Towards a new paradigm: an examination of the interface between design and ergonomics through the use of case-study methods

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TOWARDS A NEW PARADIGM : AN EXAMINATION OF THE INTERFACE BETWEEN DESIGN AND ERGONOMICS THROUGH THE USE OF CASE-STUDY METHODS.

by

Steven W. Garner  B.A. (Hons). PGCE.

A MASTERS THESIS

Submitted in partial fulfilment of the requirements for the award of

Master of Philosophy
to Loughborough University of Technology

Department of Design and Technology.

February 1988

© By Steven W. Garner.
This thesis is the original work of Steven W Garner.

Neither the thesis nor published work nor the original work contained herein has been submitted for an award of this or any other university or the CNAA.
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DIAGRAMMATIC REPRESENTATION OF THESIS STRUCTURE.

Introduction

The Parent Domains of Design and Ergonomics

The Case-Study Approach

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Ergonomics
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Analysis and Conclusion

- 1 -
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By its very nature the research was bound to seek out people who defy categorisation. Their activities necessitate working across the traditional design/ergonomic boundaries. To most of the subjects of this study it is a daily occurrence. Contributions to this research have come from many quarters and I am indebted to such experienced ergonomists as Professor Stuart Kirk of Loughborough University, Dr. Ian Gailer of the Institute for Consumer Ergonomics and Mr John Wood of CCD in Weybridge who allowed me time and access to their institutions and staff. The same thanks are due to a number of eminent designers who provided evidence from their domain and which enabled me to define the nature of the contemporary relationship between design and ergonomics. These have included Mr Alan Williams of DCA in Warwick, Mr Ken Baynes, designer, educationalist and author, and Mr Mike Hall of Loughborough University.

Special thanks go to Olle Bobyer of Ergonomi Design Gruppen and Erik Hannson and Jorgen Winkel of the Swedish Board of Occupational Health and Safety, all based in Stockholm. I would particularly like to thank Sten Engdal and his family who were so hospitable during my stay in Sweden. In terms of production I am grateful to Sue Beaumont for her efforts in word processing the vast majority of the raw text for this thesis - a service that made my task an achievable one.

ABSTRACT

Towards a New Paradigm: An Examination of the Interface between Design and Ergonomics through the use of Case-Study Methods.

Both the designer and the ergonomist occupy important positions within our industrial society. Traditionally their contribution to this society has suffered from both public and professional misunderstandings regarding the role of each. To compound this issue both professions are undergoing radical changes in the light of a developing sociological, technological and commercial environment. This research is focussed on one aspect of this change; that is, the nature of a developing relationship between design and ergonomics. It presents this relationship as an interface and attempts to illuminate the richness and variety of design/ergonomic activity at this interface.

Chapter Two presents an overview of what has been termed the 'parent' domains of design and ergonomics, while Chapter Three seeks to establish the validity of employing case-study methods for an illumination of the interface. This dwells upon the work of Thomas Kuhn and uses his notion of 'paradigms' to assist in the definition of a contemporary relationship. Chapters Four and Five present a thorough analysis of the sixteen case-studies used for the research. They provide evidence for viewing design/ergonomic activity as a widespread and increasingly independent phenomenon. This is shown to have implications for higher education as well as the professions of design and ergonomics.
CHAPTER ONE

1.0 INTRODUCTION

Historically, the relationship between designers and ergonomists has, to say the least, been cautious. One feels that both camps have only just moved into a period of maturity. They have only recently, grudgingly acknowledged areas of each others contribution while vociferously confirming some stereotypical image of secondhand origin. 'Stylists and colourists' says the label undeservedly hung around the collective neck of the design professions. 'Mere common sense' is a phrase unkindly used by designers to describe the human factors assistance proffered in the realisation of some new product or service. Often it has been seen only as anthropometrics. It may be acceptable for the lay person to remain ignorant of the strategies, skills and potential of designers and ergonomists but for these skilled groups of professionals to do so is simply bad management.

The relationship between ergonomics and design is not a new question. It was sought over 35 years ago and the debate continues. The research has taken three years to collect and reveals major reasons for extending this debate. It started out with the intention of assisting both designers and ergonomists to understand the strategies and objectives that lay within the others working procedures. However it became clear that complex working relationships were already well established, albeit in small pockets, and the focus of the research soon shifted to an examination of the nature and occurrences of such an interface between design and ergonomics.
1.0 Since the period of immaturity referred to above there have been a number of major changes in the fields of both design and ergonomics. These have reflected wider changes within society as a whole. Technological and commercial developments have prompted many of these while new demands have altered the way in which both design and ergonomics can contribute in such an environment. New knowledge has brought into question that which has long been accepted. Central to the research is the notion that design and ergonomics exhibit an interface, an area of common concern that is the result of the contemporary developments highlighted above. There would be clear implications for both professions as well as students of both areas if the rich nature of the relationship occurring at this interface could be illuminated. This research attempts such an illumination.

1.1 RESEARCH METHODOLOGY

The choice of research methodology was a decision of the utmost importance. The widespread but diverse instances of combined design and ergonomic activity led to a cautious approach in the definition of the activities. While the 'parent' domains of design and ergonomics could provide some assistance it was important to remember that 'hybrid' examples at this interface could exhibit qualities entirely separate from their parents. It was for this reason that a case-study approach was adopted. A number of authors, particularly those active in the social sciences have questioned the universal validity of research strategies that set out to prove or disprove theoretical assumptions. While researchers such as Parlett and Hamilton in education or Bromley in the field of psychology acknowledge the applicability of such hypothetico-deductive strategies in certain situations, they have gone to great lengths to demonstrate that it may do little more than reveal only the anticipated. They argue that illumination of the complexity of interaction is far more likely to reveal a 'truth' than a series of proven conclusions. Case-study methods have allowed the investigation of each occurrence of design/ergonomic activity as a separate but rich instance of the aforementioned interface.
1.1 The thesis is concerned with the presentation of two aspects of the research. The first of these involve a justification of a research methodology appropriate to the domains of design and ergonomics. Essentially the thesis seeks to establish the validity of a case-study approach for this work. The second part presents the analysis of the research programme that is based on case-study methods. In order to facilitate this examination the sixteen case-studies are presented as four groups. These are; the Institute for Consumer Ergonomics; the Design/Ergonomic Interface in Sweden; British Consultancies Active at the Interface; and forthly, Design and Ergonomics in Education.

1.2 INTRODUCTION TO RESEARCH CONSIDERATIONS

The early stages of this research were motivated by a perplexity as to the nature of the relationship between design and ergonomics. It was a perplexity that had developed as a result of general involvement in design and related matters over the last decade but which had only been brought into focus recently. Although relatively young subjects, both design and ergonomics have made a deep and profound impression on our industrial and technological society. Increasingly, nowadays, interest has been focussed on the relationship between the two subjects. It is an interest reflected in the popularity of public exhibitions such as Natural Design, held at the Victoria and Albert Museum in 1985, and the establishment of the new Design and Ergonomics Forum at the Royal College of Art, under Denis O'Brien. This research contributes to the growing interest by investigating a number of instances of what may be termed design/ergonomic activity.

While much has been written on the multi-disciplinary and distinct nature of the parent domains of design and ergonomics very little research has been undertaken to record the nature of the activity that occurs at the interface, even though evidence of its existence surrounds us in the products and systems of our man-made environment. The people that form this interface appear to develop skills of working and communicating across a perceived divide.
1.2 How this is done is still unclear but it has provided the focus for continued research projects like that at the RCA.

This research deliberately restricts the analysis of these parent domains for two key reasons. Firstly, a great deal of literature is available concerning the domains but it has largely been written from a standpoint within the domain, i.e. based on the assumptions and values of that particular group. Therefore the objectivity of the interpretation will be questionable. Secondly, the immense scope of these parent domains necessitate a restriction of the analysis to the area of common interest or overlap. The greater part of the domains involve activities and interests entirely separate and a comprehensive analysis of these would not contribute to an understanding of their joint functioning. Activity of this nature is termed 'design/ergonomic' in order to differentiate it from that of the parent domains of design and ergonomics.

The research sets out to illuminate the richness and diversity of design/ergonomic activity and presents historical as well as contemporary manifestations of the interface. However, the major part of the research is taken up with a detailed analysis of specific occurrences or cases drawn from a variety of commercial and research institutions both in Britain and abroad. Other manifestations of the relationship were found in educational practice from the rather general school-based experience to the complex and sophisticated models presented by higher education.

The perplexity referred to earlier stemmed from two realisations that had grown out of an ill-defined and sporadic process of investigation and which led up to the establishment of more formal research procedures. These realisations were:

a. That instances of design/ergonomic activity appeared to be increasing on a number of fronts. Consultancies were exploiting increasingly diverse teams where design and ergonomic specialists were expected to contribute to a common objective. Furthermore many companies were now establishing complex
research and development capabilities which necessitate the interaction of designers and ergonomists, as well as other specialists, in a multi-disciplinary way that has not been experienced before.

Partly in recognition of these and partly for reasons not made immediately explicit, higher education had developed the nature of the experience it offered to students of both subjects, for example, the employment of ergonomists to teach on design courses. Increasingly this development involved the inclusion of simultaneous exposure to design and ergonomics, usually via project work.

b. The second realisation involved the nature of the relationship. Although there was evidence of increasing instances of the type described above, it appeared from early observation of a number of these instances that they exhibited more differences than similarities. That is, while the observed instances exhibited procedures that were occasionally similar to one or other of the 'parent' groups, they appeared to display few features common to each other. Instances of design/ergonomic activity appeared to exist in isolation. In other words they appeared to be characterised by their uniqueness rather than by any family resemblance.

It was apparent that any research strategy employed to investigate instances of this design/ergonomic activity would have to acknowledge their diverse and perhaps unique nature. In a search for a suitable strategy two approaches were considered. One based on the values of natural science and the other based on those of the social sciences. These approaches are considered in greater detail in Chapter Three.

1.3 THE SEARCH FOR A SUITABLE STRATEGY

If design and ergonomics are multi-disciplinary, involving the integration of many different fields, then the application of an individual research method drawn from the natural sciences, the social sciences or any other domain, would appear to be insensitive
1.3 and inappropriate to a true analysis of the phenomenon. Thomas cont. KUHN's book, *The Structure of Scientific Revolutions*, illuminates this issue. In this he refers to sets of assumptions and values that are defined and accepted by members of a given community. He calls these assumptions 'paradigms' and presents a case for viewing the natural and social sciences as a series of paradigms which guide the selection and evaluation of evidence. As time passes more and more evidence appears that does not fit the paradigm. KUHN proposes that this is at first ignored or explained away, but that eventually the evidence becomes so overwhelming that the paradigm is overthrown in a 'scientific revolution'. A new paradigm is established and normal science resumes.

If KUHN's argument is credible, as many authors seem to acknowledge, then it has many implications for this research project. Increasingly this interface between design and ergonomics appears to be developing an identity of its own. An apparent independence is being established by many practitioners in the field but unfortunately the identification of this independence relies on tools which are drawn from the existing paradigms of the natural and social sciences. A 'clean' research procedure is sought that allows the evidence to indicate the existence of any paradigm.

1.4 THE CASE-STUDY APPROACH

There is a vast amount of information available concerning research methods and this has been fully exploited in order to provide and justify an appropriate strategy. The methodology underpins the validity of the whole research. To have engaged in a strategy without first exploring alternatives, would have seriously weakened the quality of the research.

The method of investigation chosen for this research is that of case-study analysis. Case-study is not the name for a standard methodological package. It is a complex and eclectic family of research methods that attempt to focus an enquiry around an instance. If anything it associates itself with the illuminative paradigm rather than with the experimental paradigm found in both natural and social
1.4 science. However this is not to say that it is limited in research methods. Case-studies are an agglomerate of methods, free to adopt new ones if these can be shown to be suitable for the further illumination of the instance in which they are applied.

Sixteen examples of the design and ergonomics interface have been chosen, four from education and twelve from the commercial world. In order to facilitate the examination of these case-studies they have been presented as four groups and these correspond to the four sections in chapter Four of this thesis. Each case-study presents a working relationship that has been developed for its own particular needs. They are therefore widely different in their scope, intentions, personnel and application. Because of this diversity the definition of any potential paradigm is approached cautiously so as not to colour the detailed descriptions of the case-studies or mask subtle trends. Although case-study is a diverse and varied technique the emphasis in this thesis is on focussed interview. Some of the institutions investigated comprise up to five of these focussed interviews.

Case-study methodology is well documented in the social sciences. It is a method sensitive to the belief that knowledge is not an absolute truth, but a product of its social context. It acknowledges that every research method is a means of producing knowledge, not collecting it. Ideally the case-studies should allow illumination of any paradigm within which they operate. Similarly any tentative thoughts on the existence of a possible new or hybrid paradigm should extend the illumination and interpretation of the observations made during each case-study. KUHN identifies one such illuminative thought when he refers to the formative stages of the normal sciences as 'pre-paradigm'. Only the case studies can provide evidence that design/ergonomic activity may also be experiencing a pre-paradigmatic state.

It was suggested earlier that an extensive analysis of the parent domains of design and ergonomics would do little to illuminate the design/ergonomic interface as it operates today. However, by way of
1.4 Introduction to these domains, Chapter Two presents a concise overview of an historical and contemporary relationship as defined by a number of practising designers, ergonomists and researchers.
CHAPTER TWO
THE PARENT DOMAINS OF DESIGN AND ERGONOMICS

2.0 DEFINITIONS AND RELATIONSHIPS

The sheer scope of both domains renders design and ergonomics very difficult to define in anything but the most general of terms. In 1979 the Design Council published the findings of a working party under the chairmanship of Professor David Keith-Lucas. It was a consultative document concerning the aims of design education at secondary level and it contained the following definition of design.

"In the English language the word 'design' can mean many things... (It) can embrace the activity and the products of the architect, the engineer, the craftsman, the decorator and the artist... One can design a machine, a system, a circuit or an experiment. All of these usages, however, contain some common elements. To design is always to describe some form, structure, pattern or arrangement for a proposed thing, system or event. A design is always an integrated whole, a balanced prescription, a product of judgement and invention as well as of knowledge and skill" (1).

The same all-embracing terminology is used by ergonomists in the definition of their subject. One of the most widely respected textbooks on the subject, Human Factors in Engineering and Design, was jointly written by McCormick and Sanders and describes ergonomics as:

"...the consideration of human beings in carrying out such functions as (a) the design and creation of man-made objects, products, equipment, facilities and environments that people use; (b) the development of procedures for performing work and other human activities; (c) the provision of services to people; and
McCORMICK and SANDERS provide an insight to their perception of the relationship between ergonomics and design with their more concise definition 'designing for human use'. A further complication arises with the American preference for the title Human Factors rather than Ergonomics although these terms appear synonymous.

Professor Hywel MURRELL has the distinction of being involved at the beginning of the profession of ergonomics at about the time of the Second World War, indeed he claims to have been responsible for the term 'ergonomics'. MURRELL's analysis of the beginnings of the profession give some indication of his perception of the longstanding interdependence of design and ergonomics. In a recent article he defines design as 'the production of something which has some useful purpose' (3), and goes on to identify three criteria by which this can be judged. MURRELL's identification of 'usability' in addition to 'function' and 'appearance' is a deliberate attempt to present ergonomics as a key element in the design process.

The further articulation of this relationship has come from many quarters. In June 1986 the Royal College of Art (RCA) hosted the first of the Design and Ergonomics Forums and this can be seen as the revival of an enquiry that goes back forty years. Design Magazine has reflected this enquiry and recent articles have sought to determine the contemporary relationships as opposed to those prevalent in a formative phase of both professions in the 1940's and 50's. An article in the July 1986 issue of 'Design' talks of ergonomists working with designers to suggest improvements and work out compromises. It also goes on to illuminate the difficulties and these include a lack of understanding of each others work and deep-rooted prejudices (4).

