included industriousness (15), persistence in research (12), wholehearted devotion to science/research (6), curiosity about his topic (2), objectivity (4), humility, readiness to listen to others (6), openness to new ideas (3), readiness to criticize his own work (1), showing of initiative in overcoming research problems (1), ability to obtain materials and equipment (3), ability to make decisions and follow them through (1), and general "personal characteristics" (11).

Characteristics vis-à-vis other research scientists included ability to work well with others (6), ability to secure good contacts throughout the scientific community (5), desire for scientific exchange with other scientists (1), ability to inspire and enthuse others to do research (4), desire to pass on knowledge to others (2) and "being a humanist" (1).

With the rider that some characteristics may go under several headings, another set may be identified as those characteristics which have come about through training. In this category comes the possession of a wide background knowledge/good education (13), an ability to keep on top of the subject (9) coupled with an ability to keep abreast of current developments (10), a wide experience (4), and a knowledge of foreign languages (4). Also being well organized/having objectives (4), being disciplined (1), knowing when to work and when to relax (3), possessing knowledge of areas outside his/her own field (2), having an ability to do careful research (4), having systematic and "rational" methods of working (5) and resting his theories on strong lab.-work (2).

Under a final heading come "advantages due to his surroundings", such as working with a good research team (4), being encouraged by the surrounding research atmosphere (10), having no problems with equipment or technicians (4) and being highly valued as a scientist in his own country (1). One respondent darkly hinted that the scientist he mentioned might have materialistic and psychological motivations which no one knew about!

Analysis

Amongst the "natural abilities", I have put "creative mind", mentioned by 7 scientists. However, a naturally creative mind can be blunted by an educational system which discourages creativity. 5 scientists mentioned self-confidence or characteristics such as drive, which is akin to it; this is significant, since several scientists mentioned that they felt Turkish scientists possessed an inferiority complex.

Turning to personal characteristics, we note that hard work, persistence and wholehearted devotion to science feature high on the list - 33 mentions in all. Such characteristics point to high motivation, as do keeping on top of the subject and abreast of current developments - 19 mentions. Being humble, ready to listen to others, objective and honest gain a total of 15 mentions.

Some characteristics are formed more by training than others are. For example, a good scientific training or wide background knowledge were mentioned by 13 respondents; systematic work or the use of rational methods by 5, care in research by 4 and being empirically minded by 2. A knowledge of areas outside his own field (2 mentions) and a grasp of a
variety of physical problems (1 mention) may also be due to good education. Being disciplined and well organized (8 mentions) suggest training and also motivation.

Finally, some respondents saw the stimulus of a "research atmosphere" (10 mentions), working with other good scientists (4 mentions), being in contact with other research scientists (6 mentions), and being highly valued by society at large (1 mention).

Conclusions

What characteristics do Turkish scientists admire in scientists they look up to? Presumably the ones they mentioned were not obvious in other more "normal" scientists. Since 43 of the 54 scientists mentioned were foreigners, it would not be amiss to hypothesize that the characteristics most often mentioned were ones that they felt were abnormal in the Turkish scientific milieu. Dedication to science as revealed by hard work and persistence came out top. Next came keeping on top of one's subject. These both imply a very strong motivation, perhaps due to greater rewards for the same amount of effort or stronger research expectations.

Entries under "Other" included: lessons not relevant enough to everyday life (2), too many hours given to non-scientific subjects such as history and geography (3), trying to copy different curricula from different countries at different periods (1).

Included under "Other" were the following: not enough books (2), not enough teachers (3) due to poor pay (2), the educational system does not seem to have any aims and objectives (1).

Included under "Other" included: lessons not relevant enough to everyday life (2), too many hours given to non-scientific subjects such as history and geography (3), trying to copy different curricula from different countries at different periods (1).

Included under "Other" were the following: not enough books (2), not enough teachers (3) due to poor pay (2), the educational system does not seem to have any aims and objectives (1).

Enter your response here.
Appendix 3 (contd.).

43a.

Entries under "Other" included: not sending girls to school in country areas (3); our main value is to make a living, and so more lucrative professions are preferred (4), no real support for science in the background a child is brought up in. Also see entries in the main text.

