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MECHANICAL ACUMEN: AN EMPIRICAL STUDY OF THE TECHNICAL SAGACITY OF SOME DERBYSHIRE SCHOOL CHILDREN

by

DAVID R. HALES

A Masters dissertation submitted in partial fulfilment of the requirements for the award of MASTER OF PHILOSOPHY

Department of Design and Technology
Loughborough University of Technology

July 1989

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ABSTRACT OF THE RESEARCH

MECHANICAL ACUMEN: AN EMPIRICAL STUDY OF THE TECHNICAL SAGACITY OF SOME DERBYSHIRE SCHOOL CHILDREN

This report initially sets out to establish a sound rationale for some small-scale action research and begins by discussing some of the educational arguments for developing a technological capability in school children. However, the work is not argued to be solely a crusade for better designers or engineers as its involvement in making technical judgments through cross-curricular, design-related activity is regarded to have a general relevance in the education of all children.

Early investigations into the product choices made by children revealed a high measure of technical awareness in the sample population although there was no evidence of any voluntary objective appraisal on which their judgments were based. When requests to comment upon the functional criteria of products were made, the sample population failed to produce even the simplest form of quantitative response. Children experienced some difficulty in even recognising the basic criteria upon which separate products were dependent for their successful operation.

The value of appraisals based purely upon such a subjective judgment model is challenged in the report and the suggested deficiency is used to herald the development of alternative resources designed to improve the present situation. The remainder of the report is based upon the use of these resources in the field through programmes of product-driven, design-related activity. The research is finally supported by results which indicate that, given the appropriate methodology and resources, such quantitative appraisals by children are possible at a very early stage.

Studies which involve the examination of the inherent mechanical principles of manufactured products will have clear relevance in many courses of a technological nature. This investigation may be of particular interest, therefore, to those school teachers and college lecturers whose students have recourse to technological project work. In addition to this group, the findings may also find some support from those interested in the application of basic mechanical principles within the future core curricula in Craft, Design and Technology, Science and Mathematics.

David R. Hales
July 1989
AUTHOR DECLARATIONS

1. During the period of registered study in which this dissertation was prepared, the author has not been registered for any other academic award or qualification.

2. The material included in this dissertation has not been submitted wholly or in part for any academic award or qualification other than for which it is now submitted.

3. The author is responsible for the work submitted in this dissertation. The original work is his own, except as specified in the acknowledgements.

David R. Hales
July 1989
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Mrs. J. Greer, Longford Primary School, Derbyshire

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David R Hales
July 1989
"When you can measure what you are speaking about, and express it in numbers, you know something about it; when you cannot measure it when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind: it may be the beginning of knowledge, but you have scarcely, in your own thoughts, advanced to the state of science."

LORD KELVIN, 1883
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CHAPTER 1
RATIONALE FOR ACTION

1.1 Background
The motives for initially embarking on this study were borne from the writer's observations of project activities in the Further Education sector and the variance in emphasis and interpretation exists. More specifically, particular interest was promoted from the implied lack of merit afforded, by both teachers and students alike, to some of the finer detailing decisions within overall design proposals and solutions to project work. Consequently, it is argued that the emphasis in the past has apparently been placed upon the creative use of technology in satisfying a given need, at the resulting expense of addressing the more functional and operational characteristics of performance in design efficacy.

Clearly, design proposals are not likely to be successfully converted into marketable products without a working knowledge and understanding of some of the basic laws of mechanical science. Substantially, it is the apparent lack of capability in students to identify and effectively apply some of the more basic mechanical principles of science which has been the prime mover in motivating the writer to undertake this study. Furthermore, it can be argued that deficiency is not peculiar to the writer's own personal experiences as similar needs have long since received national recognition.

1.2 Introduction
For some years now, Britain has been faced with a shrinking demand
for its own engineering products and a reduced access to traditional markets. There has been, in consequence, an increased awareness of the immense significance of 'design' and that we, as a nation, need to pay more attention to this area generally if we are to increase our competitiveness in world markets. It may conceivably be suggested that technically more saleable and reliable products constitute an essential policy for economic survival.

This is not a recent problem, as accounts [1] of similar needs have been traced back to the mid-1920's when the difficulty of selling British goods abroad drew attention to low standards of industrial design. The weakness in Britain's competitiveness overseas has also been suggested to date back to the pre-1850's [2], to a negative contribution made by Britain's education service and to the lack of prestige which was afforded by the British to her engineers and managers. More recently, the Finniston enquiry made the observation [3], that 'Engineering tends to be regarded as a subordinate branch of science'. British engineers have, apparently, always grappled with the dual problems of achieving the practical competence in making things work whilst, simultaneously, attaining a recognised position in society.

However, the proposal that the education service be used to remedy the problem has not been without its critics.

1.3 A Change in Emphasis

Pickup [4] traces the source of the problem back to somewhere deep within Britain's cultural heritage when he suggests that the difficulty arises from society being based on a two culture system; that of the 'arts' and the 'sciences'. He continues to describe the existence of a third culture within continental society called 'technik', and claims
that its British counterpart, although recognised to exist, has never enjoyed the same high status which it does abroad. Britain, he suggests, has always issued a higher regard for 'pure', rather than 'applied' science and bestowed a similar higher status upon 'academic' rather than on 'vocational' work.

There are similar comparisons made by Barnett [5] who suggests a fundamental difference in emphasis within the traditional training of the British craftsman and his Continental counterpart. He compares, on the one hand, an early English tradition where knowledge and skills were arbitrarily passed on and so tended to perpetuate the 'mystery' surrounding the craft with a systematic and formal training programme which incorporated basic scientific and engineering principles. Although Horner [6] questions the existence of a 'technik' culture, he agrees that its underlying philosophy is something which should be evident within our education system.

This particular view is in direct opposition to the more popular interpretation which has been given to the phrase "The Three R's" by William Curtis in 1807. Although an education based upon 'Reading, Writing and Arithmetic' appears somewhat simplistic to Archer's [7] contrary interpretation which is as follows:

(1) Reading and Writing
(2) Reckoning and Figuring
(3) Wroughting and Wrighting

He suggests the derivatives of the modern terms of 'numeracy' and 'literacy' to be features which have clear associations with the first two categories and identifies his concern that the once valued emphasis on 'wroughting and wrighting' had perhaps, until recently, almost disappeared.
'modern English has no word, equivalent to numeracy and literacy, meaning the ability to understand, appreciate and value those ideas which are expressed through the medium of making and doing' [8]

The domination of the English education system by the humanities has, according to Archer, been directly instrumental in setting aside the features of 'doing and making'.

An alleged abhorance, in English society, of any association with the 'practical' is also recognised by McCormick [9] and he further proposes that we 'copy the Continental (more properly the German) pattern' of education. Comparisons made by Pickup [10], between the British and European education systems, similarly indicate a lack of vocational relevance in the general education of young people in this country. Horner [11] similarly concludes this to be a matter of mis-interpretation by the policy-making decisions of the institutions which provide the vocational qualifications rather than a problem of changing national mentality.

Traditionally, perhaps, there has been excessive emphasis in the school curriculum on the accumulation of increasing amounts of inert knowledge although there is much evidence to suggest that this early position may now have seen some modification during the last decade. In 1979 the National Association of Head Teacher's declared that it had 'always accepted that what is taught in the schools must: be relevant to the outside world; and relate to the economic needs of the country' [12]. But how far can we differentiate between general education and vocational preparation? This very question was posed by Nicholson [13], in 1981, before he declared that this 'well rehearsed dichotomy was mythical' and went on to point out that the employer still looks
for 'Maths, English and Technical abilities'. He was making particular reference, at this stage, to the extensive use of project work in schools and the acquisition of cognitive skills in a practical and applied context.

It is not the purpose of this dissertation to identify each significant element of this aspect. Clearly, the growing school interest in practical work and applied science is well documented and the literature gives good account of the earlier progress in technical education during the 1950's. Perhaps it will be sufficient to record, therefore, the extent of positive support given in 1967, by the Schools Council to the development of a technical emphasis in the secondary school curriculum and the view that a technical education should not 'be reserved for the artisan, the manager or the designer, but be an essential part of secondary education for all' [14].

1.4 Technical Capability

The value of a technical emphasis was earlier recorded by Crowther in 1957 when he referred to 'The Alternative Road' and advocated the need to 'rehabilitate the word "practical" in educational circles', as it was often used in a pejorative sense. This highlighted the need 'to define it more clearly' [15]. The recommendation was to derive a system of education which did not suffer from the need for academic ability in the conventional sense. Crowther called for 'a practical education making progressively exacting demands' [16], and great stress was placed on the fact that not all pupils were motivated by the 'academic tradition which inspires and is embodied in our grammar schools and universities' [17]. In identifying two kinds of mind [18]
Crowther described the first to be an 'academic' type, 'which is readily attuned to abstract thinking and can comprehend the meaning of a generalisation' [19] and an alternative type 'which cannot grasp the general except by way of the particular, which cannot understand what is meant by the rule until they have observed the examples' [20]. Although the latter was considered to be 'not necessarily inferior' [21] this, it is suggested, was the inevitable label which was attached to many interpretations.