Denis O'BRIEN at the RCA has been influential in extending and updating this debate. He has described both ergonomics and design as
2.0 'gate-keeping subjects', the former standing at the entrance to the human and physical sciences, the latter standing at the entrance to the creative arts. (5). That there should be such a growing volume of studies of the area between the two is indicative of a contemporary interest in examining the relationship between design and ergonomics. Although each subject has in isolation been able to establish a sound and workable philosophical base, it is similarly indicative of the complexity of the relationship that there should still, after many decades of publications, be no widely accepted views on the confluence of these subjects.

The responsibility for attempting to define the relationship must lie with those members of the professions now practising and researching. It is implicit in both design and ergonomics that change is not only acknowledged but encouraged. The opportunities offered for both of these are all too common in our rapidly developing technological society. Both subjects rely to a great extent on the wealth of knowledge established by previous researchers. However, investigations into the contemporary relationship can only come about through involvement in this changing contemporary scene.

The thesis sets out to reveal the values that have given rise to a relationship that is still in its infancy. If these values can be likened to the paradigmatic states defined by KUHN then a short investigation of the parent domains may assist in charting the movement towards a new or hybrid paradigm. The next two sections aim to illuminate two distinct but formative issues that in some way are profoundly influential to the affective paradigms of the parent domains. For ergonomics this entails an examination of its foundation within a scientific tradition that has not always been compatible with its own developing objectives. The formative issues within design however revolve around a more philosophical standpoint and more particularly concern the efforts to define design methodology.
Ergonomics is a relatively young subject and many of the researchers who instigated the first studies under this name are still alive and practising today. The roots of the profession of design are not much older but tracing the earliest occurrences of the activities we know of as design and ergonomics would be a very difficult task. The activities in their most basic form are some of the oldest and most profound of human capabilities. Nevertheless whether one takes as the starting point the professions of architecture, applied artist or form-giver for industrial production, the design profession had established below it a sound foundation by the time the first studies under the name of ergonomics took place.

So it was that the involvement of researchers in studies of human performance in tasks of work - the inception and development of the subject that came to be known as ergonomics, took place during a phase of consolidation in the design profession.

The roots of the profession of ergonomist are relatively clear. The past fifty years have provided accessible and thorough documentation from its conception and involvement during the Second World War through to its incorporation with many areas of industry, commerce and research.

As is so often the case in human development it was the efficiencies demanded by wartime pressures that instigated some of the earliest ergonomic studies. Professor Hywel MURRELL recounts his own involvement at this time in the Army Operational Research Group (AORG). (3) The assessment of man/machine/task efficiency was the responsibility of AORG 9, a group who studied a range of drills, armoured fighting vehicles, guns and material handling methods at the request of the Medical Research Council. Although MURRELL's work took him into studies with the Royal Navy it became apparent that there were a number of people whose interest in human performance extended beyond the military sphere. This interest led to the establishment, towards the end of 1949, of a study group composed not only of those researchers with experience of the military studies
2.1 but also a number of scientists. The Ergonomics Research Society took its name from MURRELL's manipulation and unification of various related latin terms. 'Nomergatology' and 'anthroponomies' were finally rejected in favour of the joining of 'Ergos' meaning work and 'Nemos' referring to law, surroundings or locality, in the term 'ergonomics'.

The membership of the society was confined solely to those active in research, the overwhelming emphasis at this early stage being the collation and dissemination of data. This academic bias, whilst allowing a period of consolidation and comparison of methodologies for the researchers, did tend to isolate the society from industrial application even though the 1956 Birmingham conference aimed to counter this by publishing the proceedings in a format directly usable by industry or commerce. (6)

Emphasis on the practicality of the subject continued with further studies in the display of information and optimum seating heights for various working conditions, leading to the British Standards Institute (BSI) publishing design recommendations for school furniture.

During the 1950's the movement to disseminate ergonomic data was widespread and was particularly aimed at encouraging manufacturers to acknowledge and incorporate this new knowledge. However the emphasis remained with the armed services due to their heightened requirement for improvement, generous funding, accessibility to hardware and 'captive' research subjects with studies published by both the British and the Americans (7). However two milestones in the development of this body of knowledge took place outside of the military sphere and they represent some of the earliest attempts to establish a formal relationship between ergonomics and design. In 1957 'Engineering' magazine produced a booklet entitled 'Data on Human Performance for Engineering Designers', while the engineering employers of Bristol Ltd promoted a number of courses on the subject. The first book on ergonomics was a compilation of a series of papers resulting from British Productivity Council seminars (8). It was MURRELL again who compiled the above papers in 1960 which five years later provided the foundation for the first full length text book on Ergonomics (9).
2.1 With the continued consolidation of its knowledge base the field of ergonomics became increasingly concerned with the fruit of its research - the application of information resulting from thorough and truly scientific research. Technical journals encouraged the application of recent findings through the publication of related ergonomic studies - directly supporting design modification as a result of user studies.

Applied Ergonomics, first published in 1969 echoes this movement away from the narrow and insular activities of the early post-war studies as represented in the initial 'Ergonomics' journal of the late 1950's. Applied Ergonomics carried such articles as 'The Victoria line - Passenger considerations' (10), which discussed the application of ergonomics to public transport, and 'Desk Heights' (11), revealing a self confidence in its authority and a sincerity in its desire to become involved in the design and production mechanism of industry and commerce. In the forward to the very first journal the editor explained his aims and philosophy in these words:

"There is an increasing need to put into practical use the data and techniques amassed by scientific ergonomics research... A major part of this process is the wide presentation in readily usable form of the practical knowledge in ergonomics to those in industry and elsewhere who are now creating a demand for just such information". (12)

Ironically the increasing strength of the ergonomics knowledge-base appears to have worked against its incorporation via those professions that were in a good position to do so - namely those in the design and engineering fields. Instead industry witnessed the establishment of yet another specialist whose skills were applied and made meaningful through industry's increasingly complex system of teamwork.

A new range of undergraduate courses within the field of ergonomics were developed in the 1960's at Loughborough, UWIST and Nottingham after achieving considerable success with their postgraduate work.
2.1 Other universities were to follow with this research including Aston, Birmingham, Hull and London. They are indicative of the anomalous situation in which the establishment and furtherance of scientific credibility through specialist study was in direct conflict with ergonomics' apparent objectives concerning its overdue application in an increasingly product-oriented society.

2.2 THE INTEREST IN DESIGN METHODOLOGY

An obstacle to the examination of the relationship of design and ergonomics is their relative youth in comparison with other fields within the Sciences, Arts or Humanities. In these, established bodies of knowledge combine with well defined boundaries to alleviate many of the demarcation disputes that are so much part and parcel of the discussions within design or ergonomics. The introduction presented the view that both domains have only recently entered a period of maturity, and therefore any comparison of methodology or content must inevitably draw upon material that is developmental or experimental.

The 1950's saw a number of designers, teachers and researchers attempt to understand and formalize a process with which they were very familiar and yet which proved elusive to categorisation. These designers went to great lengths to demonstrate that such activities and procedures had extensive applications in a number of professions and some, like those involving the Human Sciences, can find them not only suitable but essential in a process that involves evaluation and modification.

The late 1960's and early 1970's can be seen as a watershed in the analysis of design methodology. The period marks a phase of disillusionment by some leading researchers as to the aims of the subject while for others it has stimulated new thought. Prior to these years the movement had been vigorous and heroic, guided by the optimism and scholarly competence of such bodies as the Design Research Society. Nigel CROSS has regarded the first conference in Design Methods held in London in 1962 as marking the
2.2 'birth' of design methodology (13) but discussion was extensive in cont. the late 1950's with contributions from various quarters, most notably Bruce ARCHER, now Professor. However it was in the 1960's that the consolidation of this movement to develop systematic design procedures for a previously ill-defined activity was begun.

The latter period, after the early 1970's is marked by its dissatisfaction with the convenient 'pigeon-holing' and overt systematizing of design activity. The issues extended not only to planning but living in general, both notoriously unsympathetic to the logical step by step process that the research work of the 1960's had set out to establish. This dissatisfaction can be traced firstly in an interview with Christopher ALEXANDER which was subsequently published by the Design Methods Group in 1971. When asked about the future areas for design methodology he replied "Forget it, forget the whole thing... until those people who talk about design methods are actually engaged in the problem of creating buildings" (14).

A more constructive criticism of early work was made by Horst RITTEL a year later (15) when he proposed that the contemporary restructuring of thoughts was a maturing of the movement rather than a negation of its ideals. As CROSS points out, RITTEL's use of the term 'second-generation' was a brilliant device that allowed the earlier 'first-generation' research to be acknowledged but superseded by the issues that so concerned authors such as ALEXANDER.

It is the implications of this second-generation research that hold most relevance for this thesis. The collective methods and findings acknowledge the complexity of modern design practice in comparison to the simplicity and often naivety of some of the earlier models.

RITTEL's proposals for second-generation design methodology include a re-structuring of the design process to acknowledge a more participatory approach in a system which had become, according to the scholars at least, prescriptive and protectionist. An argumentative process, proposes RITTEL, allows contribution from a number of sources not least the user or consumer.

This inclusive rather than isolationist policy of the 1970's in some
2.2 ways reflects wider social developments concerning freedom and
tolerance where one of the few things one could be certain about was
the presence of uncertainty.

Apparently irreconcilable conflicts epitomised the era and design
methodology had its fair share as scholars sought to question and
tentatively propose the role of rationality and intuition, logic and
imagination, and order and chance. J. Christopher Jones lent his not
inconsiderable scholarly weight to the argument against the
establishment of a stifling 'logical framework' and his promotion of
the qualities of chance or accident are a marked contrast to much of
the first-generation design philosophy that had by then filtered down
through the system (15). The use of chance by Jones was however
not as alien as the initial criticism would have us believe. Random
procedures had simply been incorporated as stages in an otherwise
rational process.

Second-generation thought had come about as a result of the
dissatisfaction experienced when first-generation theories and
methods failed to achieve comprehensive application. Research
attention shifted from the structure of the process to a
consideration of the nature of the problem and it was as a result of
this consideration that a series of articles from various authors
explored and incorporated new theories concerning 'ill-defined'
problems.

The formulation of theories concerning the nature of real-life design
problems is a milestone in design research because for the first time
scholars acknowledged a fact that architects, (see Alexander's
comments on the determinants of an Indian village, 17), designers,
engineers and a host of other professions concerned with designerly
activity, had tacitly known for many years. Namely that the problem,
so easily presented and itemised in early research was in fact ill-
structured, difficult to define and 'wicked'.

The above research, already twenty years old in some instances, has a
profound relevance to this thesis. It is the embryonic beginnings of
2.2 an attitude of sensitization to a problem rather than the mechanical compartmentalising of factors to suit a convenient methodology, and underpins much of what JONES was promoting in his appeals against 'logical frameworks'(18). Both design and ergonomics are very much concerned with sensitizing themselves to the nature of problems while at the same time incorporating a strategy for maximising the resolution of these problems.

This chapter has presented two key issues from the recent development of the professions of design and ergonomics. They are issues that may be seen as extremely influential in the determination of a relationship between these two areas. Their value lies in their ability to present an historical perspective which in turn may assist the interpretation of contemporary observations. It is important that any 'model' relationships that may be inferred from this brief historical overview are seen as inferior to those proposed in the case-study analysis of Chapter Four. The following chapter begins the justification of a research methodology that aims to support this point.
CHAPTER TWO — REFERENCES


CHAPTER THREE

THE CASE-STUDY APPROACH

3.0 THE PLATFORM OF SCIENTIFIC ENQUIRY.

The methods of science, of which experimentation is the 'classic' and perhaps best known, have provided immense knowledge concerning the material and physical universe. It is little wonder then that the observations, experiments and conclusions of classical scientists such as Newton should be considered the results of a methodology that is profound and all embracing. However twentieth century philosophical enquiry has sought to question the nature of scientific truth. The works of recent authors such as HEMPEL (1), POPPER (2) and KUHN (3) have influenced the considerations involved in the formulation of an appropriate research strategy for investigation of the design/ergonomic interface.

Carl HEMPEL, in his book The Philosophy of Natural Science, has divided the various branches of scientific enquiry into two major groups, the empirical and the non-empirical sciences. The empirical sciences, by which HEMPEL is referring to the social as well as the natural sciences are further defined. They are concerned with systematic observation, interviews, surveys, psychological or clinical testing and many types of examination (4). He identifies the dependence on empirical evidence as the distinguishing characteristic of the empirical sciences and contrasts it with the non-empirical disciplines of logic and pure mathematics whose propositions are proved without essential reference to empirical findings.

The significance for this research lies in the possibility of maintaining the justifiability and tradition of scientific research without being dependent upon the methodology of natural science that superficially appears insensitive to the unique or local characteristics of the examples of the design/ergonomic interface.
Although the social sciences involve studies that do not necessarily lend themselves to the procedures of experimental research, many social scientists have sought to exploit experimental values in other areas. These values have been developed through the practice of natural science, a practice that is well suited to experimental research. McNEILL has attributed the undoubted success of experimentation to its compatibility with the assumptions of the natural scientist. That is:

'They assume that the natural world has an independent existence of its own, which is as it is regardless of those who are studying it, and which is governed by laws which can be discovered by the research scientist if only the right methods can be developed'. (5)

McNEILL shows how knowledge that is gained in this way can be regarded as objective and factual, i.e. it is correct for all times and all places, and is not going to be different according to who discovers it.

Although the value of these methods as an explanatory tool is considerable, their main asset is in allowing prediction and apparent control over the particular phenomenon being studied. Various authors have identified the exploitation of experimentation and shown its uses and abuses in a number of contexts. PARLETT and HAMILTON (6) refer to its function in an evaluative methodology for educational development; KIDDER (7) examines the suitability of experimentation in a number of social research situations and HEMPEL (8) uses a selection of medical studies to describe the functioning of the methodology. In each of these cases the authors refer to the logic of this method as 'hypothetico-deductive'. Experimentation is primarily a logical testing method whereby the scientist aims to disprove a hypothesis that derives from observations or theories. Fig 2 presents McNEILL and TOWNLEY's diagrammatic interpretation of the logic of hypothetico-deductive methodology (9).
HEMPEL's studies, using the hypothetico-deductive methodology, quite openly reveal the weaknesses of such a strategy and show why the social sciences particularly have proposed alternative research methods. In testing the validity of hypotheses, assumptions must be made about the variables which compose any given phenomenon. These can be subdivided into those that are perceived to be controlled by the experimenter, termed the 'independent variables', and those that vary as a result of actions, termed 'dependent variables'. An investigative strategy based on these assumptions begs two questions;

(a) Is it possible to identify and hold so called independent variables steady? Even in natural science the experiment is restricted to those independent variables that are known or expected, with unknown factors difficult to discount.

3.0 The problems in situations of a social rather than a natural scientific nature heighten this concern.

(b) If the identification of such variables is based on the values and assumptions of the scientist, who is to say that these values are true or correct for all times? Thomas KUHN has raised the notion that natural scientific knowledge does not exist independently and objectively but is constructed and created by scientists within a framework of common assumptions. This he terms a paradigm. (10)

The implications of KUHN's work for this research lie in the questioning of the values of applying a strategy that does not acknowledge its inbuilt limitations. In the case of the design/ergonomic interface the problem increasingly becomes one of illuminating the nature of the paradigm or paradigms rather than simply examining the phenomenon that evolves under them. KUHN's work inspires the search for a set of methods that openly reveal their value system and fairly acknowledge the weaknesses inherent in much of the accepted research methodology.

3.1 KUHN'S POSITION ON THE VALIDITY OF SCIENTIFIC TRUTHS.

The philosophical enquiries of Thomas KUHN have explored this distinction between the methods of the natural and social scientists. In the preface to his seminal book The Structure of Scientific Revolutions he refers to his time within a social science community. He refers to the differences he experienced between this community and the natural scientists amongst whom he had been trained.

'Particularly I was struck by the number and extent of the overt disagreements between social scientists about the nature of legitimate scientific problems and methods. Both history and acquaintance made me doubt that practitioners of the natural sciences possess firmer or more permanent answers to such questions than their colleagues in social science'. (11)
KUHN's objective is to encourage a change in the perception and evaluation of familiar data and he supports his view with reference to a variety of scientific research. KUHN proposes that the history of scientific research has either confirmed the existing values, i.e. it has provided knowledge within the established paradigm, or alternatively it has contributed to evidence that challenges the paradigm. If or when this evidence accumulates to a certain level it dramatically overthrows the existing values in what KUHN terms a scientific revolution. He identifies this process of gradual build up followed by revolution as being the normal pattern for mature science, constantly evolving in discernable stages but usually operating under a dominant paradigm.