44. This question usually involved some discussion which had to be narrowed down (in the interests of time) to the specific situation described in Q.44b.

44b. lessens it greatly: 2 (3) doesn't lessen it at all: 26 (37) lessens it a little: 39 (56) don't know: 3 (4)

45 and 45a. Research publications (Turkish and foreign) expected of an incoming docent

<table>
<thead>
<tr>
<th>Faculty/Program</th>
<th>AU</th>
<th>BU***</th>
<th>EU</th>
<th>HU</th>
<th>IU</th>
<th>ITU</th>
<th>METU***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry</td>
<td>2, 2, 2, 5*</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>7<em>8</em>2,1,3</td>
<td>1,0,0</td>
</tr>
<tr>
<td>Physics</td>
<td>5, 3, 6</td>
<td>-</td>
<td>1,1</td>
<td>6,3,0</td>
<td>2,5</td>
<td>-</td>
<td>8,2</td>
</tr>
<tr>
<td>Biochemistry</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>4,3</td>
<td>3** 6**</td>
<td>-</td>
<td>3</td>
</tr>
</tbody>
</table>

* Faculty of Pharmacy, ** Faculty of Medicine, *** Stipulated foreign publication only

46. Research publications (Turkish and foreign) expected of a professorial candidate:

<table>
<thead>
<tr>
<th>Faculty/Program</th>
<th>AU</th>
<th>BU***</th>
<th>EU</th>
<th>HU</th>
<th>IU</th>
<th>ITU</th>
<th>METU***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry</td>
<td>3-4, 4-5</td>
<td>10-15</td>
<td>-</td>
<td>5-6, 7-8</td>
<td>3-4, 4-5</td>
<td>3-4</td>
<td>6-7,10,15</td>
</tr>
<tr>
<td>Physics</td>
<td>6, 8-9, 15</td>
<td>-</td>
<td>2-3, 3-4</td>
<td>3-4, 4-5</td>
<td>5-6, 9-10</td>
<td>-</td>
<td>10+, 10+</td>
</tr>
<tr>
<td>Biochemistry</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>10-15, 13</td>
<td>15-20*</td>
<td>-</td>
<td>8</td>
</tr>
</tbody>
</table>

* Faculty of Pharmacy, ** Faculty of Medicine

47. 1: 16(22), 2: 28(39), 3: 28(39)

48. 1: 9(13), 2: 37(52), 3: 23(32), don't know: 2(3)

49 - 49b. After several respondents, these questions were omitted to gain time, since all respondents until then had said only very good students were taken on as assistant.

50. not looked down upon: 1(2), looked down upon: 63(98)

50b. yes: 13(20), no: 50(77), don't know: 2(3)

50c. 1: 0, 2: 19(30), 3: 45(70)

51. Responses given by 52 respondents who had been abroad included:
a) Re. better facilities/organization of research: better equipment and other facilities (49); more time to do research - fewer outside distractions and less teaching and administration (21); more and better technicians and research assistants (5); laboratories are already well organized/established (8); less bureaucracy (1); easier to obtain financial support abroad (1).
b) Re. motivating factors: there is a "research atmosphere" there with everyone around you working hard/more research planning (20); people work more in teams abroad, which encourages you to work better (6); Turks abroad work harder because they do not want to be shown up (3); Turks going abroad are more highly motivated (presumably because they go to obtain a degree) (4); abroad those who do research are rewarded, those who don't are not (1); abroad more value is given to research (2); outside Turkey, research is regarded as a more natural activity (1); your research problem is already clearly defined, the research team already established (5); there is a greater opportunity to choose research topics, because of a wider range of equipment (2).
c) Re. communication and intellectual exchange: it is easier to follow
the current literature (15); there are more people to talk to about your research problems and the latest developments (15); you are closer to the latest developments (4); there are more people to talk to who have a greater knowledge of the subject (3); there is more criticism and better evaluation (1); there is a social atmosphere in labs abroad conducive to doing research (1).

d) Re. ease of publishing: knowing the foreign language better helps you to follow the current literature and to publish (6); it is easier to publish together with a western scientist (2).
e) Miscellaneous: those Turks who go abroad or who live abroad are usually good at research anyway (1); competition gives greater possibilities to better people (1).