It is interesting to review, at this stage, the apparent conflict which still exists between the proposed view of 'doing' things including its clear association with 'capability' in general education and the questionable status given to the in the vocational 'practical' preparation.

The Government having examined Crowther's recommendations chose not to follow up with their implementation although [22], according to McCullock, 'perhaps the most obvious of the Crowther report's long term effect in this area was its contribution to the creation of the Schools Council Project in Technology which was launched in 1967' [23]. He continues to suggest that Crowther's 'practical route' was, in some cases, avoided by the school's sixth forms because of its close association with 'the technical college route' and the connection with 'second class status technology' and also 'the popular misconception that an engineer is someone in a boiler suit with greasy hands' [24].

It is suggested here that nothing could be further from Crowther's original translation and McCullock draws particular attention to this by discussing the contrasts between the different notions of 'practical education'. He compares the Crowther concept with the original rationale of the Technical and Vocational Education Initiative (TVEI) which
identifies the domination of the 11-16 curriculum with the abstract and theoretical and a corresponding under-valuation of practical experience and useful knowledge. He concludes that within the Crowther report there are important clues towards the formulation of 'a liberal antidote to current vocational prescriptions - a conception of "practical education" which places greater stress upon educational values than upon industrial and vocational aims' [25]. McCullock's account may serve as a reminder of the division which existed in the early 1960's and the resurgence of similar dispute some ten years later in developing School Technology. The failure to formulate an effective vision of the 'alternative road' led McCullock (1984) to conclude that 'if the "practical" still requires "rehabilitation", as it did in 1959, it is also no less in need of elucidation than it was all those years ago' [26].

In 1981, Harrison [27], in attempting to redress a suggested imbalance in the school curriculum, described three dimensions of the 'British Technic'. These, he identified to be Resources, Awareness and Capability although the principal one of these, he considered to be Technical Capability. He justified his argument by suggesting that the development of innovation and design capability must be simultaneous with the development of knowledge and skill. He additionally endorsed the view that such development should be, not only appropriate but, essential for all school children [28].

Since the establishment of its Education for Capability Committee in 1979, the Royal Society of Arts has backed a deliberate campaign to encourage the personal quality of 'capability' in school children. The Education for Capability Manifesto gives clear opinion of the need to attend to an inequality between the worlds of 'education' and 'training'.

(7)
"The idea of the 'educated person' is that of a scholarly individual who has been neither educated nor trained to exercise useful skills; who is able to understand but not to act .........................They (young people) acquire knowledge of particular subjects, but are not equipped to use knowledge in ways which are relevant to the world outside the education system." [29]

The present Manifesto also suggests that today's need is to promote similar qualities to those which Harrison identifies in his 'technic' culture, through the advancement of a:

'culture which is concerned with doing, making and organising and the creative arts. This culture emphasises the day to day management of affairs, the formulation and solution of problems and the design, manufacture and marketing of goods and services.' [30].

Support in Britain for the development of such a culture is growing as there are now over two hundred and fifty signatories to the Manifesto from leaders of Industry, Commerce and Education. Government legislation through the Education Reform Bill and the identification of a National Curriculum Statement also reflect such objectives although, it is interesting to note that 'Capability' is not regarded as a subject to be taught but rather as a process of development comprising an integration of multi-curricular components. In other words, the activity is suggested in the matter to be design-related rather than design-initiated.

1.5 Design-Related Activity

It was the Feilden Report in 1963 [31] which first highlighted the need to encourage and co-ordinate experiments in methods of teaching design at undergraduate and postgraduate levels in universities, colleges and industry. Soon afterwards, efforts were made through the education service to introduce design and technology into the range of subjects offered by the examining boards.
The Design Council [32] published the first of its reports on education in 1976, giving recommendations that 15-20 per cent of engineering degree courses be devoted to engineering design. In the following year, the Carter committee [33] advocated structured design courses at secondary level, both to give students an insight into design as a career and, for the general education of children. The general recognition of the need to introduce design into the broad band of education was more recently endorsed by the Design Council [34] in 1980. This was better known as the Keith-Lucas Report and it gave clear signals that the role of 'design' should no longer be regarded as appropriate only to those pupils whose future careers were dependent upon it. Indeed, the report included a special note of the contribution which 'design' could make to the general education of all pupils. The proposal was to encourage the involvement of all children in some form of design awareness, whatever their personal career ambitions.

Possibly one of the better known of the early advances made in promoting design activities into the secondary sector, arose from the introduction of 'modular technology', through the School's Council in association with the National Centre for School Technology. Whilst generally applauding the introduction of 'technology' into the school curriculum with such effect, the writer questions the lack of apparent emphasis afforded to 'design'. In describing its working definition of technology, the School's Council [35] clearly illustrated the significance of a design component within the technological process although, some important questions of interpretation are highlighted by one of the statements made.
the technologist working as a problem solver operates within particular constraints and with particular resources and, in this respect, closely resembles the designer. However, the designer tends to concentrate on the aesthetic aspects of a problem, the technologist must have regard for its function, technical and scientific aspects as well." [36]

To suggest that the world of design should centre around the 'aesthetic aspects of a problem' and to state that 'design' has no regard for 'its function, technical and scientific aspects', may suggest to the lay-technologist that 'design' has very little to do with the functional parameters of manufactured products. Furthermore, there is evidence to suggest that considerable confusion existed in schools at this time, as it was necessary to remind them of the need to engage pupils in a '... full involvement of the complete process of technological work, wherever possible.' [37] There is no dispute, in this study, of 'who does what' as these points are given only to illustrate the writer's suggestion that the design function was, and perhaps still is, in danger of some gross mis-interpretation and mis-representation.

Technologically based project work has gradually become accepted into the secondary schools over the past twenty years although during this period there are suggestions that the system has lacked a necessary degree of standardisation. H M I findings in 1985 [38] would certainly endorse the need for broader agreement on the constituent elements of technology at school level although the introduction of national standards and criteria will have done much in establishing just that. However, the essential differences in CDT courses are presently described in the areas of Design and Realisation, Technology, and Design and Communication. The 'technology' criteria are principally concerned with design and problem-solving processes leading to the making and evaluation of artefacts and systems. It draws upon scientific
principles. Technology also involves management of the environment and familiarity with the concepts of materials, energy and control:

"The aims of any course in Craft, Design and Technology should reflect the complex abilities required to exercise control over the man-made environment but the common core of activity can be identified as designing and communicating, making, testing and evaluating. Although these skills and the related value judgements are common to all courses in Craft, Design and Technology, the "knowledge" content of differing courses will vary. To make provision for the range of activities it is necessary to offer examinations to cover particular areas of study which will have in common the central aims of Craft, Design and Technology as a subject." [39]

There are additional concerns however, at the growing emphasis on high technology subjects [40] which, it is argued, could push school technology back into content-loaded courses and away from a strong practical emphasis on design [41]. All this evidence endorses the concern of the writer that the appreciation and application of some of the more basic mechanical principles will become scarce if 'design' takes on, what is fast becoming, an increasingly subservient role to technology, especially if the latter continues to be given such prominence.

The fourth of the Design Council's reports into education came in 1987 [42] and does much to underline the missed opportunities of the past by describing the benefits to be gained from the use of design-related activities in primary education. Great emphasis is placed on the contribution to be made in different curricular areas from the use of design-related skills and are regarded "every bit as 'basic' as literacy or numeracy" [43]. The writer suggests that this quotation reflects, not only the present belief in the relevance of design-related capability in primary children, but also supports the view that the pursuit of measured levels of technological capability is regarded today
to be a justifiable and relevant feature of the general education of all children. Clearly, the essence of TVEI is to ensure that youngsters are provided with learning opportunities which equip them for the demands of working life and the National Curriculum provides the framework for integrating and relating the worlds of education and work. According to the recommendations made by the National Curriculum Council in 1988 [44], the current advice is to cultivate the simultaneous development of knowledge and application in mathematics and science. A similar cross-curricula dimension has consistently been sought through TVEI programmes through the promotion of broad and balanced curricula studies for 14 to 16 year olds in which science and technology are included. Ministers have, apparently, made it clear [45] that the National Curriculum is not intended to restrict the processes and organisation of TVEI and there is legitimate scope for developing experiential and practical approaches to learning as well as for the retention of the more modular type of course structure. Although the source of this study was clearly motivated from observations of a deficiency during project activities in Further Education, the writer suggests that there may be some broader implications for the development of basic mechanical concepts and principles within earlier sectors of education.