Perhaps more importantly for this research KUHN advances the theory that there exists an immature stage to these paradigms. In this a number of different value systems co-exist in competitive tension until one gains favour with sufficient people for it to become the dominant belief or paradigm. One of KUHN's examples will suffice to illustrate this point.

Today's physics textbooks tell the student that light is photons, i.e. quantum-mechanical entities that exhibit some characteristics of waves and some of particles. However, before this, physics texts taught that light was transverse wave motion, a concept rooted in the paradigm that derived ultimately from the optical writings of Young and Fresnel in the early nineteenth century. During the eighteenth century the paradigm for this field was provided by Newton's 'Opticks' which taught that light was material corpuscles. A case of different paradigms resulting, via scientific revolutions, from new discoveries. Prior to Newton's work however there were no generally accepted views concerning the nature of light. Instead there were a number of competing schools and sub-schools of thought that held, for example, that light was particles emanating from material bodies or that it was a modification of the medium that intervened between body and eye. Although each school sought to identify with a potential paradigm there was insufficient consensus for one to become
3.1 established. KUHN has defined this normal immature phase of competing values as the 'pre-paradigm' stage. (12)

In attempting to identify the nature of the phenomenon of design/ergonomic activity it is important to understand the value systems or paradigms under which each domain operates. If design and ergonomics each operate under a different paradigm or alternatively if they are experiencing an extensive pre-paradigmatic stage, then the exploitation of a research method derived from only one set of values will seriously bias the findings. A strategy is therefore required that operates as impartially as possible in order that the true nature of the effective paradigm or paradigms is reflected. However the strategy must be amenable to modification as greater knowledge of any paradigms will dictate the use of certain methods. As indicated in the introduction the method must illuminate the paradigm and yet ideally the paradigm should illuminate the appropriate method.

With the obvious awareness of the issues proposed by the paradigm theory, KUHN has expressed great faith in the methods of the social scientists. It is to their methods the research now turns in order to establish an appropriate investigative strategy.

3.2 THE 'TRUTH' OF CASE-STUDIES

In his book 'Research Methods' McNEILL goes to great lengths to identify and distinguish the intentions and applications of methodologies that have their roots in the social sciences. Nevertheless he concludes with a warning against classifying studies and strategies into neat little boxes (13). McNEILL's proposition that research studies in the real world often use a variety of methods chosen for their suitability for the task in hand would seem to discount the search for one particular strategy. Bearing McNEILL's warning in mind, the case-study approach was examined and seemed to provide the foundation for a strategy that was adaptable, sensitive and practical.
3.2 A case-study involves the detailed research of a single example of whatever the researcher wishes to investigate. From early involvement in a number of instances in the design/ergonomics interface it appeared that the greatest common feature was their uniqueness! The application of a procedure that did not necessitate the identification of a 'representative sample' was therefore a major necessity. Case-studies offer no claim to representativeness. The essence of the technique resides in the fact that each subject studied, whether it be an individual, a group, an event or an institution is treated as a unit on its own. Care must be exercised in viewing a case-study as a methodological package. The advantage of case-study to this research was its capacity to incorporate almost any method of research that is deemed appropriate, though the less statistical methods are more usual. ADELMAN (14) supports this eclectic nature of case-study, placing the techniques for the collection of information well within the wider tradition of sociological and anthropological fieldwork. These techniques include participant and non-participant observation, various categories of interview, audio-visual recording, field-note taking, document collection and the negotiation of products e.g. the discussion of the accuracy of an account with those involved.

3.3 THE APPLICATION OF CASE-STUDY PROCEDURES TO THE INVESTIGATION OF THE DESIGN/ERGONOMICS INTERFACE

Design and ergonomics exhibit complex activities that are strongly influenced by the environment in which they operate. While equally complex sectors, notably education, have undergone wide-ranging research programmes that illuminate and evaluate the nature of the activity, both design and ergonomics have often been judged purely on their end result.

The use of case-studies as a research tool is relatively new and its aims are often ill-articulated. However its validity for certain situations is well supported. Papers by SIMONS (15) and MACDONALD and WALKER (16) explore the value of case-study procedures when applied to educational evaluation and the advantages they note were refined by ADELMAN (17) some years later.

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Case-study commands a respected place in the repertoire of theory builders from such disciplines as medicine, law, engineering, psychology and anthropology. Nevertheless the operational requirements of this method of research differ depending on which model is referred to. The final section of this chapter discusses the procedural requirements for a case-study analysis of the design/ergonomic interface.

An analysis of case-studies drawn from a cross section of disciplines reveals a variety of opinions regarding the conduct of the research. One author who has sought to define a framework for what he terms 'fieldwork' in case-study is STENHOUSE. Although he indicates that the benefits of a completely open approach may be very valuable in certain studies, the nature of this research appears to dictate the establishment of guides that structure rather than dictate the conduct of the case-study.

Observation is considered a key element of case-study by many researchers. By observing is meant perceiving and recording events, behaviour, speech and appearances in the case under study. However the sociological researchers differ on how this may be best achieved. DITTON (18) and FESTINGER (19) adopt a very covert approach in their studies, not disclosing their true purpose. POLSKY (20) on the other hand is emphatic that the researcher should be completely open about what he or she is doing. The trade-off between the moral, academic and practical issues at stake have promoted the development of different classes of observation, from the 'fully participant' studies of anthropologists to those who do not declare their motives or even their presence to the subjects in 'covert observation'.

The nature of this particular research dictates that the fieldwork is condensed. The opportunity for extended observation is not available and therefore the main weight is carried by the interview. The research contracts seek to expose fully the nature and conduct of the research. Once the subjects have this knowledge the process of observation and interview will naturally fluctuate and will be encouraged to do so.
3.3 The advantages of checking observation by interview and interview by observation have not been overlooked.

For many researchers, successful interviewing is primarily a matter of establishing and understanding interview procedure. This may involve training the interviewers, devising appropriate questions and evaluating them, or selecting the best sample of subjects.

For some research problems however, a less structured approach than that provided by a standardised overview is appropriate: Largely as a result of the perceived deficiencies of the above strategy and the popularity of anthropological fieldwork, an assortment of informal interview strategies have been developed. KIDDER (21) refers to these strategies variously as 'focused', 'clinical' or 'non-directive'. KIDDER proposes that this latter group are

'useful when investigators are scouting a new area of research or when they want to find out what the basic issues are, how people conceptualise the topic, what terminology is used by respondents, and what is their level of understanding'.

The exploratory nature of this initial piece of research into the functioning of the design and ergonomics interface necessitates the exploitation of these less structured interviews.

All but three of the thirteen interviews undertaken for this research were recorded and a transcript of each was made.

Condensed fieldwork places much more emphasis on interview because observation cannot play so important a role. Nevertheless the interrelationship of interview and observation is vital, especially in testing the hypotheses that result from a focused interview strategy.

Many researchers regard case-study as qualitative but this research has presented a case for a wider appreciation of this method of exploration. Case-studies can be used to test hypotheses, particularly in the examination of a single exception that shows the hypotheses to be false. STAKE (22) has presented the case for viewing the case-studies as receptors of both qualitative and quantitative information. He refers to highly statistical.
3.3 Institutional and vocational studies and contrasts them to the complex, holistic and multi-faceted description of case-studies from the social sciences.

BROMLEY (23) provides a salutary warning concerning the collection of information in case-studies. With reference to a number of case-studies drawn from the medical and psychological disciplines he stresses the need to keep fact and opinion separate, even though opinions are employed to interpret the facts. The seductive nature of first impressions is also discussed by BROMLEY who shows how later evidence may be discounted or misinterpreted.

Another important phase in the conduct of case-study involves the examination and comparison of the various observations and statements in order to note points of agreement and disagreement. This comparison can use information drawn from one case-study in order to interpret that particular case, or it can seek to compare the case to the more general findings by drawing information from a number of case-studies. BROMLEY stresses the interpretative role of the researcher who has to "put a construction on the evidence". With regard to this ADELMAN (24) has drawn attention to the advantages of providing access to the 'raw' data as well as the 'cooked' data in order for later researchers to reconsider for themselves the relationship between interpretation and evidence.

Chapter Four presents the case studies as four groups. No attempt has been made within each group analysis to propose generalisations about the class to which all the case studies should relate. A discussion of this issue takes place in the overview and conclusion that make up Chapter Five.
CHAPTER THREE – REFERENCES

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CHAPTER FOUR

THE CASE-STUDIES AND ANALYSIS.

4.0 INTRODUCTION

Sixteen examples of the design/ergonomics interface have been chosen, four from education and twelve from the commercial world. Each case-study was chosen as an instance that appeared to exhibit some aspect or aspects of design and ergonomics joint-functioning and an effort was made to choose as diverse a range of instances as possible. In order to facilitate the examination and comparison of the case-studies they have been presented as four groups. It is not intended that these groupings are viewed as indicative of any profound relationship or difference as they were compiled before any of the findings were analysed. The groupings are merely administrative blocks and any relationships ought to be sought between individual cases rather than between groups.

A group may comprise of just one case-study as in Group One. Here the Institute For Consumer Ergonomics is analysed by means of interviews with five experienced employees. Other groups present interviews with individuals from a variety of institutions, for example, Group Two assembles the investigations of three commercial consultancies concerned in some way with both design and ergonomics.

Each group is introduced with a short description of the subjects followed by the analysis. The research is drawn together in preparation for Chapter Five which seeks to use the sub-conclusions from each group in support of the identification of the paradigmatic state operating at this developing interface between design and ergonomics.
GROUP ONE: THE INSTITUTE FOR CONSUMER ERGONOMICS

Both the accessibility and the high profile of the Department of Human Sciences at Loughborough University suggested its inclusion in this research. Its world-wide reputation is based not only on the academic ability of its staff but on the applicability and practicality of certain areas of its research. One independent offshoot of this research is specifically oriented towards liaison with commercial organisations and operates under the title of the Institute for Consumer Ergonomics (I.C.E.).

A bright, attractive and well laid out brochure is produced by the Institute for initial communication with potential clients and the concise introduction provides the necessary background for this case-study.

'The Institute for Consumer Ergonomics was set up in 1970 by Loughborough University of Technology and the Consumers Association to promote the application of ergonomics to the design of products, equipment, buildings and services that are in general use. It is a non-profit making independent organisation employing research staff with training in engineering, psychology and physiology as well as ergonomics. It carries out research and consultancy work for Government, Industry and Commerce. Since 1970 the variety of topics investigated has been considerable and reflects the multidisciplinary character of the Institute. The success of the Institute is founded on the development of close working relationships with clients throughout the course of a project. Projects range in duration from a few days to several years depending on the requirements of the client'.

The initial contacts were made through Professor Stuart Kirk who in addition to being the Head of the Human Sciences Department is also
the Director of I.C.E. and through Dr. Ian Galer, the Scientific Director of the Institute who was able to direct my case-study into the most profitable areas and facilitate the interviews with the staff.

Whilst acknowledging the fundamental links with the University, the Institute promotes a deliberate autonomy to the extent that it occupies its own premises some two miles from the University Campus. The premises comprise the usual offices, seminar rooms and workspaces one would expect to find in such a professional organisation but careful consideration to colour-scheme, graphics, corporate displays and publicity present a professional image far in advance of most of the University based research departments.

In fact the implementation of design in a broad sense to convey competence and professionalism was one of the first observations made, during the preliminary meetings with I.C.E.

After two or three informal meetings with Ian Galer the research contract was drawn up. This explicitly stated the research requirements and objectives and it was on this document that Ian Galer based his decision regarding who would be most suitable to interview.

There are at present 36 full or part time members of the Institute. Some provide occasional consultancy services while working in related fields, others are engaged full-time on longer term research projects. It was important that interviews were held with those who may illuminate the design /ergonomics interface as well as those who could specifically provide an overview of the activities and intentions of the Institute. A degree of selection was necessary, resulting in a choice of five, not including Professor Kirk, whose interview forms part of the analysis in Group 4. They were:

a. Maggie Page - Consumer product design and safety.

b. Peter Stroud - Industrial/commercial products and transport systems.
4.1 c. Dean Southall - Automotive ergonomics.
d. Julie Spicer - Occupational systems.
e. Pete Thomas - Accident Research Unit.

It was felt by Ian Galer that these people provided the most useful contacts for the research and each was provided with a synopsis of research to date together with the objectives for the research at ICE. This synopsis can be found in Appendix A. The research was initially established as an investigation of the design/ergonomics interface but the interviews are best analysed with reference to a number of sub-issues that came to be defined during the conversations.

These can be summarised as:-

1. The nature of the Institute and its employees.
2. Difficulties within joint design/ergonomic activity.
3. The relationship between ergonomics and design.
4. The changing nature of the interface.
5. Education and the interface.

4.1.1 THE NATURE OF THE INSTITUTE AND ITS EMPLOYEES.

Since its establishment in 1970 the Institute has been involved in both the evaluation and development of products in such fields as the elderly, the handicapped, consumer products and transport and it was this involvement that suggested its suitability for investigation as a perceived design/ergonomic interface. As stated in their publicity brochure the employees at ICE are drawn from a number of backgrounds and these multi-disciplinary talents have given rise to an organisational function based on breadth as well as depth.
The activities of the Institute appear to have undergone some considerable changes in the past two decades. While to some extent long-term research contracts are still in evidence, the indications are that the timescale and nature of the projects are in the process of redefinition. Prof. Kirk, the Director of the Institute, states that ICE would like to engage in both the fundamental research in order to further develop the database of ergonomics knowledge, and undertake the short-term consultancy work that he believes lies essentially in the design related areas. However Prof. Kirk asserts that due to commercial pressures to remain viable a 'very large' percentage of the Institute's work falls into the latter category. The work and comments of Stroud, Page and Southall all support this change in emphasis with Southall quoting three days to three months as his average involvement, with one or two exceptions. A further reason for this shift might be the lack of funding available in the present climate for fundamental research. Prof. Kirk points to tighter controls by the Science and Engineering Research Council (S.E.R.C.) together with their requirements for 'practically oriented' projects as reasons for disengagement of long-term, basic research.

It quickly became evident during this case-study that the interviewees were not going to fall easily into one category or another. While some exhibited expected skills or attitudes others displayed contradictory or unrelated abilities and opinions. This variety proved to be profound and was fundamental to the nature of the Institute.

There appears to be many self-confessed practical people. Page indicates an enjoyment of the practical side of building houses and maintenance, while Southall categorises himself as an 'extremely practical person'. He shares a background in engineering with Stroud, which may account for a practical leaning. Page and Thomas have no such background but still class themselves as practical. Page is confident that her skills have developed on the job and interestingly states that she believes that she doesn't have a very good ergonomists attitude at times.

This last point may be seen as indicative of the shift of emphasis made by the Institute in terms of the contemporary role of the
ergonomist - a distancing from the traditional model. What it is shifting towards is much harder to define.

4.1.2 DIFFICULTIES WITHIN JOINT DESIGN / ERGONOMIC ACTIVITY.

In talking with the various members of the Institute, who would for the most part readily describe themselves as ergonomists, there were few difficulties in communicating with someone from a design background. Nevertheless communication was often cited as one of the major areas of difficulty in their activity. This may be due more to the diversity of activities with which the Institute is involved rather than specific difficulties of the employees, although Page identifies a lack in her training of personal and communication skills. "When I first started working here the idea of dealing with people was very daunting".

Certainly the diversity of tasks undertaken by ICE mean that any individual may be asked to learn a great deal about a client and their procedures at very short notice. The difficulties that arise in such a situation are common to design consultancies also, who find themselves juggling with a variety of clients (see Group 3). Spicer, in referring to communication within a project in conjunction with an outside organisation referred to a lack of understanding, "they misinterpret your questions totally because they look at things in quite a different way".