52. Many of the above were mentioned again by similar numbers of respondents. Also: they know a language widely used in the scientific world (6); there are more financial and emotional rewards for successful researchers (4); more co-operation between the universities and industry (3); more competition (2); fewer or no family and other social problems to influence their work (3); better personal relationships (1); greater organization and discipline there (2).

53. See Table 5.7
53a. See Table 5.10
53b. This, and the similar 58f, 69a and 70a seemed to require an evaluation of importance which respondents found difficult to give, and so the results have not been counted.

54. See Table 5.8
54a. See Table 5.9
54b. Comments are found in the text.

55. Yes: 11, no: 53
55a. 5 knew of 1 case each, 5 of 2 cases each, and 1 of 3 cases.
55b. No: 11
55d. Answers discussed in the text.

56. Reasons given included: the referee system has not developed properly in Turkey (36); Turks send their best work abroad (28); people here are tolerant of poor work to "encourage" people - especially young researchers (3); lack of qualified people in the field (5); no publishing tradition here yet (2); generally lower standards here (4); we tend to copy what is done in the West, so we can't publish there (1); no "research atmosphere" here in Turkey (3); promotion here depends on obeying rules about numbers of research papers, the quality of which is not looked at, and so people publish the minimum with the minimum quality (1); in the West, there is greater competition (6), more of a research tradition (3), more communication between scientists (2) and more possibilities to do a wider spread of experiments and so more original work (7).

57. Yes: 74, not asked: 1
58. Yes: 37(50), no: 13(18), only in some fields: 24(32)
58a. (to the 37+24 = 61) Yes: 28, no: 14, no answer: 19
58c. (to the 14) Yes: 2, no: 8, no answer: 4
58d. (to the 61) Agree: 5, disagree: 12, agree but only in some cases: 44
58e. (only 6 respondents did not reply to parts of this question, 4 of whom were the late-comers, which means that some of the 12 "disagrees" in Q.58d still answered parts of this question.) See Table 5.2. Entries under "Other" included: lack of qualified people in the sub-discipline (5); lack of confidence in one's ability to criticize (5); fear of the caprices of senior academics (1); people don't take enough interest in each other's work (1).

59. Excuse: 4(5), partly excuse: 50(67), truth in all of them: 21(29)
59a. a) Re. role facilities. Lack of "research atmosphere" (15); lack of "research tradition" (8); not enough researchers with a good basic training (9);
lack of time (11); many of us commute to other universities or take on other "moonlighting" jobs, have too heavy a teaching load, or are hindered by student problems; lack of co-operation - it is often difficult to use other people's facilities (4); lack of organization (1); lack of trained technical assistants (1); people in the same sub-discipline are spread out across the country instead of being in the same research team (2).
b) Re. incentive to do research: general lack of motivation (7); promotion is not linked with whether or not we do research (2); research is not appreciated or rewarded financially or in other ways (6); there is no "publish or perish" syndrome here as exists in the West (2); there is no demand from outside or inside the university (4).
c) Personal attitudes: discouragement/lowering of morale due to student troubles (4), a piling-up of minor difficulties (4), personal problems (2), comparing ourselves with counterparts in the West, with all their facilities (2); people are lazy (We got used to not working in Ottoman times) (2); there is a knowledge gap between us and our Western counterparts and so it is easier to do teaching rather than have all the bother involved in trying to keep up with the latest research (1); lack of curiosity (3)
d) Miscellaneous: it is difficult for us to learn foreign languages (2); people who come into research in Turkey are not of a high enough quality (1); the quality of our research reflects the general structure of society in Turkey (1); the inadequacies of the way of life in Turkish society affect our research (2).