It is important to note, however, that there are two strands to the writer's belief. Firstly, from the need for children to be comfortable in accommodating the many technical decisions which have become a necessary aspect of life in a consumer - orientated society and also, in the vehicular property or process of design and more meaningful and purposeful learning which appears to generate technologically based activity. The envisaged study will, therefore, pursue an investigation
which is considered neither design nor technologically subject specific. It will include some action research and require a sample population, there must be no argument as to its relevance. The work will, in consequence, make use of existing courses in design and technology and the need to encourage pupils in making critical appraisals of existing designs. In the past, the Schools Council (1969) [46] described the need to develop powers of 'discrimination' in light of real needs which tend to be present in any 'consumer-orientated' society. According to their report, there were two needs in this context - 'to make judgements, and to achieve satisfaction through the use of artefacts in whose construction the pupil has played no part' [47]. To the writer's knowledge, there has been little research into resourcing or production of support material associated with this area of work. In light of the GCSE national criteria for Craft, Design and Technology and the perceived continued interest in this precise aspect of work, the study can now justifiably proceed with purpose.

1.6 Research Proposals
During the last thirty years or so, there has been a fundamental change in our education system. The traditional philosophy which blindly followed the acquisition of specialised areas of knowledge for its own sake has clearly been challenged. It has also been suggested that the present system of education may have failed to promote other important considerations, earlier described in this introduction. The basic notion which has been proposed is associated with the need to embody the spirit of 'Capability' and 'Technik' through technological and design-related activities. According to the previous discussion it appears, to the writer, that the initial motives for embarking on this study are embodied in some of the aims now being propagated in the
general education sector. There have been additional signals [48] to endorse the view that secondary school programmes which are more participative and experiential would be a welcomed development. Furthermore, if assessments in CDT allow for appropriate and inappropriate answers, as well as the more traditional right and wrong answers that are more familiar to subjects such as physics and mathematics, then the problems undertaken in CDT work require the additional elements of compromise and sound judgement in satisfactorily realising suitable solutions to real problems.

The evaluation of manufactured products in meeting their functional requirements is a challenging task and should not be underestimated. However, the critical appraisal of existing designs can be taken from a variety of standpoints (eg. aesthetic, economic, moral and technical).

The writer's intention will, nevertheless, emphasis the more technical aspects of functional performance and in order to reduce any mis-interpretation the desired technical capability will be referred to as 'Mechanical Acumen'. The following definition has been devised by the writer to both consolidate the introductory dialogue and to further underline the nature of this investigation.

1.6.1 Definition of Mechanical Acumen

'The capability to evaluate the basic mechanical principles which directly influence the functional performance of products'

The Department of Education and Science (1987) [49], in its review of assessment frameworks for design and technological activities, makes direct reference to earlier reports of the complex relationship between 'content' and the 'processes' and 'demands' of the activity:
'When there is a body of received knowledge to be acquired before speculation and imagination can be given free rein, then curiosity and enthusiasm will surely be quenched..... It is most important not to equate intellectual vigour with excessive reliance upon the committing to memory of large quantities of factual knowledge.'

(Dainton Report 1968 - paras 148/149)

This point is regarded to be a vitally important feature requiring further emphasis and the writer is immediately reminded of his past disappointment in the limited evidence of design efficacy afforded by his students to their work. In such situations, the difficulty which arises is in the teacher’s ability to devise suitable strategies which can be used to guide and focus attention into areas of content which might be used to enrich the activity. Furthermore, the writer is clearly attracted to the notion of establishing the necessary pre-requisites for successful project activity although, the DES report [49] continues to suggest that the temptation, having isolated some general categories of content, is then to establish a body of knowledge which may be taught to and subsequently applied:

'To predetermine the knowledge and skills that are needed to tackle a task is to deny the nature of the activity.... This is not only a central feature of design and technology, it is also crucial to education itself.' (para 4.8)

Having briefly acknowledged the dangers of reducing the activity to a 'content' base it might be sufficient to say, for the present, that to consolidate the basic understanding of a simple mechanical principle at the evaluation stage is also of debatable value.

The literature gives much advice [50] on the management of GCSE coursework where teachers are reminded of the cardinal principal of 'fitness for purpose'. The individual competences which are necessary to evaluate the technical performance of a product and to judge if
individual designs satisfy their original specifications are considered [51] to be, although difficult, very worthy features of pursuit in Design and Technology activities. Furthermore the following quotation, which is taken from the manifesto published in 'Our Future Needs Technology' in April 1985, is used to summarise the context in which the Education Service is presently (1988) seeking to develop 'Technology for all across the Curriculum' [52]

'Everyone is caught up in technological change: all must be enabled to understand what is happening, to re-adjust, and to participate. To the extent that we are all free to choose the values by which we wish to be guided, we all have a stake in shaping the future of technological change. It is not enough to recognise technology as the mainspring of economic growth and social change, and for the improvement of strategic systems and weapons for our national defence - though this is essential. We all need to feel in our bones that technological innovation and enterprise enhances human relationships, capabilities and purposes'.

Consequently, the purpose of this study will not be to develop either a holistic or specialist competence in 'design', but rather will address the cultivation of a basic component of technical literacy for all children through a series of design-related activities.

1.6.2 Statement of Intent

Although it has been suggested that the present system may be failing to include some of the important considerations just described, the writer has found no factual evidence which indicates that an assessment of the said attribute of Mechanical Acumen in children has ever been carried out. It was, therefore, necessary to attempt its appraisal in order to establish a basis for further development.
The proposal of this investigation, therefore is to:

(a) Examine the prevalence of Mechanical Acumen in a sample of children in one Derbyshire school.

(b) Nominate proposals and initiate the resources to enhance present levels of Mechanical Acumen.

Having described the economic arguments and educational justification for this study the remainder will report upon the planning and results of some small scale action research which was devised in response to the two previous statements.

CHAPTER (1) REFERENCES


[8] Ibid., p.4.


[16] Ibid., p.37.

[17] Ibid., p.391.

[18] Ibid., p.394.

[19] Ibid., p.394.

[20] Ibid., p.394.

[21] Ibid., p.468.


[23] Ibid., pp. 68-70.

[24] Ibid., p.69.

[25] Ibid., p.68.

[26] Ibid., p.69.

[28] Ibid., p.5.


[30] Ibid.


[36] Ibid., p.2.


[40] TIMES EDUCATIONAL SUPPLEMENT. (1.1.85). No. 3618. p.2.

[41] Ibid.


[43] Ibid., para. 4.8


[48] TIMES EDUCATIONAL SUPPLEMENT (27.06.86). No.3652. p.11


CHAPTER 2
EXPLORATORY PILOT STUDY

Earlier discussion gave clear indication of the proposed direction of the investigation and the intention to develop Mechanical Acumen. A closer examination of some basic mechanical principles will now be considered in order to arrange limits for the proposed development of this capability within the confines of this study.

2.1 Basic Mechanical Principles

Probably the best known of the more recent developments in school technology is the series of Modular Courses in Technology developed by the School's Council and the National Centre for School Technology. A comprehensive statement of 'assumed knowledge' [53] suggests that no prior technological knowledge is required by pupils embarking on the 'Mechanisms' module although some basic aspects of Mathematics, Science and Technical Studies is said to be preferred. It is additionally suggested that this basic entry requirement should have normally been covered by the third year. Consequently, no previous knowledge of mechanisms is required, other than a knowledge of the basic scientific quantities and some items of basic numeric skill for possible future use and application within the anticipated 'Mechanisms' module [54].

It is additionally indicated that some pupils may not exhibit proficiency in all items of 'assumed knowledge' although, it is suggested, that the module should enable the pupil to 'make simple calculations involved in mechanical design [55].

Within the early weeks of the course it is further proposed that

(21)
pupils pursue an examination of early machines [56]. Namely, those given in the lever, windlass, pulley, wedge and screw.

A close examination of these five ancient machines which are illustrated in the pupil's course notes [57], reveals two basic mechanical principles which are common factors in all five. Namely, these are:

(i) Principle of Moments
(ii) Inclined Plane

This particular observation is not made in the text although the course notes go on to direct the learner towards activities such as labelling diagrams with the load, fulcrum and effort, showing how the pulley is a disguised form of lever, giving an application of the inclined plane, and describing the use of the inclined plane as a screw thread [58]. The two principles are illustrated in very clear terms but unfortunately, no mention is made of the recurring nature of these two basic principles in each mechanism investigated. The identification of the same principles within everyday products is also, apparently, not considered relevant to the study of 'Mechanisms'.

It is not the intention here to question the wisdom of the promoters of the 'Mechanisms' module in not making this particular point, but merely to restate the possible divergence of opinion which may exist between their aims and the objectives followed by this investigation. Furthermore, as the principal aspect of this study is to improve Mechanical Acumen, the two previously identified principles are considered most appropriate limits of enquiry for the purpose of the proposed survey.