Another obstruction to the joint-functioning of design and ergonomics are the views, often stereotypical, held and propagated by one group in respect of the other. Stroud is critical of the lack of basic ergonomic understanding of some designers. He indicates that a number of designers he has come across see ergonomics purely as static anthropometry rather than a dynamic science. Thomas is far more critical in his opinion of designers. "Engineers........address in a sound fashion the whole area of safety. It's the designers that let it down". And Spicer; "In my experience, when I have worked with designers, very often the are looking at the styling first, or they have got a concept of what the thing will look like at the end of the day".

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4.1.2 Stroud, perhaps as a result of his joint engineering and ergonomic background continues with a more pragmatic opinion. "It doesn't matter what we say as ergonomists, the design has got to sell and it's marketing who are running the show, not research, which is quite salutary". Stroud is also aware of the other side of the coin, the aspects of ergonomic practice that can become distorted into the stereotype. He refers to a project in Australia where he was told "for God's sake don't say 'it depends' - that's all ergonomists ever say, it depends". Education has clearly got a major role to play in this breaking down of stereotypical views and many members of ICE have experience of college and university teaching where they have the opportunity to do this.

Other widely held beliefs concern the perceived lack of understanding on the part of some designers in certain vital areas. Firstly in the area of evaluation Southall proposes that traditionally the designer took it upon him or herself to decide where modifications were needed. This observation provides an interesting comparison with the comments by Engdal (Group 2) on early Swedish design particularly as Southall sees his work as offering an objective methodology for assessing many subjective factors. The second concern that was reflected in a number of cases involved the apparent protectionist attitude displayed by designers. Again Southall proposes that there can be problems telling a designer or design team that their precious idea is fundamentally flawed. Similarly Spicer recounts "I have worked with some designers who I suspect were rather jealous of their position. They felt that they could do a perfectly good job and didn't really see why ergonomists were being brought in".

4.1.3 THE RELATIONSHIP BETWEEN ERGONOMICS AND DESIGN.

Within the Institute there appears to be a great deal of agreement that in the very broad field of product development many domains overlap or have a close interrelationship with others. Of these, the relationship between ergonomics, engineering and design appears to be one of the strongest. The domains share many procedures, with the activities of one group often bearing a close resemblance to the
activities of another. The comments by Page concerning the requirement to constantly brief herself on the current client or job has already been likened to that aspect of a consultant designers role, but she believes the similarity is far more fundamental. "Ergonomics covers such a wide field. It's very similar in a way to design in that you could be designing anything". This comment was made in reference to the separate education systems of design and ergonomics and their shared difficulty in preparing students for the type of work they may enter.

The role of group or teamwork is fundamental to both design and ergonomics and both Prof. Kirk and Stroud stress the importance of its development in their teaching strategies. They point to teamwork in education as a means of developing a common understanding, a common language for communicating particular developments or findings.

The ergonomists within the Institute display a range of communicative tools in their day to day activity. Not only are they articulate with natural language there are many examples of communication using a graphic language of drawing, sketching and modelling. Page presented a strong and professional folder of illustrations and photographs to illustrate the points she was making in the interview - a method of communicating that has traditionally been the province of the design professions.

On the whole the ergonomists were unwilling to define their work as designing, preferring to see their work as only a part within a process. However when probed on this one many referred to designing their tests and test equipment. The nature of the work is such that commercially available test equipment is not suitable. Practising ergonomists therefore have to make up such things as anthropometry devices for their work with the elderly or handicapped. Page observes "some of the ingenuity that goes on in this place has to be seen to be believed". Thomas was the only interviewee who stated that he rarely got involved in designing or developing test apparatus. The nature of the work in the Accident Research Unit is
such, however, that actual crashed vehicles are not only more suitable but in plentiful supply!

The issue of creativity is an interesting one. On the one hand the ergonomists appear to employ a purely analytical strategy more in keeping with the scientific background of the subject. The dependence on procedures based on statistical analysis is evident in the work of Thomas for example. There does however appear to be a 'creativity of analysis' that is evident in the methods and procedures of many other ergonomists working at ICE, and which may be seen as one aspect of the changing nature of ergonomics as it is manifested in this Institute. Southall holds the view that "We are all creative to a certain extent" but asserts that ergonomists are taking away the mystique of creativity. "We are applying a scientific method to creativity, we do not actually think of the new concepts, we set up discussion groups, ... encourage people to talk about the problems they have encountered,... and analyse the results. Out comes the solution".

The shift towards client-based consultancy work outlined at the beginning of this section has brought this particular branch of ergonomics into an area common to many design consultancies, namely listening and distilling from a clients briefing, the salient points for research and development. Spicer illustrates this skill whether it be employed by an ergonomist or a designer. "In talking with the clients, the managers of a factory, we do keep detailed notes. They don't always realise the significance of what they are saying". Where there are major differences between what the client thinks is required and what the ergonomist perceives there is evidence that two schemes have been presented.

Page refers to the skill of "looking through other people's eyes", while Stroud stresses the ability of "looking, observing and taking notes, even when you know that many of these will not be used". In discussing with manufacturers the use of their products Spicer stresses the need to understand the possible misuses also. She feels that many designers often neglect this aspect in the research and evaluation of products. Basically there appears to be great
importance placed on not only questioning but questioning the question.

One of the most obvious similarities between this area of ergonomics and design is the use of modelling. Although very few finished or representative models were encountered the activity of modelling can furnish information in a variety of design or ergonomic situations. Spicer believes that "you can see quite a lot with a very simple mock-up" and uses coloured overlays to model two dimensional systems in order that limitations can be spotted. The dynamic way that tools or products are actually used mean that a solution on paper is not appropriate for testing. Stroud sees the benefits of modelling as a means to examine ideas in a number of situations.

Once the notion of modelling ideas is accepted - whether this be for anthropometric analysis of users or as a communicative tool for client/ergonomist meetings - the activity is not, on the face of it, that far removed from the activity of the designer. They are both researching, developing, modelling, testing, evaluating and communicating with a client. The movement of ICE away from traditional research is summed up in a quote from Page. "I don't want to spent my time just criticising, I want to offer constructive criticism and go on to make better products". This comment seems typical of the approach at ICE. Southall this time. "If you look at the ergonomists round here, and we have been talking about a minority, the way they will sort out a problem is to say that handle should be here and it should be like this. Well that is design". Nevertheless in spite of this apparent willingness to get involved in design issues all of the ergonomists interviewed stressed the major function of their work was to present a clear ergonomic specification. Stroud refers to many occasions when ergonomists have drawn the line at the specification without going on to define the type of design that may satisfy it.

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4.1.4 THE CHANGING NATURE OF THE INTERFACE.

This chapter has so far referred to the case studies in order to illuminate the attitudes and opinions of a number of ergonomists. It has specifically highlighted areas where design activity and ergonomic activity exist naturally and symbiotically. It has also presented evidence to support the notion that they exhibit unique or incompatible characteristics. This section attempts to present those characteristics that may be used to define an interface between design and ergonomics as witnessed at one particular location, the Institute for Consumer Ergonomics.

Stroud identifies the contemporary client as a manufacturer or organisation wishing to employ somebody who will knowledgeably and sensitively immerse themselves in the whole matrix of problems and possible solutions. The case-studies exhibit much that is in accord with this definition. A key element in this is the belief in the compromise rather than the optimum solution. Historically ergonomic research may have seen extended and exhaustive studies undertaken but modern commercial pressures call for an amended philosophy. "All solutions are compromises" observes Southall, "We make sure a thing meets a certain criteria but it's a trade-off between function and style".

It is significant that Stroud sees the ability to make trade-offs and compromises under pressure as an essential component of an ergonomists training, "To come up with a rough answer...... to point us in the right direction". However at the same time he also believes that ergonomics, "done properly, is a science". Spicer states that she too is always willing to compromise but adds that the advantages of doing a job a certain way will always be made clear to the client.

Perhaps one of the main developments at this interface mirrors a general change in industrial and commercial practice. With the increase in scientific management techniques the role of co-ordinator has been seen as vital to the smooth and efficient running of any organisation. Similarly with the expansion of teamwork systems,
especially in the area of research and development, the role of the co-ordinator is vital.

This co-ordinating role is one that Southall believes ergonomists are fulfilling, "particularly,... because we come from outside of the organisation. When we are trying to tackle a problem we come to understand aspects of the new product such as how it is going to be produced, manufactured, who's going to use it, which means that we have to cross all the departmental boundaries of a large organisation and talk to people. Very clearly my role has been in bringing people together".

Prof. Kirk offers a more cynical viewpoint. "I think the difficulty is that everyone regards himself or herself as a co-ordinator...... I must have about thirty years experience now, of doing research and applications connected with ergonomics, design and engineering. In every situation, I think it is fair to say, where you have had each discipline represented the co-ordinating aspects have been triplicated".

With regard to the people that work at this interface, Prof. Kirk believes they should have a sensitivity, if not a working knowledge, to the skills of all three disciplines. He acknowledges the difficulty in achieving this – even finding time for all of the ergonomic components is difficult enough but the ergonomics undergraduate course at Loughborough University does aim to sensitize the students to the broad range of skills, values and issues that the Institute for Consumer Ergonomics confront in their day to day activities. "Ideally what one would like to see is people who have got all the skills inbuilt," asserts Prof. Kirk.

The developing phenomenon of teamwork has resulted in designers and ergonomist working together for many years now. Where engineers are concerned this two way sharing of methods and procedures becomes a three way process. Southall describes one such sharing process. "A couple of chaps from here have just been over to a motor company to teach them some techniques on seat design and comfort evaluation. They have been working with them really as a training exercise to
4.1.4 help them develop their skills for design".

cont.

Prof. Kirk believes it is the 'high tech' industries and those in the service sector that have best utilized the skills of design, engineering and ergonomics while the traditional industries such as those in domestic and electrical products have lost markets through insufficient analysis and development of their products. This attitude is reflected in a comment by Southall which succinctly encapsulates the activity at this interface. "There should not be the distinction between ergonomists and designers because you cannot design effectively without ergonomics and you cannot really do good ergonomics if you cannot design".

4.1.5 EDUCATION AND THE INTERFACE.

Although Group 4 will present the major part of the analysis regarding education, the following points arose as a direct result of the investigations at ICE.

One would expect Prof. Kirk to hold a number of views concerning educational aims and objectives because in addition to his directorship at ICE he holds the post of Head of the Department of Human Sciences at Loughborough University. However, the investigations reveal a widespread concern for the education of future students who must face this changing commercial environment.

Many of those interviewed thought it important to increase the practical elements of an undergraduate course in ergonomics. Refering to her own education Spicer points out, "we were very limited in the materials we could use or the equipment we could build". In fact, the Institute may depend on this practical competence as the engineering backgrounds of Southall and particularly Stroud display. "I generally go onto projects where there is some technical requirement because I have an engineering background". The MSc course appears equally deficient in this area, Page again; "I think they are short of time essentially and there is insufficient practical work. Insufficient practical opportunities to do things like appraising products and dealing with people". Many of
4.15 The skills displayed by the group in such areas as materials, processes or equipment have been developed on-the-job and certainly one way of bringing on-the-job experience to an educational course is by placing the students in an organisation as part of their training. The four year B.Sc course at Loughborough University has an industrial or commercial placement in its third year but further connections are thought valuable, "I think it would help students to see how some workplaces work through visits etc. You learn so much when you see how an organisation works or a product is designed in a real situation. Even watching videos of workplaces is very useful".

The role for education in reducing the stereotypical opinions of one group in respect of the other was frequently mentioned and the teamwork situations appear to be a favoured way of achieving this. The development of a common language as indicated by Stroud was also seen as important. He sees the need to put students under realistic pressure, to come up with solutions and within short-term deadlines. This very much reflects the developing nature of the work at ICE. An interesting issue arose with the question of whether a design or an ergonomic education should come first, assuming a student wished to take one as a first degree and the second as masters degree. Southall expressed concern regarding the constraining tendency of a scientific education and believed that "perhaps it's better that you are a creative person who then learns the objective ways of obtaining reliable data". Perhaps this opinion shares something in common with a belief that ergonomists lack imagination for how something might be achieved or Page's pleas for commitment to a definite proposal.

For a discipline based on question-asking there appeared to be, within ICE anyway, some doubt that this was as fully developed as it might be.

This last ability was one that designers were accused of lacking most frequently. Thomas believes that education should equate those designing with the way in which it is actually used. To this end he believes that designers ought to go out to see the recovered cars from road accidents that he deals with on a day to day basis.
4.1.5 Most of those interviewed acknowledged the difficulty of doing any more than sensitizing students to the breadth of issues involved within such a short space of time but similarly believed any shared experiences could only help the development of design and ergonomics:
CASE-STUDY ANALYSIS.

4.2 GROUP TWO: THE DESIGN/ERGONOMIC INTERFACE IN SWEDEN.

The second group differs from the other groups in that it presents studies undertaken in Scandinavia. Early research had indicated that design and ergonomics received serious consideration in Scandinavian countries, particularly in the dominant economy of Sweden. Evidence had also come to light of a well-developed relationship between these subjects.

Group Two comprises three case-studies, the National Swedish Board of Occupational Safety and Health, known by the title Arbetskyddsstyrelsen; the leading ergonomics and design consultancy in Sweden, Ergonomi Design Gruppen; and an individual furniture designer/researcher, Mr Sten Engdal. All three subjects are based in Stockholm.

4.2.1 ARBETARSKYDDSTYRELSEN

Occupying a large office and laboratory complex on the outskirts of Stockholm is the National Board of Occupational Health and Safety. It operates on a scale befitting a national centre with over two hundred employees drawn from a wide range of professions including medicine, physiology, psychology, ergonomics, engineering, and administration. It has an international reputation based on the publication of research but it was the relationship between the analysis and its application that was of most importance to this study.

Although the Arbetskyddsstyrelsen receives a large part of its funding direct from central government in the form of long-term research projects it also gets a great deal of support from trade unions and other bodies concerned with the welfare of a particular labourforce. It is common for trade unions to instigate and fund research projects themselves, although the industrial atmosphere is such that it is usually a joint venture between management and unions. Initiatives of this nature are not cheap and contributions
4.2.1 from the workforce are high but the benefits in health, welfare and up-to-date machinery can be enormous.

There appears to exist an enlightened attitude whereby both management and unions are aware of the necessity for research and development of industrial processes and equipment. Such an attitude supports comprehensive research activity in the major universities as well as the Arbetskyddsstyrelsen. It would be difficult for these facilities to survive without grass-roots acceptance of the requirement for occupational research. This thesis may only reveal the tip of a social phenomenon of great complexity and much lies outside of its scope.

A shift of emphasis was acknowledged by a number of people at the Arbetskyddsstyrelsen, from very long-term projects to shorter ones. This reflected the greater dependence on industrial concerns and trade unions for research work. These clients usually required findings more quickly and in a more readily usable form than the governmental departments that traditionally sponsored research contracts. Some of their more recent research involved projects that enabled drivers to sit more comfortably; painters to work in greater safety; and machine operators to see their work with greater clarity. In projects such as these great emphasis is placed on the comments and opinions of those who have used the existing product or who have been involved in the established working procedures and who are likely to be involved with a new, developed version. Research of this nature is as likely to be based on-site as in the laboratory.

Erik Hansson, one of the researchers at the Centre, stressed this involvement of not only those directly involved such as drivers or operators, but also those responsible for buying, safety and general company policy. They are all to some extent involved in suggesting changes and all have an interest in better working procedures. This system of involvement appears to be a well established procedure in Swedish industry and is highly influential in the structure of companies such as Volvo, Saab and the telecommunications giant, L.M.Ericsson. However the apparently smooth passage of development is not maintained at the Arbetskyddsstyrelsen as they have no product design facilities of their own. All of the research findings
must be interpreted by external design consultancies who must refer to the reports and specifications of the Board in the development of ideas, drawings and models. These are then returned for further analysis and testing.