60. The idea was rejected by 4 respondents and 10 did not respond, making 61 respondents. Responses included:
a) Advantages gained before coming to Turkey: they are more used to doing research (16); better trained (12); more self-confident (5); more experienced (3); more creative (1); they see publishing as the natural end to research (2); they can simply continue what they have already started outside Turkey (6); they know a foreign language which helps with publishing and with following the current literature (6); they have a greater working discipline (12); they are used to working at a certain pace, and keep up this momentum when they come here (1)

b) It is easier for them to do research in Turkey than it is for Turks, because: they usually have lighter teaching and administrative loads, and so can give more time to research (23); they are more closely in touch with the necessary stimulating environment outside Turkey (22); they are more in touch with recent developments (9); the university authorities help foreigners more by, for example, giving them better facilities (14); they are usually better paid, and so do not have the same personal and financial problems (2); they can get their friends abroad to help by sending chemicals, etc. (4); they only come to universities where there are good research facilities (1); they are able to go to scientific congresses and conferences more often (1).
c) They have a greater motivation to do research/publish because outside Turkey numbers of publications are considered important (3); they know their time here is limited and so they want to accomplish something during that time (3), they want to show a good example to Turkish researchers (2).
Appendix 3 (contd.).

66. Yes: 0, no: 65
67. better: 28, same: 27, worse: 1, not been abroad for long enough: 15, not asked: 4
67a. a) Re. facilities: better labs. and equipment (20); technicians (1); living conditions (1); more time to do research (7); all the equipment was already set up (1)
b) Effect of other scientists there: abroad there was/were a "research atmosphere", with everyone around you doing research (11); more co-ordination between scientists and so you could get them to do certain tests for you quickly (1); more people to talk over research problems with (5); more shared excitement of discovery which is missing in Turkey (1); better team-work (1); more was expected of you there (1)
c) Miscellaneous: abroad, I had greater motivation (1); fewer university, social and personal problems to lower morale (2); and greater self-criticism (1)

67b. I was tied to my supervisor's whims, and he was tied to a certain value system; also, quantity not quality is more important in the West (1).

68, 68a and 68b. See Table 5.6

69. See Table 5.3. Under "Other", comments included: lack of demand from industry (2); lack of overall planning (1); lack of finance (1); student troubles (2); cliques reduce the pleasure of research (1); problems of university administration (1); colleagues around you are primitive in their make-up and personality (1); the desire to do research is crushed under the weight of bureaucracy (1); inability of scientists to work together (1); promotion does not depend on research done but on a statutory thesis (1); the invention of various excuses for laziness (1); those who don't do research are a bad example to each other - without realizing it, they spread laziness around like the plague (1)

70. See Table 5.26. Under "Other" were the following entries: difficulties in getting equipment and supplies (1); too heavy a teaching load (2); too many bureaucratic formalities and procedures (1); not enough financial rewards for researchers (1); the uncertainty of continued research support (1); rivalry between departments/chairs close to each other (1); "primitive" co-workers wreck your research (1); importance is given to individual rather than team work (1); lack of encouraging working atmosphere to support work that is done (1); the supporting institutions don't check up or evaluate what they are supporting (2); no demand from industry (1); the political situation (1).

71. adequate: 21(29), inadequate: 47(65), don't know: 4, not asked: 3
   a) Re. improving communication between scientists: TÜBİTAK should co-ordinate research more (4), improve communication between scientists (9), hold conferences for small groups of researchers more often (2), support publishing more (1), perhaps by publishing a journal in each sub-discipline instead of each faculty publishing its own journal (1)
b) Re. research institutes/centres: TÜBİTAK should open more research institutes (3) or a central research centre (1); invite academics to do research at special research institutes or to use the facilities at other research centres (2).
c) Re. TÜBİTAK research projects: it should support projects more relevant to Turkey's needs (6); distribute projects more carefully and more fairly (4); exercise more control over the projects it supports (3); lessen the paper-work involved in its projects (3); work more quickly in considering project applications (1); finance more groups (1); bring together every summer people working on the same projects (1).
d) General comments: it is influenced too much by personal (6) or political (2) considerations; it has no real science policy (3); it should increase the number of post-doctoral fellowships (4); it should supply small amounts of foreign currency (1); it does not use its potential (1); it should have a committee to advise young research assistants on what topics to investigate (1).
Appendix 3 (contd.).