In order to clarify and confirm the present position in school, it was considered desirable to conduct a pilot study in order to establish an initial foundation for further action. It was decided to interview a
small sample of children who were following courses in CDT. The aims of the interview were to:

(a) consider the prominence of technical awareness.

(b) investigate other influences which appear to affect the judgments which children make when choosing products.

(c) assess present levels of Mechanical Acumen.

2.2 Interview Parameters

The choice of host school for the pilot study resulted from the consideration of four main requirements. These were that the school selected should be:

(i) regarded to be an exemplar of good CDT practice

(ii) involved with TVEI developments

(iii) outside the immediate catchment area of the writer's normal place of work, in order to eliminate possible suspicions of ulterior motives for research.

(iv) sympathetic to the philosophies of 'Education for Capability' or Harrison's 'British Technic'.

2.2.1 The School

Ilkeston School was opened in 1914 by King George II and stands on a pleasant site surrounded by its extensive playing fields. It was founded as a result of the efforts of Ilkeston townsfolk to bring secondary education to the borough. Initially a county secondary school, it became a grammar school serving a wide area following the Education Act of 1944. On reorganisation in 1977 the school became one of four maintained secondary comprehensive schools in the town but of these Ilkeston School alone had a sixth form provision.

Nineteen subjects were offered at Advanced level which include subjects in Design and Technology, although this was limited to Engineering Drawing for the (1985/6) session. However, it was envisaged to run

(23)
'A' level Design and Technology in the following year.

Other favourable points which promoted the initial approach to be made arose from the confirmation by the LEA Advisor that the school contained a CDT section of some distinction. In addition to this, the school was one of five participating institutions in the Derbyshire County Council's TVEI project.

Having met the first three of the identified criteria Ilkeston School was selected. Further consideration of the fourth and final criterion was left until discussion with the staff involved did suggest to the writer that the school was a suitable choice.

2.2.2 The Sample

The feasibility of interviewing learners from the following groups was discussed with the head of CDT.

| 6th Form | (1) Design and Technology - London 'A' |
| (2) Technology - Cambridge 'A' |
| (3) Engineering Drawing - AEB 'A' |
| 5th Form | (4) Design - London 'O' |
| (5) Modular Technology - Cambridge 'O' |
| (6) Graphic Communication - AEB 'O' |
| (7) TVEI Option/MEG 'O' |
| 4th Form | (8) Design and Realisation |
| (9) Modular Technology |
| (10) Graphic Communication |
| (11) TVEI/MEG 'O' |

The viability of organising a sample of equal numbers of boys/girls (eg. sample of two girls and two boys from each of the above groups) was considered but found to be impractical because of the insufficient numbers of girls taking CDT subjects.

In order to reduce the possible disruption and 'play-down' the attention given to the interviews, the preference was to conduct them very
close to the usual CDT area but out of earshot and therefore, separate from respective peergroups. An office adjacent to the craft room was made available for this purpose. The preference was to conduct the interviews during the usual CDT periods, following individual discussions with these members of staff who were agreeable for their students to be interviewed within their normal CDT period. This presented no problem.

Ideally, the sample would have been representative of the total ability range in school. Selections were therefore made, by members of the teaching staff, of those pupils who were considered to be either 'Limited' (L) or 'Exceptional' (E) achievers.

It was unfortunate that the number of girls available in CDT lessons was not sufficient to make any comparisons from the results. Nevertheless, they were included in the requested sample, as follows:

**TABLE 1**

<table>
<thead>
<tr>
<th>REQUESTED PILOT SAMPLE STRATIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group Description</strong></td>
</tr>
<tr>
<td>----------------------------------------</td>
</tr>
<tr>
<td><strong>Form</strong></td>
</tr>
<tr>
<td>6th (1)</td>
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<tr>
<td></td>
</tr>
<tr>
<td>6th (2)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>6th (3)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>6th (4)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>6th (5)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>4th (6)</td>
</tr>
<tr>
<td>4th (7)</td>
</tr>
<tr>
<td>4th (8)</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
</tr>
</tbody>
</table>

(25)
It was finally agreed that the actual selection be made 'on the day'. The main reason for this proposal was in attempting to promote and preserve as normal a response as possible. Selection 'on the day' did ensure that little prior 'cramming' was likely as the chances of being selected were slim.

**TABLE 2**

**ACTUAL PILOT SAMPLE STRATIFICATION**

<table>
<thead>
<tr>
<th>Group Description</th>
<th>Form</th>
<th>Examination</th>
<th>L</th>
<th>E</th>
<th>L</th>
<th>E</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>6th (1) Engineering Drawing (AEB 'A' Level)</td>
<td>6th (1)</td>
<td>Engineering Drawing (AEB 'A' Level)</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) Design (London 'O' Level)</td>
<td>5th (2)</td>
<td>Design (London 'O' Level)</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) Modular Technology (Cambridge 'O' Level)</td>
<td>5th (3)</td>
<td>Modular Technology (Cambridge 'O' Level)</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) Graphic Communication (AEB 'O' Level)</td>
<td>5th (4)</td>
<td>Graphic Communication (AEB 'O' Level)</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5) TVEI-Locally Devised (City &amp; Guilds 6868)</td>
<td>5th (5)</td>
<td>TVEI-Locally Devised (City &amp; Guilds 6868)</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6) Design &amp; Realisation</td>
<td>4th (6)</td>
<td>Design &amp; Communication</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(7) Modular Technology</td>
<td>4th (7)</td>
<td>Modular Technology</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(8) Design &amp; Communication</td>
<td>4th (8)</td>
<td>Design &amp; Communication</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td></td>
<td></td>
<td>27</td>
<td>3</td>
<td>30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.2.3 The Diagnostic Instruments

In order to establish a reference point on which to develop future support materials, particularly in connection with the capability of children to make discriminatory value judgments, a series of questions was devised in order to examine the criteria being applied by children when making their personal choices of product (see Appendix I). The underlying purpose of each interview, and the resulting appraisal of individual discussions, were purposefully concealed from the sample throughout, in order to preserve a more accurate reflection of the
pupil's true response. This was arranged by purporting the activity to be a market research exercise and, hopefully, the later analyses of individual preferences resulted in an accurate appraisal of their true reaction to existing designs. It was considered vital, however, that such assessment resulted from the appraisal of a range of products which were familiar to both boys and girls.

Each of the sample of pupils was asked individually to make their personal preference from a collection of well-known household products. A small sample of the products used is illustrated in Fig. 1, although a complete list of products can be found in Appendix I. In order to reduce the possible discussion of the activity between participants, it was considered preferable to interview the sample individually and within the shortest possible time. The length of the interview was also governed by the practical restrictions placed upon the activity by the various timetables involved and an estimate of thirty minutes per interview proved to be a suitable time and was accommodated very easily within the single (35 min) and double (70 min) periods in operation at the school.

When making preferred choices of product the formulation of individual value judgments could have been expressed in terms of technical efficiency or economic cost (all items included a price tag). Alternatively, respondents may have been more concerned with ethical issues, aesthetic appeal or some element of social responsibility. Consequently, in order to monitor the prominence of such a variety of possible response, an existing framework emanating from the SEC [59], was used to achieve this aim by classifying responses into separate categories, comprising the elements of either Technical, Economic,
FIG. 1 PRODUCTS USED IN THE PILOT STUDY
Aesthetic or Moral judgements. The following guidelines [60] were used in accrediting response to corresponding judgement groups:

**Technical Values** - involve an appreciation and application of the following concepts: efficiency, and the ways in which input is compared with the resultant output; robustness; flexibility, and the ways in which the performance of a man-made object or system might be sensitive to change; precision, and the qualities of fit and fitness for purpose, valued either for their own sakes or as a means to an end; confidence, and the ways in which the possible reliability or unreliability of information is taken into account.

**Economic Values** - involve an appreciation and application of the following concepts: the broad distinction between the ideas of use-value, intrinsic value, and value-in-exchange; the distinction between value, price and cost; the marginal value of one product or product variation over another; the effects of variation in supply and demand on availability and price.

**Aesthetic Values** - involve an awareness of the structures, proportion and colours to be found in the natural world and the man-made world; of the importance of aesthetic factors in all forms of human communication and self expression; of the inter-relationship between workmanship, tools and the aesthetic quality of the resulting environment or artefact.

**Moral Values** - involve an awareness of mankind's impact on the natural environment and his responsibility for its and his own future survival; of the inter-relationship between the man-made world and religious, social economic and political philosophies; of the needs of individuals in society and ways of meeting them; of the importance of ethical
values in carrying out design activity and evaluating the effects of technology.