In an attempt to jointly examine the nature of the relationship and offer Swedish design students a realistic experience, the Arbetarskyddsstyrelsen and the foremost design education centre in Stockholm, the Konsfachscheule have promoted a joint initiative. They have put together a range of projects that promote an understanding of the analytical and investigative approach while encouraging the creative and manipulatory skills necessary for prototype development. One such project involved the assessment and development of fork-lift trucks with a major manufacturer and this enabled teams of students to exploit the advantages of computer techniques in many of these stages.

Another of the researchers, Jorgen Winkel, had recently taken up a post at the Arbetarskyddsstyrelsen after concluding his physiological analysis of foot swelling and leg activity at the University of Lulea in Sweden. His work now involves the further research and application of these studies. He holds strong views on research and his opinions shed some illumination on the relationship of design and ergonomics. Winkel echoed the feelings of others in that he thought research was a complex issue, as demanding of creativity as of analysis. His opinion that research often asks the wrong questions appears to indicate the particular requirement for design/ergonomic activity to implement a comprehensive range of abilities.

Winkel's work recently involved him in the development of the cabin space of domestic refuse wagons. The research exploited a number of means of establishing the nature of the problem and employed a range of specialists to contribute. The mechanism of this teamwork entailed the establishment of a 'common platform', from which the specialist information could be traded-off, while allowing and encouraging contributions from non-specialist users. In this particular case the drivers and operators were asked to go through
4.2.1 various activities within a full-size laboratory mock-up in order to requirements not communicated by any other means could be interpreted and incorporated.

Winkel lamented the still widely practised activity of handing over the research findings to a designer or design team for interpretation and conversion to a viable product or system. Whilst acknowledging the specialist contribution that can be made in such areas as materials, production or marketing, a policy of concentration was felt to be a hindrance to the development of the much-needed skill of 'asking the right questions'. Getting a team to co-ordinate its activities, to work together as one body takes time and can be expensive. Few companies outside of the multi-national corporations can afford to involve large teams of specialists who have spent time developing both the sensitivity to each others contribution and the necessary common language to communicate with.

Winkel believed strongly in the use of realistic situations for the development of these abilities. One cited example, the analysis and development of an aircraft trolley for passenger refreshments, necessitated its continual evaluation within an actual aeroplane. This was because it was felt that at that particular stage of the research a laboratory mock-up may mask some of the finer perceptual factors. However the obvious costs incurred would deter all but the most user-conscious of manufacturers from adopting this approach.

Ironically the investment in such extensive analysis and trials can result in not only in a better product or system but may provide evidence to support changes to much larger patterns of work. A project involving the investigation of cleaning and maintenance tasks undertaken by the Arbetarskyddsstyrelsen for a large commercial concern required the analysis of their current systems and procedures. The recommendations contained in the report had implications beyond the initial brief which was to investigate only one small group of cleaners. It was clear to the research team that major improvements could be made if structural reorganisation was accepted by the management and workforce. As has been mentioned, the cost of this type of study is often seen as prohibitively expensive for many companies who have alternative intentions for
4.2.1 available capital. This concern may be exaggerated if the findings indicate major reorganisation, even if long-term savings are predicted.

Sweden has been influential in the development of this type of extensive research. The Guardian (4.8.87) carried a feature on Swedish prosperity in which research was highlighted as a major factor. In the article, John Palmer supports and provides further examples of the philosophy encountered in this research, namely the writing off of short-term research costs on the strength of long-term profitability and enhanced industrial relations.

Although it was acknowledged that the trend was towards shorter-term, commercial projects, the work of the Arbetarskyddsstyrelsen was still very much concerned with the large scale, complex, systems-oriented research. Their activities chiefly revolve around work organisation and involve process to a greater extent than product. The Arbetarskyddsstyrelsen is unique in Swedish society in that it is the natural focal point for those involved in work research and for the various university departments of occupational health and safety within Sweden. The larger projects can run for several years with research directors held on a retainer basis for even longer periods.

Whilst appreciating the necessity for research over these longer timescales, one of the objectives of the study was to investigate the manifestation of ergonomics in the world of design with its demands for quick and usable results. To this end a case-study was sought that had experience not only with the values of ergonomic research but with the day to day pressures of commercial design practice. Ergonomi Design Gruppen of Stockholm was approached as it was felt that they exhibited the above characteristics and occupied a position in this heightened commercial environment.

4.2.2 ERGONOMI DESIGN GRUPPEN (EDG).

The consultancy occupies a converted mission house in Bromma, a suburb of Stockholm overlooking the entrance to the harbour. The
fourteen members that make up Ergonomi Design Gruppen have a variety of backgrounds but share two common features in their relative youth and their desire to employ their skills to the benefit of society rather than for its exploitation. Much of their work in the past has been concerned with the development of products for the disabled and other minority groups but they now have a wide experience in fields such as transport, precision instruments, systems, factories, consumer products and health care equipment. The skills of the group range from physiology, psychology and ergonomics through to industrial design, engineering and computing. It is a blend of skills that has resulted from the merging of two smaller consultancies, Designgruppen AB and Ergonomi Design AB.

Each project undertaken is initially discussed and the appropriate teams assembled by mutual consent. The nature of the team will differ depending on the type of work required. In the past projects have necessitated contributions from a number of specialists as each has differing requirements for research and realisation. The timescale is also an influential factor in determining the nature of the service offered by Ergonomi Design Gruppen.

It was Olle Bobyer who outlined some of the attitudes and objectives of the group. The general interest in human factors from a commercial as well as a moral point of view has provided a range of clients for the group. The research undertaken, while being extremely thorough, acknowledges the constraints placed upon a company competing in the marketplace. This willingness to amalgamate the research findings with the practicalities of manufacturing production and marketing have placed Ergonomi Design Gruppen in the forefront of Swedish design consultancies.

The group freely admit that most clients are only vaguely aware of their actual process of innovation and development and yet their proven track record reflects and strengthens commercial confidence. While many companies have seen the financial benefits of traditional industrial design practice, this area has had the benefit of many decades in which to mature. The joint use of ergonomists and
4.2.2 designers on the other hand is still in its infancy and its judges must apply appropriate criteria in evaluating its success. It is the propagation of these criteria which underpins the work at the EDG.

As with the Arbetarskyddsstyrelsen many of the research projects are funded by trade unions, handicap institutions, charities and various research bodies as well as direct governmental involvement in the provision of contracts. Some projects have brought the two groups together, the Arbetarskyddsstyrelsen relying on the EDG's skills of realisation to implement their findings in the development of products that are both usable and commercially viable.

In the discussions with Bobyer the analysis of methodologies invariably returned to the establishment of the problem. He cited his experience with design education that he felt failed to develop an enthusiasm for the creative use of scientific methodology as an important part of the design process. While fostering skills of manipulation such as the involvement with materials, form, experimentation, humour and change, design education was guilty of not encouraging the implementation of quantifiable and repeatable research.

Ergonomi Design Gruppen's contact with clients and users is extensive and often results in a three to five year study with extensive user trials within this period. As noted earlier an open ended research programme can provide findings of little relevance to a manufacturer except in the very long-term. Therefore the establishment of an initial specification was seen as essential in order to define the parameters of the research.

Cost prohibits the involvement of more than two or three members of the group but it is common for these to become established on-site for many weeks at a time in order to sensitize themselves to the complexity of issues that comprise even the simplest design problem. The use of video and time-lapse photography provides information that may not be available by any other means, including interviews with the same operators. Bobyer believes that very often these
workers are unwilling or unable to communicate processes that have become daily routine.

This environmental investigation involves the researchers mixing with the employees, getting involved in their activities and becoming part of the daily routine. This in turn necessitates the exploitation of a range of social abilities if close and accurate observation is to be maintained. The resulting feedback is often the most meaningful and may take the form of verbal comments or observations. Examples of useful feedback from this type of involvement may be watching workers misusing a tool to make a job easier or quicker or examining a hand tool that has been bound with tape in order to make the grip more functional or comfortable. Very often these important insights are not communicated or they do not show up in laboratory set ups, and in many cases they are deliberately hidden.

The group believe this source of information is vital to development and vigorously defend the scale of funding that extensive research entails in order that nothing is overlooked.

From the examples that were revealed and from discussions with other members of the group it appears that the design process, while being systematic, is run in parallel to the research. Many of the group said they made drawings and produced rough models of ideas while they were still coming to terms with the exact nature of the problem - indeed this activity often assisted the clarification of some aspect of the investigation.

Although Bobyer advised caution in developing an idea too far too early he did acknowledge the important role these two and three dimensional languages had both for communicating ideas and for enabling a greater understanding or manipulation of an idea.

When the initial research is completed the group exploit models, mock-ups, test rigs and prototypes more fully. One project involved the mock-up of a full size printing room within a factory to evaluate worker movements and their relationship with the machinery.

Bobyer acknowledged the value of his earlier experience as a model maker and found models an invaluable aid to his work. This had
4.2.2 ranged from simple two dimensional shapes that can be modified and moved around on scale drawing to the type of full size simulation mentioned above. Mathematical modelling is often the most convenient and the most economical method of testing an idea and many clients often expect to see and feel a high quality model at the conclusion of a project in addition to part drawings or costings.

Ergonomi Design Gruppen have no technical staff for these model and prototype making activities. They pride themselves and in fact depend upon the development of sensitivities that come about through direct involvement with materials and processes. They deliberately maintain a working procedure that is as likely to bring them into contact with packaging, fashion or model making, as much as polymer technology, statistics or engineering. Their unique synthesis of these skills defy easy categorisation. They are not ergonomists with access to design facilities as their process has so much in common with designerly thought. Nevertheless to call them designers does an injustice to the depth and quality of the research undertaken. It is a blend of skills within full time staff that few consultancies could match.

Boyer sees their role as one factor in a tripartite system involving specialist research bodies and industry, where so many factors merge together.

One outcome of this complexity of the research, design and development process (as witnessed in Sweden as well as in many other developed economies) is that many companies can no longer afford to maintain their own design departments. The growth of Scandinavian consultancies mirror this decline in involvement and now only the major manufacturers can bear the costs. The large electronics manufacturer L.M.Ericsson maintain a comprehensive design staff but their costs are offset by consultancy work. The Ergonomi Design Gruppen are the biggest independent consultancy and probably the most widely known in Sweden.

The political climate in Sweden has already been cited as a major contributory factor in the maintenance of the type of work undertaken
Government legislation and trade union pressure has created a demand for the research and development of an immense variety of tools, products, machines, processes and systems. However, the impetus behind the work appears to be greatly assisted by personal motivation. Although EDG members reflect a full spectrum of political values they are unified by the overriding aims inherent in the involvement in socially beneficial projects. In areas where development necessitates such personal understanding, a high level of commitment is a prerequisite. Although the group is run on strictly commercial lines and the lucrative benefits of some work often appear very attractive, overtly anti-social design projects are avoided. This idealism can only be maintained with outside support. Schumachers' old maxim, to design for people or to design for profit, still presents itself where salaries and overheads have to be paid each month. The reconciliation of the ideal with the practical has never come about easily.

One factor towards personal motivation is the involvement in self-proposed projects. Working continually in problem situations, and employing processes aimed at resolving them, has resulted in each member acquiring a range of personal projects. These range from ideas noted down for future development or simply out of interest, to projects that are taken on as part of the consultancy's main-stream work. Unfortunately, viable as these embryonic ideas may seem, the group are under no illusion as to the time and resources necessary in product development, and when these costs have to be met without client assistance the risks rarely make commercial sense. Many of these pot-boilers are held in abeyance for a suitable backer or pursued in personal time. Each member of the group will be involved in two to five projects, dependent on the type of input, and the scale of the project. In August of 1986 the consultancy had ninety projects on their books.

For much of the product or industrial design work the clients specify a time scale of between one and eight weeks. These projects maintain the necessary cash flow, and promote links with a wide range of
4.2.2 international manufacturers. However, the research, design, and evaluation cycles necessary in many projects can take much longer and the average time the group would devote to a larger scale project is between six months and one year, with one or two ongoing links extending back some twenty years. The tractor-based harvester was not uncommon in resulting from a five year contract.

The strength of the consultancy undoubtedly comes from stringent commercial handling of all aspect of work undertaken. The democracy witnessed in design, development and decision-making extended into fiscal and planning matters even where other members held responsibility or exercised power. Awareness of such aspects as the elasticity of demand and consumer spending patterns profoundly influence the designing activity and the resulting outcomes. All members spoken to constantly stressed price and cost factors when referring to project development alongside the expected ergonomic issues.

It was felt that design-based activity was fundamental to an ergonomist and that this should be a major component in the education of those who wish to follow a career in ergonomics. However, it was also felt that design education - at least that of the Swedish system, did not provide the total range of skills or experiences. Aspects such as design criticism, aimed as much at the students in their roles as consumers as in their roles as designers, left much to be desired and perpetuated many difficulties experienced by those involved in design and development.

Bobyer viewed the position of the Ergonomi Design Gruppen as regrettably unique. In a consultancy employing both ergonomists and designers the activities of problem definition and solution development knew few boundaries. Both groups had brought certain skills and knowledge, but the similarity of the two groups in their approach confounded the widespread practice of delineating the areas into two distinct professions. This partly results from the phenomenon of the specialist but also from the growing protectionism shown by most professions towards a group of skills which they can call their own.
4.2.2 This protectionist attitude may actively erode the trust, reliance and willingness to communicate that distinguishes so much design activity. The establishment of a sphere of knowledge may not only perpetuate the belief that it cannot reside in another group, but may actively discourage the exploitation or incorporation of alternative skills into one's own sphere of knowledge. It appears that design and ergonomics have been victims of these protectionist attitudes for as long as they have been defined professions.

4.2.3 NATIONAL CHARACTERISTICS.

Sweden displays a social, political, cultural and economic environment that is different in many respects from the one in Britain. Because of these differences comparison of the Swedish case-studies with those observed in Britain is fraught with danger. The Swedish studies have their own character and validity and display a response to the challenge of the Twentieth century that is earnest and personal. Design and ergonomics are built into the Swedish tradition in such a way as to make direct comparison meaningless. Nevertheless certain observations should be highlighted as these provide a key to the nature and relationship of these domains in Sweden and may illuminate issues of concern to a wider audience.

Undoubtedly greater funding made available in Sweden has facilitated the development of a relationship between design and ergonomics. This belief in investment is substantiated in Palmers' article in the Guardian referred to earlier. In analysing the factors responsible for Sweden's remarkable economic recovery in the 1980's he believed that one of the most important was "... the far sighted character of Swedish industrial management which deliberately sought to increase investment, particularly in research and development, when their competitors were all too often engaged on a short-sighted cost saving programme."

This comprehensive investment involves funding from research councils and central government, as well as a much higher level of expenditure on research and development from unions and industry. Good
information and communication has raised the awareness of all concerned and extends down to the shop floor. This information has created the industrial and commercial environment supportive of the studies undertaken by Ergonomi Design Gruppen and the researchers at the Arbetarskyddsstyrelsen. Certainly Jorgen Winkel believed his job involved raising the user-consciousness of manufacturers. Nevertheless there was some feeling that long-term research projects were being restricted in favour of shorter-term projects with a commercial leaning.

In certain ways Ergonomi Design Gruppen display most obviously both the confrontational and symbiotic nature of design and ergonomics while Sten Engdal and the Arbetarskyddsstyrelsen represent the traditional approach to these areas. EDG exploit teams of specialists but they meet for lunch every day around a large circular table. There may be genuine differences of opinion but these are openly discussed. The group all share a willingness to implement natural language, graphical and modelling languages and mathematical notation in the communication and development of their ideas. They also appear as much at home conducting scientific research or analysing statistics as they do solving problems or constructing models.

The Swedish design education system reflects a traditional approach with clear distinctions between it and subjects such as engineering, ergonomics and physiology. Engdal lamented their system whereby designers and ergonomists could go through higher education and not meet until they take up posts in industry. However new initiatives are being made. The cooperation between the Konsthochschule and the Arbetarskyddsstyrelsen allows design students to experience realistic research practices. Experiences such as these hopefully encourage research by designers and prompt an involvement along the lines outlined by Hansson.