72. (by 71 respondents) suggestions included:

a) General:- There must be a national science policy, defined by TÜBİTAK and geared to the needs of the country (there is not even a Science Committee in Parliament) (9).
- More money should be allotted for the development of science (11), for researchers who will meet Turkey's needs, such as in the area of energy (4), for scholarships for going abroad (2) and for bright students (1).
- The government should make it easier to import equipment (7)

b) Changes in the educational system:- The system should be changed from primary school to lycee so as to be more relevant to life and to prevent memorization, create a love for science and help people learn foreign languages better (22)
- The number of trade and technical schools should be increased to train up more technicians ("especially those who look after equipment worth 50 million TL") (7)
- There should be more labs, more books and better teachers at lycee level (3), more teachers (3).
- The number of lessons in the middle schools and lycees should be reduced (2).

c) Changes at university level:- The university law should be changed so that those who don't do research don't get promoted (8).
- The universities should not take so many students (7)
- The universities should be broken down into smaller administrative units (1).
- The chair system should be abolished; one man can influence everything for the bad (1)
- Better-trained academics are required (1), especially for new universities, which should not be opened before such staff became available (2)
- Professors must be made to take on more research assistants or be thrown out (3).
- Researchers should not have to teach (3), or be involved in administration (1).

d) Re. co-ordination and communication:- More co-ordination is needed between universities - they do not know what each other is doing (8), and they could co-operate over the purchase and use of equipment (4).
- More money should be available for people to get together, which will exert a peer pressure (4)

e) Re. industry's role:- Industry must be made to co-operate more with the universities; at present it doesn't think we can help at all (9).
- There should be research labs. in every branch of industry (1).

f) New institutions required:- More research institutes should be opened and made to function properly (7); I disagree (1).
- Research groups should be set up in certain fields (1)
- Documentation centres (say, one per city) need to be opened (5)
- We need to found basic research graduate schools in mathematics, physics, and chemistry and put the best students there with very good professors for 1-2 years (1)

g) More rewards for research:- From foundations or other sources (cf. Rockefeller and Ford Foundations' support for research) (6)
- People need to see that their research is appreciated; abroad young scientists are encouraged a lot by their professors and this stimulates them to do more (2)
- Societies like the Royal Society need to be founded to give honorific rewards (1)

h) Changes needed in society:- Society needs to change its idea that everyone should go to university (which pushes students into subjects they really don't want to study) (6)
- We need to arouse the interest of the public in science by use
Appendix 3 (contd.).

of the mass-media (2)
i) Miscellaneous: We need more scientific links with other countries (2), a better way of choosing scientific equipment (1), basic texts translated into Turkish (1), more foreign experts (3), a better knowledge of foreign languages (4), research projects we can do with our own equipment (2), more basic research than applied research because the former feeds the latter (2)

General comments which came out in interviews but which were not included in the text

--- People don't want to go to Trabzon (a university in N.E. Turkey) because there are no good hospitals, schools for their children or recreational facilities. There is some good equipment there, but a lot is still in crates (1978).

--- I was born in a village in the mountains. My elder sister was the first one in our family to go to school. She persuaded my father to send me to school after she had gone to a village institute to become a teacher. In any case, my father was a man who did not believe in superstitions but in realism and truth. The other villagers thought he was crazy.

--- I think the main problem with respect to research in Turkey is the economic one. To make ends meet, faculty members take on outside jobs, and this interferes with their research (2 professors).

--- I went to France to study, and won a prize for coming first in the Honours List. This made a great impression on my life and wedded me to science.

--- Professor F.H. Constable, Professor of Physical Chemistry at Istanbul University, had 9 Ph.D. students when he died at a good age.

--- Some governments don't give enough importance to science. Throughout history this has helped the development of science. When Turkish governments have given importance to science, science has gone ahead.

--- There is bad organisation in libraries and between chairs. For example, we had some money with which to set up a library, and this was done. But then none was allotted for the future. As a result, since 1973 even Chemical Abstracts has stopped coming to us.

--- The university administration does not seem to differentiate between successful and unsuccessful researchers. I believe that there is a need for successful researchers to be encouraged somehow.
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