Taped recordings of each interview were analysed and each identified response was carefully accredited to one of the four categories which acknowledged its association with either an 'aesthetic', 'economic', 'moral' or 'technical' value judgement. Table (3) illustrates the result of processing the first five responses to questions (3) and (4) although more comprehensive analyses are given in Appendix II. It can also be seen from the type of questions which appear in the early stages of the interview that they were designed to reduce anxiety levels and, hopefully, establish an accurate appraisal of the values held by each child.

TABLE 3
ACCREDITATION OF FIVE EARLY RESPONSES

No. (3) I want you to imagine that you are replacing some old kitchen tools. You need some means of opening Crown Tops, Metal Cans and Corked Bottles. Choose which articles you would buy.

No. (4) Why did you choose these particular items?

CATALOGUE OF RESPONSES

<table>
<thead>
<tr>
<th>Pupil</th>
<th>Judgment Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1/2M)</td>
<td>Quick/simple, Comfortable, Not fancy. (A) (-) (-) (T)</td>
</tr>
<tr>
<td>(2/2F)</td>
<td>Safer, Attractive, Easy to use (A) ( ) (M) (T)</td>
</tr>
<tr>
<td>(3/1M)</td>
<td>Efficient, Shape/colour, Modern/trendy (A) (-) (-) (T)</td>
</tr>
<tr>
<td>(4/1M)</td>
<td>Simple to use, Fits on wall, Little force. (-) (-) (-) (T)</td>
</tr>
<tr>
<td>(5/2M)</td>
<td>Good, Strong, Reliable, Good price, Comfort. (-) (E) (-) (T)</td>
</tr>
</tbody>
</table>

As the primary intention was to establish if the sample engaged in any form of technical discrimination, the accuracy or quality of response was not challenged at this stage as it was merely the nature of response.
which was of interest. Consequently, during the early stages of the interview there was no input from the interviewer which might have lead the participant to any preferred response, other than the usual encouragement which may have been required for the more cautious participant.

There were, however, two separate elements of assessment to be considered here. In addition to an interest in the individuals 'true reaction', the second function of the interview was to establish if pupils actively engaged in the 'evaluation' of basic scientific or mechanical principles when making their preferred choices. Consequently, throughout parts II and III of the schedule (See Appendix II), some of the more technical responses were challenged by the interviewer although considerable care was exercised in not acknowledging the quality of the responses made in order to preserve a degree of accuracy and also to guard against any unnecessary contamination of the results.

2.3 Results and Conclusions

The principal aim of Part I of the pilot study interview, in review, was to establish the types and the prominence of the various influences affecting individual choice. The total distribution of the responses is given in Table (4), and the natural variance and emphasis through the individual selections are classified within each of the aforementioned categories.

The results of this distribution have been assembled in Table (5) and shows contrary evidence to the earlier findings of the Feilden enquiry [31] of 1963. It can be seen that a major influence upon product choice (60%) was the sample's consideration of 'technical' factors leaving only
# Table 4

## Distribution of Responses

<table>
<thead>
<tr>
<th>Item</th>
<th>Participants</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td><strong>(Bottle Openers)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>000000--</td>
<td>(1)</td>
</tr>
<tr>
<td>1.2</td>
<td>000000--</td>
<td>(5)</td>
</tr>
<tr>
<td>1.3</td>
<td>010001--</td>
<td>(10)</td>
</tr>
<tr>
<td>1.4</td>
<td>010010--</td>
<td>(6)</td>
</tr>
<tr>
<td>1.5</td>
<td>000000--</td>
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</tr>
<tr>
<td>1.6</td>
<td>000000--</td>
<td>(6)</td>
</tr>
<tr>
<td><strong>(Can Openers)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>000000--</td>
<td>(1)</td>
</tr>
<tr>
<td>2.2</td>
<td>000000--</td>
<td>(0)</td>
</tr>
<tr>
<td>2.3</td>
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<td>(0)</td>
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<tr>
<td><strong>(Cork Extractors)</strong></td>
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<td></td>
</tr>
<tr>
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<td>(0)</td>
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<tr>
<td>5.2</td>
<td>000000--</td>
<td>(11)</td>
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</tr>
<tr>
<td>5.6</td>
<td>000000--</td>
<td>(2)</td>
</tr>
<tr>
<td><strong>(Can Openers - Standard Butterfly type)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>000000--</td>
<td>(12)</td>
</tr>
<tr>
<td>2.2</td>
<td>000000--</td>
<td>(17)</td>
</tr>
<tr>
<td>2.3</td>
<td>000000--</td>
<td>(1)</td>
</tr>
<tr>
<td><strong>(Can Openers - Butterfly with Corkscrew)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>000000--</td>
<td>(13)</td>
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<td>3.2</td>
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<td>3.3</td>
<td>000000--</td>
<td>(6)</td>
</tr>
<tr>
<td><strong>(Can Openers - Rotary type)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>000000--</td>
<td>(6)</td>
</tr>
<tr>
<td>4.2</td>
<td>000000--</td>
<td>(8)</td>
</tr>
<tr>
<td>4.3</td>
<td>000000--</td>
<td>(9)</td>
</tr>
<tr>
<td>4.4</td>
<td>000000--</td>
<td>(5)</td>
</tr>
<tr>
<td>4.5</td>
<td>000000--</td>
<td>(0)</td>
</tr>
<tr>
<td>4.6</td>
<td>000000--</td>
<td>(2)</td>
</tr>
<tr>
<td><strong>(Screw Top Openers - Preferred)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.1</td>
<td>000000--</td>
<td>(8)</td>
</tr>
<tr>
<td>6.2</td>
<td>000000--</td>
<td>(19)</td>
</tr>
<tr>
<td>6.3</td>
<td>000000--</td>
<td>(3)</td>
</tr>
<tr>
<td><strong>(Screw Top Openers - Worst)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.1</td>
<td>000000--</td>
<td>(10)</td>
</tr>
<tr>
<td>6.2</td>
<td>000000--</td>
<td>(3)</td>
</tr>
<tr>
<td>6.3</td>
<td>000000--</td>
<td>(14)</td>
</tr>
</tbody>
</table>

(32)
a 25% response to 'aesthetic' issues. There was little apparent regard to either 'economic' or 'moral' values when making their product selections as these two categories were equally afforded only 7.5%. To suggest that pupils engage in the discussion of the 'moral' aspects of a Can-Opener may appear to be verging upon the idealistic although pupils should, presumably, be expected to have regard for aspects of 'safety' and 'value for money'. Moreover, there are additional considerations such as the 'decline in world resources' and the 'problems of pollution' which may well be addressed when reviews of the choice of materials are made.

TABLE 5
CATEGORIES OF RESPONSE
(PART 1)

<table>
<thead>
<tr>
<th>Analysis Sheets</th>
<th>Aesthetic</th>
<th>Economic</th>
<th>Moral</th>
<th>Technical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responses</td>
<td>1,2,3,4,5,6</td>
<td>1,*,3,4,5,6</td>
<td>1,2,3,4,5,6</td>
<td>1,2,3,4,5,6</td>
</tr>
<tr>
<td>Actual (239)</td>
<td>60 (25%)</td>
<td>18 (7.5%)</td>
<td>18 (7.5%)</td>
<td>143 (60%)</td>
</tr>
<tr>
<td>Poss. (690)</td>
<td>180 (26%)</td>
<td>150 (22%)</td>
<td>180 (25%)</td>
<td>180 (26%)</td>
</tr>
<tr>
<td>Respondee</td>
<td>(33%)</td>
<td>(12%)</td>
<td>(10%)</td>
<td>(79%)</td>
</tr>
</tbody>
</table>

(* Denotes that an 'economic' response was not possible as all the Can Openers within related questions were equally priced and the effect of this can be seen to be reflected in the respective totals and percentages. (ref: Analysis Sheets 1-6).

The particular choices are considered, by the writer, to be of little consequence as the quality of individual opinions of such issues were not in question at this stage of the interview. It is rather the extent of the sample's balanced assessment which is of interest in this particular

(33)
examination of the results. It may be suggested, however, that an indicated 'aesthetic' response of around 25% is ideally pitched, illustrating a balanced judgement for this particular category. Similarly, there is the further evidence which suggests that the choices made were not affected by the possible influences of either 'economic' or 'moral' factors. Conversely, it could equally be argued that the sample's level of 'technical' awareness is more than adequately represented at 60%, perhaps to the point of excess. It must be noted, however, that these arguments assume that each classification should, and can be expected to, receive equal emphasis, and the reader should be reminded that the products under analysis were primarily functional items which perhaps prompted a technical response. The clear distinction must be made, therefore, between the allocation of equal emphasis and equal attention to each individual element of the judgement model. Consequently, the 'frequency' of response given in Table (5) will, perhaps, be a more realistic indicator of the attention given to each category. Nevertheless, a recurring pattern of emphasis does appear to emerge, albeit with a marginal improvement to the levels of response. (viz. Aesthetic 33%, Economic 12%, Moral 10% and Technical 79%.