As for the researchers interviewed, they seemed as concerned by manufacturing or costing constraints as they were with ergonomic suitability. Such a sensitivity to the complexity of the design, development and production process can only facilitate the further
4.2.3 development of lines of communication which in turn may increase knowledge and encourage sensitivity.

Both designers and ergonomists relayed the importance of asking the right questions and the role of creativity in the problem identification process.

The economic climate in Sweden has been ripe for a merging of design and ergonomics for many years now. Not only are there sound commercial reasons for doing so but there is a healthy demand for such services as a result of Government legislation and trade union pressure. Many companies, unable to carry a large research and development team of their own, are switching to the use of consultancies as and when needed. Ironically while these developments are taking place there is a small but growing trend towards protectionism, consolidation and isolation. This return towards the security of a 'specialism', a service offered by no other group, appears fuelled by fears of a recession in the economy and could have a destructive effect on the recent exciting initiatives of education, industry and research institutions.
CASE-STUDY OVERVIEW

4.3 GROUP THREE: BRITISH CONSULTANCIES AT THE INTERFACE.

The three case-studies that make up Group Three provide some of the most illuminating material in a search for evidence of the relationship between design and ergonomics. Their inclusion does much to define the contemporary state of an interface that is still very much in its infancy. The major criterion for the selection of the case-studies was that they employed both designers and ergonomists in the services they offered.

CCD is a relatively small consultancy based in Weybridge in Surrey. Of the three people that direct the company, two have a design background, both by training and experience, while the third, John Wood, is an ergonomist. Three other people are employed to assist in the analysis and realisation of products. It is Mr Wood who provides the first case-study. David Carter Associates (DCA) on the other hand are one of the major design consultancies in Britain. In terms of scale, manpower and turnover they tower over CCD and as such provide evidence of a relationship at a different level. Alan Williams, also a director, provides the focus for the second case-study. The third case-study is provided by a relatively young consultancy in two senses. Paul O'Leary and Andrew Rogers graduated from Loughborough University in 1987, each with a degree in Design and Technology. As part of their final year design practice they gained valuable experience working with a number of clients. This experience has assisted them to establish their own design consultancy. Their relevance to this study is that nearly all of their work to date has been commissioned by ergonomists involved in various research projects who have obviously felt the need for other services.

These case-studies reveal not only each others perceptions of the role of design and ergonomics but they also illuminate distinctly
4.3 different values and strategies that are brought to bear in a process involving the development of products and systems for human use.

4.3.1 ANALYSIS.

John Wood of CCD has been aware of this issue of the relationship between designers and ergonomists for some time. Having initially trained as an ergonomist at Loughborough and undertaken a postgraduate course at the RCA, 'putting ergonomics into industrial design projects' as he describes it, Wood has experience of this interface over many years. Through his work at CCD he has observed a number of developments. He points to clients requirements for usable information, not a two hundred page academic report. 'Our clients do not read much... they do not want reams of paper, they are interested in solving a problem (and) this may be done very effectively with a visual'. He is also aware that the type of design/ergonomics service that CCD offers attracts only those clients sensitive to their contribution.

Alan Williams indicates a similar development of demand. 'Clients rather liked us employing ergonomists as it would obviously underwrite the design... British Rail will say 'and what about the ergonomic report'. Client demand is a relatively new phenomenon but the designers intention of considering the user is more difficult to date. Williams believes that this approach has always been a feature of good design practice but that traditionally designers have always relied on the less systematic methods of ergonomic investigation. He points to a strategy of 'common sense' analysis by the designer, a strategy that often involved the setting up of small-scale user trials. Although he indicates that modern design practice has changed enormously Williams illustrates the earlier, less scientific strategy with reference to a long-standing relationship with Stanley Tools of Sheffield. One project concerned the development of a range of hand tools whereby ergonomic analysis involved the evaluation of a variety of prototypes by local tradesmen and professionals during their actual activities. This 'suck-it-and-see' strategy has undoubtedly proved successful for a great many of the products that
4.3.1 were available two or three decades ago. It has also proved spectacularly unsuccessful in a number of cases and is becoming increasingly inappropriate.

All of those spoken to defended the role of the specialist in this product development process. Whilst being a director of a ergonomics/design consultancy, Wood classifies himself as an ergonomist and not a designer. However all present strong views on the value of teamwork. O'Leary and Rogers reveal the synergistic benefits of not only designing together but working closely with ergonomists during the development of products. Wood supports this but admits to his advantage of a long-standing working relationship with his design based co-directors. Williams extends this debate by stating that, in his opinion, a closer working relationship is witnessed only in the more 'serious' design work. In support of this he refers to transportation and contrasts this to consumer or fashion goods. Certainly greater funding may be a major factor in facilitating research and development activity. Similarly Wood identifies modern, highly technological companies such as IBM as representative of a contemporary relationship between design and ergonomics. He points to their financial size and their modern product as being the necessary factors for a closer working relationship between the two groups.

The skills and values of each group are more difficult to categorise, particularly since the case-studies chosen are not only sensitive to the contributions of the other domain but in many instances a broad overlap exists in each others activities. The issue of creativity arose many times in the conversations. O'Leary and Rogers were critical of some of the client briefings that took place in the absence of someone who could offer a creative perspective on the nature of the problem. They found it frustrating to be asked to model a proposal that they felt was the result of a flawed specification and often found themselves offering unasked-for modifications. Wood has experience of the other side of the coin. As an ergonomist he feels he has been left out too often from the very earliest exploratory meetings between clients and designers. He
feels that designers have been, and in many respects still are, guilty of viewing ergonomics as a 'clip-on' component of design. Williams is in a different position to the others. He is responsible for buying-in the contribution of ergonomists as and when the projects demand it. As such he particularly values the ergonomists' abilities in the translation of statistical information, the findings then being fed through to the design team responsible for the development. This compartmentalising of contributions appears to be inevitable in contemporary large-scale consultancy work. Nevertheless where feasible Williams would like to see a variety of people in at the briefing stage and he states that he has often included ergonomists in the earliest discussions with clients. Indeed Williams believes that ergonomists must develop a presence at all briefings if they are to maintain a professional profile.

It was anticipated that the role of education in these issues would provide a great deal of opinion from all of those interviewed. It was largely for this reason that a major analysis of design and ergonomics in higher education took place and which appears as Group Four of the case-studies. One of the key areas of agreement is the important position that education has in the furtherance of the domains of design and ergonomics: The development of any interface between these domains is an issue that will soon reside with the young men and women training today.

'That the students of both domains should learn to work in teams was an often repeated comment. Williams believes that the design and design-related world has become one for team members not individuals. Time to allow this team development is becoming increasingly expensive as universities and polytechnics are faced with continual reductions in funding. Evidence already exists to show that a consolidation of taught subject matter is taking place rather than the expansion and exploration of contributions that is hoped for by the likes of Williams. Similarly cut-backs have reduced the ability of institutions to buy a few hours each week of the time of a professional. Wood reveals a deep concern for the losses at Central
4.3.1 School of Art and Design that have resulted from such a reduction in visiting lecturers.

As stated earlier the parent domains of design and ergonomics cover a wide range of activities and capabilities. While the relationship between design and ergonomics will be of general interest to many, only a proportion of those graduating in these subjects will work at this interface. Therefore the dilemma for higher education is one concerning the amount of time that it can afford to offer to an examination of a design/ergonomics relationship. Nevertheless Group Three identifies a number of issues that should rightly be included in the training of undergraduates of these subjects.

Wood identifies a general lack of communication skills on the part of ergonomists. Not only does he see benefits for their day to day activities, (particularly those who take up employment nearer the interface) but a greater communicative ability could be brought to bear on the articulation of the ergonomists contemporary contribution to product development - an issue that appears to cause a great deal of concern to ergonomists generally. Wood is critical of the traditional ergonomists strategy of restricting papers to 'turgid articles in (journals such as) Ergonomics or Psychology'.

There is also some concern, as expressed by Wood, that ergonomists are guilty of taking a rigid research approach into an industrial situation. He believes there is a requirement for encouraging much more flexibility in young ergonomists. As far as the ergonomics component of design education is concerned Wood believes that 'revealing the doors that can be opened' would assist many designers to implement the ergonomist to a greater extent. O'Leary and Rogers are both a product of the design training at Loughborough. They believe that design has a great deal to offer in the problem definition stage as well as in the idea resolution stage. They also believe that a sound knowledge of materials and processes has increased both their creative and practical capabilities and such abilities have been a major asset in product development.
4.3.1 The training of young people who may go on to work on or near to the interface is an extremely ill-defined requirement. The consultancies that comprise these case-studies cannot be said to be representative of the professional activities that are undertaken elsewhere. They can only contribute to a better understanding and perhaps give some indication of future directions. Wood views the relationship between design and ergonomics as a natural alliance, and this is echoed by O'Leary and Rogers in their desire to see design and ergonomics jointly applied at the inception of projects. Williams refers to a number of projects, notably one involving ergonomists from the Institute of Consumer Ergonomics at Loughborough, in which the benefits of seeing a project from a number of viewpoints are valued. The input from each of a number of specialists, not simply those of the designer and ergonomist, are seen as the contribution of a highly trained individual. There appears to be no widespread desire for a hybrid — a person with the knowledge and capabilities of both domains — and the immense difficulties of training such a person were often expressed. In an arena that Williams defines as one of compromises it appears that sensitive teamwork is currently the most successful strategy.
CASE-STUDY ANALYSIS

4.4 GROUP FOUR: DESIGN AND ERGONOMICS IN HIGHER EDUCATION.

Group Four presents subjects drawn from the field of higher education. It is focused on two departments within Loughborough University of Technology which may be seen as having a particular interest in any design/ergonomics co-functioning or interface. The Department of Human Sciences and the Department of Design and Technology are both notable in their own right and a brief overview cannot do justice to either Department. Nevertheless it is important to a full understanding of the material that some background is made available. Following this the analysis attempts to highlight important features of this situation. The interviewees were:

- Professor N. S. Kirk B.A., Ph.D - Head of the Department of Human Sciences and Director of the Institute for Consumer Ergonomics.
- Mr. D. W. Hampton - Lecturer in the Department of Design and Technology.
- First year students from the Department of Design and Technology on completion of an ergonomics component.
- Second year students from the Department of Human Sciences on completion of a design component.

'The Department of Human Sciences, formerly the Department of Ergonomics and Cybernetics, was founded in 1960 and from the start has focussed its teaching and research interests on the scientific study of Man. From the initial postgraduate work in ergonomics, it has progressively widened its interests, developing undergraduate courses in ergonomics, human biology, psychology and ecology, and postgraduate courses in ergonomics and human biology.'
This quote, taken from the Human Sciences prospectus, highlights the emphasis that is placed upon a scientific tradition. Nevertheless the prospectus goes on to inform the reader that the application of science, within developmental research interests, are vigorous and wide ranging and include the Vision and Lighting group, the Human Sciences and Advanced Technology group (HUSAT), vehicle design and computer aided design.

Students wishing to undertake a first degree in Ergonomics can choose either a three-year, full-time course or alternatively a four-year thick sandwich course whereby he or she spends the third year working in industry or other appropriate institution. The first two years of both courses are common and it is in the second year of this course that the students undertake the design component within the Department of Design and Technology. This entails a total of twelve, three-hour contact periods and is outlined in greater detail later in this section.

"Design and Technology at Loughborough University is a first degree subject concerned not only with 'Designing and Making' but with bringing together a family of skills, knowledge and values associated with artefacts, products and systems and their development and exploitation. This breadth of designing activity encompasses a vast range of human endeavour. The analysis, synthesis and creation of new products, processes and systems is the central part of 'Design and Technology' for degree students."

This quote, taken from the current prospectus of the Department of Design and Technology stresses the diversity of the subject area. It is indicative of its desire to become involved in a number of peripheral areas that have themselves become consolidated into specialist skills or professions. Such areas include electronics, mechanics, graphical communication, skilled working in wood, metal or plastics, computing and of course ergonomics.
4.4 The students within the Department of Design and Technology undertake an introduction to ergonomics in their first year. This entails an evaluation of the role of the ergonomist in industry, commerce, or research situation and is undertaken in conjunction with first year students from the Department of Human Sciences. More particularly the exercises have included the design of displays, controls, workspaces and tasks; design for safety and design to minimize fatigue. The Department of Human Sciences that teach this component for one morning per week of each of the three terms (78 hours), place great importance on the practical work involved.

Both Prof. Kirk and Denys Hampton have a vast experience of teaching and working within their specialist areas. The reasons for choosing them as case-studies however, also lie in their sensitivity to, and acknowledgement of the skills, values, and abilities offered by the other domain. From a background in engineering, Denys Hampton has promoted interests as wide ranging as psychology, history and painting. While Prof. Kirk has a first hand knowledge of the key developments and influential characters that have given rise to this very young subject of ergonomics.

The comparison of the information resulting from the four studies undertaken in Group 4 make up the remainder of this chapter. The overall objective of this comparison is to present a model or models of this design/ergonomics interface as it is perceived by staff and students at Loughborough University of Technology. However, three sub-aims should be noted:

1. To examine the intentions of the courses as expressed by the members of staff and perceived by the students.

2. To ascertain from the students the successes and deficiencies of both courses.

3. To present the views of the next generation of designers and ergonomists, particularly concerning the relationship between these two areas.
4.4.1 ANALYSIS

Both the Design and Technology course and the Ergonomics course at Loughborough feel they can do little more than sensitize their students to the knowledge and issues of the other discipline. As Prof. Kirk points out, 'ideally what one would like to see is people who have got all the skills inbuilt but if they haven't,..., part of their education should be responsible for sensitizing them to the demands of the other disciplines.'

Hampton echoes this belief, stating that students from both design and ergonomics should be provided with, 'a broad platform, not necessarily a high knowledge in every field but one in which he or she can see relationships between one area and another'.

One of the most successful arrangements for undertaking this sensitization appears to be through teamwork. Although Prof. Kirk points to teamwork as one of his key objectives, with four first year Design and Technology students working with four Ergonomics students, it is the responses from the students that are most revealing. Of the Design and Technology students, Cath noted, 'the teamwork was the main thing as far as I was concerned', while Paul observed, '.... in the first term we learnt more about teamwork than we did about ergonomics.' There is a general agreement amongst the group that although directions were often vague they enjoyed working and learning together. Such skills as listening, delegating and compromising are all cited as developed abilities as a result of having to work in mixed teams.

The second year ergonomists also support the value of team situations. When asked if they would prefer more teamwork, both with other ergonomists and other specialists, the answer was very clearly yes.

Clearly there is a willingness and a belief in the necessity for both groups to experience each others working procedures and areas of involvement. Although it might be expected that ergonomists would believe that it should be the designers task to learn more about ergonomics the response to question twelve of the questionnaire
4.4.1 (Appendix B) also displays a considerable agreement with the statement that ergonomists should learn more about designing.

As many groups that develop and maintain an identity, design and ergonomics have experienced the disadvantages as well as the advantages. The effect of misinformation and prejudice has been profound in recent decades and has done much to affect the perception of the two domains to this day. Nevertheless there is a varying degree of awareness of this issue and efforts are being made to confront it. The research set out to record subjective opinions as well as more objective responses and found that the problem was very deeply ingrained.

The students were particularly open and candid on this issue. Phil expressed one opinion common amongst the design students. 'We found that because ergonomics is laid down - it's more scientific, you can always look it up in a book'. Andrew believed that ergonomics is more concerned with 'situations where you have to get things right first time', while Paul saw it 'limiting your scope as a designer'.

Although ergonomists may refute these statements, they too are guilty of propagating stereotypical images of the designer, often referring to stylists, artists or craftsmen. Prof. Kirk is well aware of this issue and believes that teamwork can open peoples eyes to achieve better working relationships across a number of professions. He cites the traditional industries as being largely responsible for maintaining attitudes whereby design is 'tarting up the form or texture of a product'; ergonomics is 'the science of sitting or the science of knobs and dials', and engineering is 'interested purely in cogs and such'.

Prof. Kirk is, however, optimistic that the situation is changing. 'The sorts of attitudes that I've just expressed don't occur in high technology industry so if you go to IBM, Hewlett Packard, ICL and many others, there you will see major contributions being made by engineers, designers and ergonomists. The new service industries such as British Telecom are also mentioned as representative of a
new, enlightened attitude in the investigation, development and design of products or services.

The stereotypical opinions within these specialist areas are compounded by a public image that is at best vague, and often completely erroneous. This issue has arisen frequently in discussions with designers, ergonomist and educationalists and is examined more thoroughly in the conclusion to this thesis.

The optimism for teamwork situations to overcome difficulties is not shared by all however. Whilst the general feeling amongst the ergonomics students is that there should be more teamwork in the courses, one student felt moved to write on his questionnaire 'We did this in the first year - it doesn't work!'. Perhaps as Hampton points out there are some fundamental differences, 'salt and sugar' as he terms it, which cause problems in bringing the two together.

Question 13 of the questionnaire asked the ergonomists whether they functioned and communicated well with designers in a teamwork situation or whether they found it a difficult or frustrating experience. The majority opted for the latter response.

There are clearly major hurdles to be overcome in getting the two student groups to work together efficiently, not just within higher education but during their working lives. Nevertheless the overwhelming feeling from the case-studies was one of enjoyment and real learning by the students. As was stated in the introduction the future of any opinions will define and determine the nature of any working relationships over the next fifty years. A number of these opinions are worth relating as they indicate the likely nature of the development of a future design and ergonomics interface.

'Certainly I will design with an awareness of ergonomics and will also be more receptive to an ergonomist coming along and saying, well I think if you move this over here you will get a better machine.' (Design student). 'I would like to do something practical, like fitting trials, on a larger scale,..... I would like to get lots of sheets of cardboard and make a console or something.' (Design student). Both groups of students express a desire for contact in
4.4.1 all years of their course, not just part of one year as at present. They also both state that this time could be used for projects that are client-based or at least a lot more realistic.

Whilst the ergonomics students expressed a belief that devising and developing ideas was the most important skill that they developed on their design course, working in a workshop and using various materials, machines and equipment were also rated highly. This practical element, common in design courses, was seen as very important for an ergonomist, for example in the construction of good test rigs, models or mock-ups. The ability to draw was also seen as a valuable and appropriate skill.

One feature that does stand out prominently from the case studies is the widespread belief by each group that they are undertaking some of the activities of the other. The students particularly view their own specialist activity as one that incorporates some aspects of both designing and ergonomics. The two questions that were meant to ascertain the strength of this feeling amongst the ergonomists recorded some of the highest figures of the questionnaire. When asked if an ergonomist is designing if she/he analyses, develops and improves a product the modal value reached 90%. The question 'could any of your work be classed as Designing' recorded an equally high response. Kirk points out that many ergonomists are having to get involved in commercially viable, short-term consultancy work.'Whether they like it or not they have been forced in this direction... which essentially is in the design related area'.

For the designers, the ergonomics course has introduced the need to sensitize themselves to those situations involving Man and the products we surround ourselves with. It has introduced scientific and quantifiable methods as tools to analyse the variety of interaction. For the ergonomists the design course has assisted in creativity and communication as well as providing skills of direct use in the design and construction of test equipment. The designerly skill of modelling has also been introduced and has encouraged the exploitation of drawing, making and mathematical modelling.
4.4.1 One ergonomist wrote at the end of her questionnaire, 'The thing I learnt most was confidence; confidence in doing something that looked an impossibility to begin with.' There appears to be very little grass-roots reluctance to working together or being involved in each others area over a longer period. The ergonomists expressed a desire for contact and collaboration between the departments to be extended to all three years, while from the other side, Phil expressed what appears to be a common feeling amongst design students when he said 'design is ergonomics'.

Although the case-studies outline real difficulties, and in some cases disadvantages, to a policy of training in both skills, the movement towards a greater understanding and confidence in the others domain is well established. Interestingly the student opinion does not support the notion of the scientific/intuitive split proposed by Hampton. Not only do they view both groups as diverse but similar, but also that it doesn't matter which course is undertaken first assuming that both design and ergonomics were to be read at undergraduate and postgraduate level. There are a variety of opinions regarding this point but it is left to the conclusion to draw these, and many other threads together.
5.0 TOWARDS A NEW PARADIGM.

The case-studies highlight the nature of a relationship between two domains that are undergoing a changing and maturing process. The studies contain evidence of attitudes and opinions that may be seen as being partly responsible for the development of such a relationship during a period of little more than one generation. This development has not taken place in isolation. It has been intrinsically bound up within a wider sociological and technological progression.

Both design and ergonomics have been shown to be relatively young professions even though the roots of their respective activities may be viewed as basic and ancient human capabilities. These two domains do not readily fit KUHN's model of mature sciences that he uses in support of his theory of paradigms. Design and ergonomics both encapsulate a considerable range of values with regard to their subjects and they display a wide diversity in their assumptions. Consequently both domains appear to have more in common with KUHN's 'pre-paradigmatic' state of conflicting values, than with the widespread stability that he identifies as representative of a true paradigm.

If both design and ergonomics cannot be said to exhibit paradigmatic qualities, then it is reasonable to ask how any interface between the domains could be viewed as moving towards - as the title suggests - a new paradigm. The remainder of the conclusion seeks to answer this.

Case-study, as has been shown, represents a research method that openly reveals its value system. That is, the case-studies are not presented as representative of the interface.
5.0 Their value lies in their presentation of commercial strategies that are various, eclectic, interwoven and most importantly, deemed successful by each of the chosen subjects. It is this richness that allows the illumination of each personal response to the demands of a contemporary interface. From these responses there is much that can be identified concerning the wider nature of a relationship between these two maturing domains.

KUHN has provided some guidance for those seeking to understand the nature of subjects within the natural and social sciences. In his book *The Structure of Scientific Revolutions* he presents the notion that a continual erosion and/or confirmation of group values and assumptions is an entirely normal procedure. He refers to strong group values not as encapsulating any particular truth but merely as evidence of a 'paradigm'. This paradigmatic state is just as likely to be overthrown as supported, if enough members of the particular community believe it to be so. KUHN identifies this overthrowing of old values to be a relatively sudden occurrence that results from the culmination of a gradual build-up of evidence.

Some observers may wish to view the establishment of an interface as a normal, pre-paradigmatic development for both design and ergonomics as it could be argued that its existence was evidence of the expected maturation process referred to earlier. However there are a number of factors that would seem to indicate an increasing independence of such an interface. The chosen instances of design/ergonomic activity, appear to exhibit the 'competitive tension' that is identified by KUHN as indicative of a pre-paradigmatic state. They also exhibit a coherence that is worthy of identification as an entirely separate entity. That is to say, while the interface may exhibit even less maturity than the parent domains it too can claim its own pre-paradigmatic state. It may be just as likely to evolve a new paradigm as the parent domains of design and ergonomics.

It is evident from the case-studies that instances of design/ergonomic activity are a result of wider developments in our commercial and industrial society. More particularly design/ergonomic
activity may be seen as the result of market forces. It is governed and shaped by the demands of industry and commerce rather than by what the parent domains have traditionally supplied. As such, any examination of design/ergonomic activity must acknowledge the nature of these developing market forces which have had a widespread influence across a whole spectrum of design and ergonomic practices.

5.1 MARKET FORCES IN THE ESTABLISHMENT OF AN INTERFACE.

The relationship between design and ergonomics in industry has changed considerably in recent years. Many of the traditional industries such as the furniture industry are suffering a decline or consolidation, while there is general agreement regarding the prosperity of many industries in the High Technology sector and to a similar extent the service sector of our economy. Companies such as British Telecom, Philips and L.M.Ericsson have expanded and developed an organisational structure compatible with the demands of the fast moving technological society. One aspect of this is their ability to facilitate and co-ordinate the contributions of many specialists and these include designers and ergonomists. However, the costs incurred in development have deterred all but the major companies from employing a large research and development staff.

A growth in the consultancy sector has mirrored these spiralling costs and this has been a phenomenon observed in Sweden as well as in Britain. The economic pressures that have encouraged the growth of the consultancy sector have also been influential in the type of service that it offers. Increasingly, clients have demanded more from consultancies and many now advertise a very comprehensive 'package'. The case-studies reveal the influence that client demand has exerted, forcing design consultancies to offer ergonomic analysis and ergonomics consultancies to model proposals. Williams believes that clients rather like the utilisation of ergonomists as this is seen to 'underwrite' the design. He points to an awareness of these issues in companies such as British Rail.
5.1 CCD in Weybridge have observed this development and have, for many years, offered the combined services of designers and ergonomists. Even in their ergonomic studies Wood indicates the increasing demand for models and visuals to assist communication with clients who are not prepared to read through a 200 page report. Ergonomic consultancies are increasingly being drawn into the short-term, product development field. This may be partly due to the reduction of in-house staff on the part of many manufacturers but it also has much to do with impending product liability legislation.

Liability for defective goods is currently a matter for the application of the Law of Contract and the Law of Negligence but there has been increasing pressure from a number of bodies to supplement this. In 1977 the Law Commission and Scottish Law Commission presented proposals for stricter liability in the case of defective goods, and this was quickly followed by a supporting document entitled The Royal Commission on Civil Liability and Compensation for Personal Injury (1978). Both of these documents sought to establish a regime where a manufacturer or producer of a defective product could be held liable for any injury caused 'irrespective of negligence'.

Although first proposed in 1976, the EEC Directive on Product Liability was finally adopted in 1985 and has formed the foundation for impending legislation aimed at tightening these product liability laws. The Consumer Protection Act (1987) is currently a source of confusion and a cause of much alarm. As manufacturers and producers attempt to obtain clarification of the issues it is likely that it will have a more profound effect on industry than the Health and Safety at Work Act had recently. It will have a similarly profound effect on retailers.

If producers are to operate within this legislation it is clear that they must employ a strategy that involves extensive research and analysis alongside design and development. The implications for the professions of design and ergonomics are enormous. Product Liability legislation is likely to increase the occurrence of interaction between the designer and ergonomist, both within the traditional-
5.1 Style consultancies and within the growing band of hybrid consultancies. It will also affect the relationship between those active in industry itself. For those ergonomists looking to become involved in design and development the legislation is likely to provide many openings.

A number of those interviewed at the Institute for Consumer Ergonomics believe that the nature of their work is changing. There is a movement away from the longer-term research towards the shorter-term or application oriented projects. It appears that this shift is a direct result of economic pressures. Professor Kirk, who holds the positions of Head of the Department of Human Sciences and is director of the Institute for Consumer Ergonomics, supports this view.

'Such are the pressures to remain viable that the majority of the work must be within the short-term consultancy work which essentially is in the design related area'.

The reduction in finance from such bodies as the Science and Engineering Research Council (SERC) has curtailed much of the traditional work of the ergonomist. Universities and other research institutions have had to compete for dwindling resources or switch their efforts towards the more readily marketable areas of investigation. As has been shown there is considerable demand for those who make the transition into the product development field.

5.2 THE MATURITY OF THE SWEDISH PARADIGM.

The situation in Scandinavia is noticeably different to the one observed in Britain. The distinction between designer and ergonomist appears to be considerably more blurred in countries such as Sweden. A vastly different social and economic history has provided the Scandinavian countries with a completely different perspective in relation to the organisation of manufacturing and service industry. Not only do they exhibit alternative working procedures, but they have developed a vocabulary that allows a rich articulation of the
activity we know as 'designing'. Words that translate as 'form-giver' begin to identify and de-mystify the design process. It is a process with which both the design and ergonomics professions are deeply concerned. Although this maturity of relationship is evident in, for example, the craft works of Norway or Finland, it is most noticeable in the dominant economy of Sweden.

In Sweden the nature of the industrial climate encourages and facilitates the investigation and development of all manner of tools, products and systems. This not only directly improves any given situation as far as employees or workers are concerned but indirectly may increase the efficiency of the industry. Thus the demand provided by the industrial concerns, trade unions and central government has given rise to a much more varied interface with much greater activity between such areas as physiological studies and traditional industrial design. This appears to result in a willingness to fund such work and it is a willingness that seems to pervade all levels from shop floor to managing directors and ministers. Such an attitude allowed Winkel the expensive access to jet aircraft for his analysis of the hostess trolley. The Guardian published an article on 4.8.1987 that strongly supports this view. In this, John PALMER equates Sweden's post-war profitability with just such a willingness. He attributes their success to an '... investment in research and development when their competitors were all too often engaged on a short-sighted cost-saving programme'.

Nevertheless Sweden has not always found the relationship between design and ergonomics a smooth one. The incorporation of ergonomic research into the furniture industry around 1950 reveals many examples of insensitive application of incomplete information. It was only when the design profession was able to adopt a holistic approach, combining human, technical and material considerations that any success was found. Engdal reveals the immaturity of the relationship at this time. He speaks of designers viewing ergonomics as simply static anthropometrics rather than as a dynamic research process.
5.2 The contemporary relationship between design and ergonomics in Sweden comes closer than any other to exhibiting the stability that KUHN identifies as representative of a paradigmatic state. In consultancies such as Ergonomi Design Gruppen the distinction between the two activities is difficult to define and where it can be discerned they appear to exhibit a positive symbiosis. There is an expectation placed upon those in influential positions to hold qualifications in more than one area. Consequently many designers in Sweden have undertaken higher degrees in engineering, production or ergonomics and many ergonomists have followed a similar strategy. The familiarity that this develops is a cornerstone of the Swedish interface. That the Arbetarskyddsstyrelsen have no reservations about handing over their findings to design consultancies such as Ergonomi Design Gruppen is further evidence of a maturity in this complex sphere of activity.

5.3 THE ROLE FOR EDUCATION.

The undergraduate training of young designers and ergonomists is particularly difficult when compared to other disciplines. Both areas encompass a wide variety of skills and knowledge that stretch the teaching resources of universities and polytechnics. The case-studies reveal that those responsible for the content of such education believe there is little enough time for their own subjects examination. Whilst admitting the necessity for wider studies many lecturers on undergraduate degree courses in design or ergonomics are hard pressed to find the time or the resources to develop a sensitivity to the others activities. Thus the dissemination of new developments such as the changing relationship between these professions is stifled. Graduates only experience this relationship when they take up employment and although they appear to adapt readily, the opportunity for accelerated development of the phenomenon has been lost.

There is some evidence to suggest that this system can result in more than mere lost opportunities. One of the major observations from the case-studies is the widespread existence of assumptions and
5.3 Prejudices shown by one group in respect of the other. These views have arisen as a direct result of isolationist educational policies and do nothing to assist young graduates to adapt to the reality of working procedures as documented in the commercial case-studies. The prejudices are rarely malicious but they are deeply ingrained and profoundly affect the relationship between designers and ergonomists who can only make a judgement based on the model they have been presented with. Higher education has the responsibility of adjusting the model it presents to students in line with the contemporary developments taking place.

The phase of maturation of the two disciplines has only just begun to affect the long-standing opinions held by each group. The responses provided by the students indicate that many of the above issues will be evident for many years yet. Statements such as 'ergonomics limits design' or that 'design is styling' reveal major misunderstandings on the part of some students.

The June 1987 edition of Applied Ergonomics contains suitable evidence that the issue of stereotypical views is far from dead. In this, the author of the article is referring to a 'good-looking' teapot, one bearing the Design Council label, that is discovered to pour badly:

"Ever since then I have been biased, (probably quite unfairly), against any product bearing that particular tag. I suppose it is because of the stereotypes many ergonomists have of industrial designers - that they are more interested in form than function and that they have too much influence in the design council compared with other design and design related disciplines". (Vol 18, No 2).

Very often these prejudices stem from a situation of the professions own making. The ergonomic profession was so keen to establish around itself the respectability of the Scientific tradition that it was relatively late in developing its relationship with a markedly less scientific industry. It is little wonder that the design
profession undertook its own subjective version of ergonomic research in the absence of a clear understanding of an alternative. In his description of design projects that took place over two decades ago WILLIAMS reveals the reliance on common sense for ergonomic analysis. The relative simplicity of a Stanley woodworking plane perhaps lends itself to an iterative process of modelling and improvement but it established a similar self-reliance when it came to more complex design problems. The ergonomists perception of the design profession as one lacking in user consideration has developed as a result. WILLIAMS admission, as a director of one of Britain's most successful design consultancies, that his own attitude towards the contribution of ergonomists has changed is an important indication of the developing relationship between designers and ergonomists. It is a viewpoint that must be found space in the increasingly full timetables of the degree courses of both design and ergonomics.