Clearly, whichever analysis is used, the evidence does suggest a reluctance or inability, in the sample, to simultaneously address the four categories of the judgement model when making individual choices. Indeed, an estimated response of 34%, given in Table (6) does suggest that preferences had, apparently, been based upon judgements which had not addressed the majority (66%) of the available criteria.

(34)
### TABLE 6

**SCOPE OF RESPONSE**

<table>
<thead>
<tr>
<th>GROUP</th>
<th>ANALYSIS SHEETS</th>
<th>AVERAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>(1)</td>
<td>38%</td>
<td>25%</td>
</tr>
<tr>
<td>(2)</td>
<td>56</td>
<td>25</td>
</tr>
<tr>
<td>(3)</td>
<td>63</td>
<td>31</td>
</tr>
<tr>
<td>(4)</td>
<td>50</td>
<td>19</td>
</tr>
<tr>
<td>(5)</td>
<td>44</td>
<td>19</td>
</tr>
<tr>
<td>(6)</td>
<td>50</td>
<td>25</td>
</tr>
<tr>
<td>(7)</td>
<td>50</td>
<td>38</td>
</tr>
<tr>
<td>(8)</td>
<td>44</td>
<td>31</td>
</tr>
</tbody>
</table>

[Shortfall of 66%] <-------- 34%

Reasons for this might initially be directed towards the interviewing techniques although some considerable care was taken to ensure that each participant had said all that he/she thought relevant. It is acknowledged that considerable reliance was placed upon each participant actually verbalising his/her thoughts and opinions during the initial collection of raw data. In order to improve the accuracy of recorded opinion, therefore, participants were individually and repeatedly asked if there was anything which they would like to add, until they positively indicated that there was not. The general trends which have emerged are considered, by the writer, to be a fair representation of sample opinion and, furthermore, do not appear to be appropriate to any particular group within the sample.

There is some additional evidence, however, of an apparent correlation correlative between groups/courses and the extent of the technical responses made by them which warrants further discussion. The majority of technical judgements made by the sample appeared, to the writer, to be based upon a disregard of the products' function and
functional surfaces. Individuals made only partial responses to the technical criteria when making technical judgements and the extent of this phenomena is illustrated in Table (7). (See analysis sheets 29 - 60 in Appendix II for detailed information if required).

During the interviews there was clear evidence of individuals in the sample population making quite arbitrary changes to complete designs prior to any detailed analysis or consideration of the optimisation of existing solutions. For example, press-on caps were proposed to be suitable substitutes to screwed lids before the inherent criteria of the screwed lid had been fully examined (see analysis sheets 29-32 in Appendix II). In attempting to reduce friction only 3% of the sample made a complete response to the materials in contact, the surface finish and the force applied between the contact surfaces (see analysis sheets 33-36 in Appendix II). Evidently, little regard was made of the holistic nature of each inherent mechanical principle involved.

TABLE 7

<table>
<thead>
<tr>
<th>No.</th>
<th>Course</th>
<th>No. 1</th>
<th>No. 2</th>
<th>No. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3)</td>
<td>5th yr Modular Technology</td>
<td>35%</td>
<td>38%</td>
<td>37%</td>
</tr>
<tr>
<td>(7)</td>
<td>4th yr Modular Technology</td>
<td>38%</td>
<td>33%</td>
<td>36%</td>
</tr>
<tr>
<td>(4)</td>
<td>5th yr Graphic Communication</td>
<td>27%</td>
<td>25%</td>
<td>26%</td>
</tr>
<tr>
<td>(1)</td>
<td>6th yr Engineering Drawing</td>
<td>22%</td>
<td>25%</td>
<td>24%</td>
</tr>
<tr>
<td>(2)</td>
<td>5th yr Design</td>
<td>21%</td>
<td>25%</td>
<td>23%</td>
</tr>
<tr>
<td>(8)</td>
<td>4th yr Design &amp; Communication</td>
<td>24%</td>
<td>22%</td>
<td>23%</td>
</tr>
<tr>
<td>(6)</td>
<td>4th yr Design &amp; Realisation</td>
<td>22%</td>
<td>22%</td>
<td>22%</td>
</tr>
<tr>
<td>(5)</td>
<td>5th yr T V E I</td>
<td>21%</td>
<td>18%</td>
<td>20%</td>
</tr>
</tbody>
</table>

Overall Average ----------> 26%

Responses by the sample appeared to be based upon high levels of subjectivity and quantitative appraisals were very rare. For example,
when asked to assess the Velocity/Movement Ratio of the simple door wedge there were no immediate responses forthcoming. Basic concepts of Engineering Science were not generally considered by the sample when making their technical appraisals. (See analysis sheets 40-44 in Appendix II).

Moreover, it is interesting to note that the 5th yr Modular Technology group was later discovered to be an 'elite group' as pupils were selected to join the group in the hope that many would continue with an envisaged 'A' level in Design and Technology in the following year (1986/7). Any difference in the resulting averages between groups must therefore take the effect of this selection into account. As this will have an obvious effect on the results of other groups, the significance of any difference between groups is consequently suggested to be minimal.

Evidence of Mechanical Acumen was rarely demonstrated and there were few signs that individuals were aware that some of the basic principles of Engineering Science or Physics were in any way relevant to, or necessary for, the evaluation of manufactured products. Firstly, the relationship between 'tightness', 'friction' and 'helix angle' of threads was not generally realised. Secondly, when the need to consider the frictional properties was addressed, there was little evidence that any attention was given to each independent feature affecting the frictional resistance which resulted. Similar note has already been made of the holistic nature of the problem. Further comment would serve little purpose other than to observe the one noteworthy and recurring factor of the overall fragmentary pattern of the responses made - a common deficiency which was evident in all groups.
2.4 Review of Findings

That the findings did suggest a low level of Mechanical Acumen in the sample population, thereby converting earlier suspicion into firm opinion. However, the observations made do suggest that levels of technical awareness are likely to be higher in the sample today than in their counterparts, some twenty five years ago. The value judgements which were made by the sample did appear to take account of technical issues although there were clear indications of a possible need to develop a more systematic and detailed assessment of inherent technical criteria. Moreover, when particular principles were identified by the sample, there was little appreciation or regard for the separate elements within each principle involved.

Furthermore, there was additional evidence which has prompted the writer to question the value of the many technical judgements which were made, if they were formulated on such a subjective basis as the results might suggest. Moreover, as there appeared to be little realisation of the presence of any inherent mechanical principles, it follows that little objective assessment was made whenever the appraisals of the technical performance of products were given. An accurate and objective technical capability can only be justifiably established from a prior quantitative study of the inherent mechanical principles which directly influence the product's functional performance. The responses made throughout the pilot study, it was observed, were never couched in quantitative terms. It is suggested, by the writer, that in order to achieve a 'technical' judgment of any quality, there must be that element of objectivity introduced. Technical objectivity is, therefore, regarded to be central to the development of Mechanical Acumen and, as a result, suggests the need to examine the problems
which are associated with the formation of quantitative assessments.

There appears to be three points which arise out of the study of the sample group. It is suggested that individuals had:

- either (i) NOT established a good grasp of the basic underlying principles.
- and/or (ii) NOT appreciated the ways in which the principles were embedded into the products.
- and/or (iii) NOT acquired the necessary levels of cognitive functioning to establish a quantitative assessment of each principle.

The dangers of over-emphasising the purely technical aspects of design have already been acknowledged and certainly there is clear need for more initiatives to develop other Aesthetic, Economic, and Moral aspects of design. The intention is not to develop an introductory course in product analysis but to use a small part of that process as a vehicle in developing a precise capability. Not for the creation of new solutions to design problems but rather to concentrate on the pupil's competence in optimising existing design solutions.

There is generally much confusion and difference of opinion still surrounding 'CDT', 'Design Technology' and 'Design' curricular activities although, the writer quotes Green (1974) [61] in consolidating the essence of this study. There is no such thing as 'good or bad design' but only 'appropriate and inappropriate, efficient or inefficient solutions to problems'. The findings of this pilot study illustrate the limited capability of the sample in critically examining the extent to which existing designs are appropriate and efficient in meeting a specified need. Consequently, the writer further suggests that the development of new curriculum areas in product-based and design-related activities are justifiable measures in attempting to address this identified deficiency.
CHAPTER (2) REFERENCES


[54] Ibid. pp. 9 - 10

[55] Ibid. p.9.

[56] Ibid. pp. 12 - 15


[58] Ibid. p.7.


CHAPTER 3
RESOURCE PROPOSALS AND DEVELOPMENT

In the preceding chapters a case has been argued in support of developing a more enlightened way of looking at products and to make some of the basic mechanical principles more meaningful for all children. The following discussion will review some of the resources which are presently available, in order to illustrate the questionable relevance which they may have in promoting the precise capabilities earlier described in this study.

3.1 Science Apparatus

The review will begin by examining a suggested influence which the Nuffield Science project, in the early 1960's, may have had on the design of present science equipment. According to the literature [62] schools were turning at this time towards applied science teaching and engineering project work in order to make school science more lifelike. Indeed, great store was placed on getting the 'feel of science' and for the pupils to experience and discover for themselves [63]. Recommended equipment was devised, in order that pupils working individually, in pairs, or at the most in groups of four, could undertake class experiments and so discover scientific concepts and principles for themselves. The associated hardware suggests much dependence upon the type of friction and lever kit which is well known to most, if not all, school science departments today. However, the writer's suspicion is that the success of the Nuffield scheme may have prejudiced the need to further explore alternative forms of equipment for the development of such basic understanding.

(41)
The development of such a 'practical hands-on' approach is sure evidence of an alignment with Crowther's proposals for the type of 'practical' education described in chapter 1. It was Page [64] who reported that 96% of all schools contacted during his survey did subscribe to the alternative road thesis, although of the pupils who did benefit from this approach only 37% of the schools thought that this could include any of the brightest pupils. It is also interesting to note that in addition to the principle of 'teaching science for understanding', the Nuffield scheme gave equal emphasis towards, the children's grasp of what it was like 'to be a scientist' [65]. Moreover, the basic ideals of Nuffield Science can be seen to run throughout the recommended practical work and associated apparatus. This leads the writer to suggest that, the underlying philosophy of the Nuffield programme and its influence upon the incumbent apparatus, have possibly been instrumental in setting a precedent for the design of apparatus on other schemes where the emphasis on 'academic' ability and 'scientific' analysis may not be regarded to be so prominent.

To further justify this, reference to Bloom's Taxonomy of Educational Objectives [66] is useful in clarifying an important connection with the earlier discussion of Crowther's view. In behavioural terms, the exhibition of 'practical' or 'manual skill' would normally be classified within the 'psychomotor domain'. However, by reason of the integrative nature of 'capability', there is significant argument to suggest that 'doing' skills should be recognised as different behaviour. This distinction can be emphasised by consideration of the participating nature of contributions made by the 'cognitive' and 'affective domains'. This is not to say that 'cognitive' and 'affective' elements are not present in the 'practical' but rather to demonstrate that 'doing' is
regarded, by the writer here, to be more closely associated with 'capability' and Crowther's concept of 'practical education', rather than with the 'practical' elements of manual skill which are classified within Bloom's psychomotor domain.

Gronlund [67], in using a hierarchial form of behavioural objective, would presumably sympathise with Crowther's call for 'increasing intellectual demands' and also associate the capability of making value judgements with increasing intellectual levels of ability from 'knowledge' and 'comprehension' through 'application, analysis and synthesis' to finally reach 'evaluation' at the highest level of the cognitive domain. Historically, the emphasis in school has, perhaps, been directed towards the first two of these. By concentrating on 'knowledge and comprehension', the examining authorities, before the introduction of the new GCSE courses, have perhaps been guilty of neglecting higher levels of ability within the hierarchy of learning just described.

Gagne [68] also employs the notion of learning hierarchies by using them as statements of all pre-requisite learning and refers to them as 'enabling objectives'. This will serve as a reminder that in order to make an informed value judgement there is a requirement to satisfy additional pre-requisite levels of 'application, analysis and synthesis'. The identification of 'enabling objectives' to establish a basis for further learning is of vital importance in any development of educational materials although this view appears to be in direct conflict with the earlier difficulties associated with the 'content' based activities of some Design and Technology courses.

In view of the additional note made of the apparent conflict which exists between the 'traditional' and 'alternative' routes, it may initially
appear to any prospective creator of the new materials that the foregoing philosophies present the horns of a dilemma. The Crowther model which suggests that some pupils learn best by seeing applications before principles may appear to be in opposition to the view which suggests a progression through increasing levels of intellectual demand. This is made particularly meaningful when note is made of the position which 'application' holds within Bloom's Taxonomy, an element which Crowther perhaps regarded to be in a more prominent position although, on the other hand, Crowther's recommendations also saw the need for 'increasing intellectual demands'. The writer therefore, in subscribing to both views, suggests it to be a question of mis-interpretation or a mis-match between the original and underlying concepts, rather than a conflict of viewpoint. Clearly, the advocacy of seeing 'applications' before 'principles' is provoked from different sources for varying levels of cognitive development. To actually apply any principle of mechanics assumes the prior understanding of the principle involved. Crowther's use of 'application' is therefore regarded here to be associated with the initial motivation for, and to illustrate the relevance of, new learning. As such it is further regarded, by the writer, to be positioned at an 'awareness' level and, therefore, is argued to be a pre-requisite or 'enabling' objective and used in an introductory sense prior to entry into Bloom's 'cognitive' domain.

In his discussion of the use of problem solving activities in the primary school, Johnsey [69] considers the close relationship between the problem solving process that the technologist might use and the application of the scientific principles upon which the resulting artefacts rely. Although he agrees with the need for children to experiment and to adopt a scientific posture when attempting to establish accurate results
and conclusions, he warns of the possible alienation of the problem solving process which might result from the teacher pre-empting the particular scientific ideas useful to the activity. Johnsey, consequently, suggests the answer lies in the simultaneous development of practical problem solving ability with the more traditional methods for teaching the science curriculum and not as a substitute for them.

3.2 The Primary School Connection

This suggested partial return to more didactic methods appears to strike at the very root of Piagetian philosophy which has been such an enormous influence upon primary science and maths since the early 1960's. The spirit embodied by Piaget makes children the active agents of their own learning. In this scheme of things, the child is a lone individual discovering the world and there is no place for the teacher, except as a provider of suitable "learning environments" for children. However, more recent research into cognitive development and learning questions the established "learning by doing" approach to teaching primary science. Driver [70], in her discussion of a developmental approach to science teaching, draws heavily upon the view which directly opposes the basic Piagetian philosophy by calling for a structuring of the subject taught. There are others like Mercer and Edwards [71] who presently question the value of lessons which are based upon Piagetian ideology. They describe, what they consider to be, the negative influences of Piaget upon the Plowden Report and the Nuffield Project. Despite the emphasis placed upon heuristic methods, they suggest that some children learn quite well to carry out structured procedures that they are required to do in the classroom. Mercer and Edwards have called this a 'ritual understanding' and describe it purely as a procedural knowledge of the science which the
pupil is studying. This, they suggest, is accomplished merely by the rote learning of type problems and mechanical procedures. They believe, furthermore, that there are other children who go beyond this stage by developing a 'principled understanding' which allows for a much deeper understanding of the basic principles that science is, essentially, all about.

Driver's challenge of the 'learning by doing' approach is based upon need to reconcile the principles and ideals of Piaget with the practical realities of pursuing pre-determined curriculum goals. Her objection is not in the engagement of the practical aspects of the activity but in the arbitrary formation of basic concepts which is advocated through the broad freedoms which exist. However, she further argues [72] that the 'practical' approach, contrary to popular opinion, places higher levels of intellectual demand on the pupil by requesting him to learn at two levels at once:

"they (the pupils) are exposed both to new phenomena and also to their accepted theoretical interpretation" (p.79)

It is the demand for pupils to link experiences which she regards to be a vital element for the successful integration of, what can otherwise appear to the pupil to be, a series of disjointed lessons with little practical use outside school. It is this integrative aspect which Driver regards to be a failing in the Piagetian ethos. She argues that the active integration of science into the general education of young people helps them to make some more sense of the world and proposes a review of all science experiences.

It means selecting illustrative phenomena not simply because of the support they give to a theoretical idea, but because they are of practical use and everyday interest in their own right. It also means bringing the theoretical ideas within the compass of pupil's understanding'. (p.80).
Furthermore, the notion of structured practical experiences offers the additional opportunity to encourage and develop skills which are as relevant to all occupations as they are to the scientist. Indeed as Driver [73] concludes, such an idea suggests that the teacher's role is to help pupils relate their experiences in a more meaningful way and justifies her view by using the following passage from the Bullock Report [74], reminding the writer of his earlier references to Crowther's 'alternative mind':

'What the teacher has in mind may be the desirable destination of a thinking process, but a learner needs to trace the steps from the familiar to the new, from the fact or idea he possesses to that which he is to acquire. In other words, the learner has to make a journey in thought for himself'.