THE CONTEMPORARY INTERFACE BETWEEN DESIGN AND ERGONOMICS.

It has been shown that design and ergonomics have been increasingly pushed together as a result of economic pressures. The development of products and systems is now so complex and expensive that mistakes made in any one of the various stages can cost huge sums to rectify. The product liability legislation referred to earlier is only one example of the many pitfalls of letting a faulty design out onto the market. Within the development process itself, errors can be costly or time may be lost to a competitor. Sections of the design profession and the ergonomics profession may be seen as increasingly concerned with both problem-finding and solution-finding. That is, the chosen case-studies reveal an involvement in both questioning and answering. It would appear that both professions have much to offer in determining the true requirements of a client. SPICER highlights the difficulty of clients or subjects not giving the answers that are needed and she feels that the ergonomics training assists in this activity. Certainly DCA employ ergonomists at the earliest briefing stages in order to allow them to contribute to, and clarify, client requirements. Nevertheless the O'Leary/Rogers case-study presents a concise justification for the inclusion of a design-trained person at
the formation of a project specification. They reveal in some detail the benefits of applying a creative strategy at both the briefing and development stages. O'Leary and Rogers are critical of an overtly linear or systematic process for the establishment of a product specification. They present the case for implementing graphical and three-dimensional modelling at the earliest stages to assist communication, draw attention to problems and facilitate examination. They refer to actual projects where the lack of creativity at the earliest stages has resulted in missed opportunities and wasted time.

It appears that education is still a long way from examining these joint systematic and intuitive strategies. Although many courses offer a combined experience, usually through some sort of project work, young designers and ergonomists seldom meet for more than the briefest of encounters. There is no grassroots reluctance to further cooperation, indeed many of the students interviewed stated their preference for links throughout each year of their education.

The training offered by the Institute for Consumer Ergonomics is a response to the unfulfilled demand for certain skills in the design industry. The Institute has been working with one of the large motor manufacturers in providing in-service training for established designers, primarily in the area of comfort evaluation. Although designers have achieved remarkable results with regard to mass-market comfort, particularly in the area of vehicle seat design, techniques of systematic analysis have traditionally been under-used. It appears that initiatives such as these may redress this. In-service training is an important development for both design and ergonomics and it may provide the catalyst for changes to undergraduate education.

Perhaps one of the key developmental areas lies in the field of psychology. The objectives of both design and ergonomics are fundamentally concerned with Man's relationship with the world that he builds for himself. Our technologically advanced society enables us to build this world in many different ways and according to many different values. Recent years have seen a movement towards a re-
5.4 evaluation by the design profession as to its role in this process.

Architecture, planning, and product design, amongst many others, have increasingly turned away from the mere satisfaction of physical demands.

In the light of recent material and technological developments the design profession has been presented with a new potential. Microchip technology, for example, offers a freedom from many of the traditional restraints inherent in electro-mechanical products. Those that have confronted the implications of this have sought answers to product semantics and immersed themselves in issues concerned with the psyche of the user. It is a potential that demands great insight and creativity and the design profession has done much in respect of an examination and discussion of the possible ways forward. Ergonomics has traditionally attempted an articulation of this issue but has lacked the necessary vocabulary for a debate of concerns such as desirability. Proportion and elegance have received little formal attention from ergonomists and consequently ergonomic design has been labelled as unadventurous or lacking in style. Product semantics and the richness of the human psyche could provide an innovative meeting point for design and ergonomics courses. The psychology of designing is likely to be of increasing importance as we go into the future and the opportunity to combine two powerful schools for its exploration should not be missed. Roy Axe, the director of concept engineering at Austin Rover, is one of many experienced designers who see the future lying in this direction. In a future where all products may function to a similar standard and retail at a similar price, it will be 'product personality' that determines consumer acceptance.

Traditionally both areas have suffered from a public image that has at best been vague and often completely misunderstood. While Prof. Kirk points to a similar difficulty experienced by such subjects as economics or astro-physics, it is clear that the activities within design and ergonomics are perhaps some of the least understood. Design education has made great strides in recent years and has brought an awareness of the needs and methods involved in our
technological society to a large percentage of the school-age population. Nevertheless Prof. Kirk would like to see greater public education and the introduction of ergonomics to the school curriculum.

The role of consumer groups and publications such as 'Which' have also played a part in raising awareness generally. They may be seen to have indirectly facilitated the further development of a relationship between the domains.

As the professional stature of the two domains increases so their ability to influence the commercial structure within which they operate, increases. Hampton believes that there are still too few designers at boardroom level and any positive developments in the future can only come about if people with sensitivities in these areas reach positions of power. Certainly changes are taking place. The movement of ergonomics into product development entails practices not experienced before. Southall refers to graphical communication as 'often the clearest way of putting your recommendations' and agrees with Stroud on the necessity for compromise in a field more used to definitive strategies.

The nature of future developments for both design and ergonomics appear to be comprehensive but their direction can only be vaguely indicated. Clearly major new initiatives are taking place and the definition of any interface will be heavily influenced by these. It remains to be seen whether Britain can provide the necessary environment for the further development of design/ergonomic activity. If the journal Applied Ergonomics is any indicator of development then it appears that the human sciences are keen to place their tradition in context. The following observation was published in the June edition:

'We are getting into a dangerous age, it seems, where the pre-eminence of science is taken to be a fact. It is a little alarming how people can become blinded by science in this way,
5.4 and ignore the role of intuition and emotion, and of human experience'. (Vol 18, No 2).

Not every ergonomist graduating this year will go on to work at the interface. There is a great deal of work still available in many scientific or laboratory situations where a deep understanding of one particular area is called for and this seems likely to continue. However a growing number will have to confront and assist in the development of this interface and therefore education has a responsibility to lay the foundations for this. Many ergonomists would benefit from exposure to design issues.

Perhaps design graduates have an even greater expectation placed upon them to understand and implement the skills of specialist groups within the design and development process. Education must facilitate this by developing innovative new course components that feed back developments from contemporary commercial situations. Practising designers and ergonomists are an invaluable resource to higher education. Funds must be made available to allow these professionals to contribute to the development of these subjects.

Further studies are continually coming to light and this project will remain on-going in order to record the development of the case-studies presented here. It is hoped that this document will inspire others to probe, develop and articulate the nature of a future relationship between the two domains of design and ergonomics.

2. ALEXANDER C. The State of the Art in Design Methods. DMG Newsletter 5 (3) (1971)


13. JONES J.C. How My Thoughts About Design Methods Have Changed During the Years. Design Methods and Theories 11 (1), (1977)


18. MacDONALD B. and WALKER R. Case Study and the Social Philosophy of Educational Research in Beyond the Numbers Game. E Hamilton et al. (1977)


APPENDICES.

A. Research proposal presented to the Institute For Consumer Ergonomics.

B. Questionnaire presented to second year undergraduate students from the Department of Human Sciences, Loughborough University of Technology.

C. Article by Shelley Adamson, Second year Ergonomist. Published in The Ergonomist, June 1987.
APPENDIX A

S W GARNER DEPARTMENT OF DESIGN AND TECHNOLOGY

RESEARCH OUTLINE AND PROPOSAL. MAY 1987

1. SYNOPSIS

Title : Towards a New Paradigm. Case-Studies of the Interface Between Design and Ergonomics. (Working title)

I have been lecturing in the Department of Design and Technology at Loughborough University for three years. My major research concern is the preparation of an M. Phil thesis that investigates the interface between the domains of design and ergonomics.

When I started this research late in 1985 it was motivated by a perplexity as to the nature of the relationship between these domains. While much has been written on the multi-disciplinary nature of both design and ergonomics, very little research has been undertaken to record the nature of the activity that occurs at the interface, even though evidence of its existence surrounds us in the products and systems of our man-made environment.

After a preliminary contrast of hypothetico-deductive and inductive research strategies, this research exploits the benefits of both by adopting a 'case-study' approach. This is shown to be sympathetic to the nature of the activity at this interface.

The research has two key objectives:

1. To observe and record a number of manifestations of this perceived design/ergonomic joint-functioning across a range of commercial and academic situations.
2. With reference to the work of Thomas Kuhn it is intended to identify the nature of the beliefs and values that Kuhn terms 'paradigms' and which may underpin activity at this interface.

A variety of case-studies will be presented as examples of this new and developing interface. These are the Institute for Consumer Ergonomics, Loughborough; David Carter Associates, Warwick; CCD, Weybridge; Ergonomi Design Gruppen, Stockholm; IDC of Loughborough, and two examples drawn from the Departments of Human Sciences and Design and Technology at Loughborough University of Technology. It is intended that these case-studies will illuminate the nature of the interface and allow conclusions to be drawn concerning how design and ergonomics education might address the consequences of the identification of a new or hybrid paradigm.

2. RESEARCH PROPOSAL.

To use the Institute for Consumer Ergonomics as one of the case studies outlined in the above synopsis.

3. NATURE OF THE RESEARCH

a. A number of visits to the institute each lasting one or two hours and all within an agreed two week period.

b. Primarily discussion and interview with individual members of the Institute but at least one larger group discussion towards the conclusion with a prepared agenda for discussion.

c. No requirement for access to confidential material. The Institute will have the right to examine and comment, alter or suppress the draft of parts of the draft on the grounds of accuracy, truth, discretion protection, relevance or balance. However, the research would benefit from access to non-confidential work undertaken by the Institute. Photographs of drawings, models, test rigs, mock-ups and other evidence of analysis and development would be most helpful in illustrating the final report.
d. Alternative interpretations to observed phenomena will be encouraged, both sides being presented where possible.

e. Subjects commitments take priority and the research aims to keep disruption and occupation of any one individual to a minimum.

4. RESEARCH OBJECTIVES.

a. To examine and record the nature of the day to day activities of the Institute.

b. To uncover the personal attitudes, perceptions and objectives of the individual subjects concerning the nature of their work.

c. To record the background education, training, employment and preparation of the individual subjects, including any relevant skills or abilities they wished they possessed.

d. To observe the strategies employed in the 'real life' situations of product analysis, evaluation and development. To uncover the attitudes towards design and the role of design-based strategies within such a process.

e. To gather opinions on the relationship of design and ergonomics, both as hypothetical models and within their real-life application.

f. To seek comments on the hypothesis that there has been recent development of distinct or hybrid design/ergonomic activity.

g. To seek comments on the appropriateness of existing education in design and ergonomics to confront these present and future issues.

h. To ascertain whether there is any support for the hypothesis that activity at this interface operates under a different set of paradigms to the parent domains of design and ergonomics.
APPENDIX B

DEPARTMENT OF DESIGN AND TECHNOLOGY

LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY

This questionnaire, concerning the areas of Design and Ergonomics, is intended as part of a much larger study undertaken by S W Garner as a higher degree research project.

I would be grateful if you could spare the time to answer the questions below to enable me to compose next years course as well as provide information for my research. If possible I would like it returned before the end of June.

All information will be treated as strictly confidential but if you would rather remain anonymous then just leave the name blank.

NAME ........................................................... .

SECTION I

All the questions in this section refer to the second module you undertook within the Dept. of Design and Technology between January and March 1987 and supervised by Denys Hampton and Steve Garner. It does not refer to the first module with Sid Pace that you undertook before Christmas.

Each question is followed by a list of components. In each of the boxes I would like you to write one number between 0 and 10 depending on how highly you rate that particular component (10 = high importance or agreement). NOTE there is no rank order and you may use any number more than once.

1. What do you consider to be the most important skills that you developed on the course?

   Using drawing to develop ideas.........................
   Using drawing to communicate ideas...................
   Sketch modelling in card...............................
   Accurate modelling in wood, metal and plastics....
   Using various machines and equipment..............
   Using new materials, techniques and handtools....
   Devising and developing ideas......................
   Working in a workshop environment................
   Other (please specify)..............................

2. Would you rather have undertaken -
More modelling activity..........................
Greater exploration of 'real' problems..........
More exercises in the use of machines and processes...
More teamwork situations with other Ergonomists......
More teamwork situations with a variety of students...
More individual work............................
More involvement in electronic or mechanical systems..
Other (please specify).............................

3. In your opinion in what way could ergonomics students gain most from the facilities offered by the Dept. of Design and Technology.

Contact and cooperation in all years..............
Bringing your own projects to the Design course.....
Less requirements in terms of 'presentation'........
More technological Design work....................
More time to develop skills with various materials, techniques and equipment..........................
Other (please specify).............................

SECTION 2

All the questions in this section should be answered in a similar manner. They are arranged in pairs and rather than simply putting a tick in each box I would like you to put a number between 0 and 10. For example:

1a. Is Ergonomics a very practical subject ?..........

1b. Or is Ergonomics a very academic subject ?.......

As there are pros and cons for both answers you may feel they both deserve a higher or lower number. 10 indicates a total agreement or 'yes' answer. You may use the same number twice

2a. Has the Design and Technology course been, or will it be, of any benefit to you in studying Ergonomics ?.....

2b. Or is it of no relevance to your work ?............
3a. Would it be better to follow one major project throughout the six weeks? 

3b. Or better to undertake several smaller exercises?

4a. Is the ability to make good test rigs, models or mock-ups very important to an Ergonomist?

4b. Or should the Ergonomist leave this to a technician or other specialist?

5a. Is the ability to draw very important to an Ergonomist, both in education and in employment?

5b. Or can you work just as well with no ability to use drawing?

6a. If an Ergonomist analyses, develops and improves a product is this 'Designing'?

6b. Or is 'Design' only carried out by 'Designers'?

7a. Do you think that any of your work could be classed as 'Designing'?

7b. Or is there no 'Designing' activity in any of your work?

8a. Is the development of products a systematic, scientific and rational activity?

8b. Or is it an intuitive, creative and artistic activity?

9a. Is creativity very important to an Ergonomist?

9b. Or does creativity play no part in an Ergonomists work?

10a. Should a good Ergonomist be a specialist in one field?

10b. Or should he/she have a much broader base of general skills?

11a. Do you think you should have access to a fully equipped workshop within the Human Sciences Dept. for modelling, drawing, prototyping and designing?

11b. Or are there more advantages in coming into another department for these facilities?

12a. Is it a Designers job to learn more about Ergonomics?

12b. Or should Ergonomists learn more about Designing?

13a. In your opinion do Designers and Ergonomists integrate, function and communicate well in a teamwork situation?

13b. Or do they find it difficult or frustrating?
APPENDIX C

Shelley Adamson, Second Year Ergonomist, Loughborough University.

One of the most important, and certainly one of the most interesting aspects of the Ergonomics course at Loughborough is design. In the first year attention is centred on the ergonomic design of equipment, a course we share with the design students. This enables us to get a basic 'feel' for design, whilst stressing to the design students the importance of good ergonomics in the overall design process.

In our second year a more detailed look at the design process is undertaken in which some of the design methods and communication skills used by designers are studied. To conclude the course we are given a major design project in which we are able to use the various design facilities available in the design workshops in order to construct a lifelike model of our design idea. The experience we gained from using lathes, saws and sanding machines was invaluable, especially for those of us who had never encountered such machines. What it also illustrated to us was how easy it was to overlook fundamental ergonomic issues once in the swing of a design. I found I was constantly having to stop and remind myself of the importance of the shape and the positioning of the controls, and not just the aesthetic appeal of the model or its ease of construction.

But perhaps of most value was the way in which it highlighted to us the very complexity of the design task. A vast amount of time and effort has to go into making sure that the design will actually 'work', and not just look good. After all, what use is a superb ergonomic control panel if the device won't even switch on? The fact that we are actually aware of the problems associated with design is one step in the right direction. What we need now is not only to be more sympathetic towards unergonomic designs, but also to be more constructive in our criticism of them. If we can persuade designers that ergonomics must be considered throughout the entire design process, then again, we will be moving forward.