It should be emphasised that the previous critique of progressive education is not used to argue the return of traditional methods. On the contrary, it is the child's active engagement in his own learning which is regarded to be a central feature of this study together with a subtle use of practical activity in achieving other 'hidden' aims of a more general nature. Clearly, there is growing evidence which suggests that general education is as much about 'content' as 'process' and that guided heuristic approaches are appropriate vehicles in achieving a more meaningful understanding, by children, of basic mechanical concepts and principles.

Consequently, the dependence upon a form of apparatus which favours those who are well equipped and happy to engage in the processes of abstract thought, who Crowther referred to as 'academic', is now questioned. Clearly, there is a debatable relevance here in using such apparatus with children whose cognitive style would prefer to experience the 'practical' application of a particular principle before
any form of detailed analysis of the inherent principle is undertaken. The writer, therefore, questions the relevance and wisdom of using such apparatus with children who neither wish to become scientists nor would benefit from such an analytical approach. Despite the earlier suggestions to the contrary, there is no factual evidence to suggest that 'academic' types would not elicit similar benefits from an approach where the experience of applied principles serve as precursors to such clinical analyses.

This is not to argue that such apparatus has no place in determining quantitative data and relationships. The suggestion of unsuitability does arise, however, from the need for some pupils to experience the applied principle prior to any such detailed analysis. It is the writer's belief, therefore, that Nuffield-type science apparatus illustrates a certain detachment from reality which may favour the 'abstract' thinker. Although, it is noted that in order to preserve clear and precise illustrations of individual principles that same element of detachment and separation is a necessary feature of good pedagogic design. Nevertheless, in the attempt to demonstrate these separate principles, the resulting equipment gives additional emphasis to the abstracted principles. The writer suggests, therefore, that by demonstrating the abstracted principles so well, the resulting apparatus and equipment fails to address the important issue of illustrating the ways in which each principle is employed in the functional operation of manufactured products.

3.3 C D T Equipment

During the mid 1960's there was growing support towards the notion of a technical education for all and the creation of modular courses,
by the Schools Council, soon followed the lead which Nuffield had made. However, the directed emphasis in this later development was not towards the central aim of a 'scientific' capability but towards the development of a 'technological' capability. The subsequent introduction of Craft, Design and Technology is seen, by the writer, as a further endorsement of the justifiable pursuit of the application of scientific principles [75]. However, there appears to be little evidence of science and technology departments combining the subject in this way. Indeed, school departments were reported in 1987 [76] to be giving insufficient emphasis to the connection between the subjects of science and technology:

'The separate technology courses, however, often divorced the subject (technology) from much of the scientific knowledge and the science courses gave insufficient attention to the application of scientific knowledge in solving technological problems. Science and technology courses should seek to ensure that scientific principles and knowledge are taught in conjunction with technological problem solving, appropriate to the age and ability of all pupils' (paras 57, 64)

Furthermore, the Royal Society for the encouragement of Arts, Manufactures and Commerce (RSA) has registered concern at the failure of Government, in its proposals for a national curriculum, to account for objectives which straddle subject boundaries and combine in the type of collaborative activity which is developed through the resolution of practical problems [77]. However, there are now indications that the Education Reform Bill's effect upon the new balanced science curriculum may be developing a more sympathetic philosophy towards awareness of the application of scientific principles within the design of products [78].

This does underline that resources are not confined to apparatus and equipment, as it clearly involves the experience and capabilities of
teaching staff and the curriculum in which they operate. The identification of these particular aspects do serve to clearly illustrate the extent of the mis-alignment which presently exists. In identifying equipment found in C D T departments, H M I reported that such resources fell into three broad categories. [79]:

'There was that which could not or should not be improvised, such as specialist electrical, electronic or pneumatic equipment. Next there were construction kits and finally that which the teacher/pupils had devised, assembled or invented' (p.22)

In the interests of clarifying the direction of this study, it may prove beneficial for the intended resources to be formally identified within the above categories. The envisaged resources are not regarded as being specialist to either technology or science. If the previous proposals for the development of Mechanical Acumen are accepted then any subject orientation will be general and have a suggested relevance for all children. The use of construction kits might at first be thought to enjoy a close alignment with the proposed resources. Indeed, the manufacturers of some construction kits do include guidance in building simulated assemblies of simple tools, mechanisms and machines. However, it has already been noted that without the creative input from the teacher many opportunities to develop associated pockets of knowledge in discovering or applying the basic principles involved may be clearly lost. The treatment may in reality be practical in nature and, consequently, may lose its possible advantage if pupils are not requested to address the physical quantities involved. The final category referred to by H M I, however, includes the type of resource which could offer the opportunities for children to pursue the type of activity which has been proposed and is now sought through this investigation.
It has been suggested that the benefit of school apparatus arises from its value in forming useful quantities and its demise lies in its purely academic function. More relevance and interest will be generated, it is proposed, through an approach which is not governed by the restrictive and abstracted activities likely from using the type of school science apparatus just described. An integrated approach which focuses attention upon a particular theme, purpose or product is, apparently the very antithesis of some present practices in school science and technology. Moreover, the advent of integrated practical activity in school science and technology is a development which would not be confined to the secondary sector.

3.4 Resource Design

The Design Council’s enquiry [80] into the function of 'design', within primary education, spoke of 'design-related activities' rather than to 'design education' as was the case in all four previous reports.

"We are not proposing the introduction of a new subject, called 'design', into the primary curriculum. Instead, we wish to identify the opportunities which exist, within the normal pattern of school activity, to develop children’ capacity for designing and understanding design...." (para 3.1)

The recommendations which emanate from the report clearly indicate that design-related activities in the primary school should be regarded as opportunities to cut across subject boundaries [81] and, more specifically, advise that 'Work in science and technology in the primary school should be linked'. (para 9.18). Present practice may be improved in a variety of different ways and there is evidence of some pioneering work being undertaken in isolated pockets of the more enlightened science and CDT department [82]. However, resources which identify the functional principles inherent in products appear to be in very
short supply and such activity is left to the ingenuity of teachers and advisors.

There are, in review, items of ready made Nuffield-type science apparatus which are used to illustrate separate scientific principles, although there are limitations in the very clinical approach to science which can result. On the other hand, the use of selected 'everyday' products as vehicles in illustrating the application of principles, has the advantages of making science more lively and relevant. Although such approaches are acknowledged to consume more time than traditional methods, the interest aroused among pupils and their increased motivation and understanding of science has clearly been considered [83] to more than compensate for the extra work.

However, the available resources appear to be limited to individual initiatives which make use of examples of actual 'fully blown' products. In addition to these difficulties, there are further implications of product design which need to be considered when using products for such pedagogic purposes.

3.4.1 Inherent Functional Criteria

An analysis of the manufactured product suggests quite a different form of functional characteristic to that described in the earlier discussion of Nuffield apparatus. In connection with the suggested feature of 'abstracted' principles in the discussion of Nuffield equipment, the converse may be true of the product. In this respect, the product is a result of the combination of 'integrated' principles where each of the separate and inherent principles do not necessarily receive clear illustration. Indeed, market forces are sometimes powerful enough to positively discourage the clear communication of inherent principles.
The inherent principles are sometimes purposefully hidden from the consumer for reasons of the design aesthetic or to preserve and protect advantages gained in the market place. The mechanical principles on which the product depends for effective functioning can, therefore, remain completely hidden by the design aesthetics, unless they are purposefully sought out. The integration of those self same principles within the products and the ability to identify them will, consequently, have further implications for the design of the proposed resources.

The notion that selected products be regarded as disguised or camouflaged forms of lever is of particular attraction, to the writer at this stage, and the examples in fig. 2 are given in illustration of simple applications of the Principle of Moments. Both the Nuffield apparatus and the mechanical principle which it described appear as the derivatives of the LEVER ACTION. It can be seen from Fig. 2 that as the level of abstraction decreases there is a corresponding increase in the level of intellectual demand required to identify the inherent functional principle. It may also be interesting to note that the Nuffield-type of lever kit is a 'quiet' form of apparatus, in this sense, with little interference to the primary pedagogic signals which are being communicated. Alternatively, the example of the bicycle illustrates a very 'noisy' example of the lever action. Much higher levels of cognitive functioning are required in this example, before any such detailed analysis is undertaken, in establishing its existence, its position and its attitude of presentation. There are similar examples which could illustrate the same notion for WEDGE ACTION and the examples of the inclined plane and the bicycle are offered (fig. 3) as two possible extremes of a parallel continuum.

It can be said that, from his experience of LEVER and WEDGE ACTIONS
FIG. 2. NOISE/ABSTRACTION CONTINUUM (LEVERAGE)

<table>
<thead>
<tr>
<th>FORCE RATIOS</th>
<th>EXPERIMENTAL APPARATUS</th>
<th>SOURCE FUNCTIONS</th>
<th>BASIC MECHANISMS</th>
<th>DEVELOPED PRODUCTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>(LOW)</td>
<td>(MOMENTS)</td>
<td>(LEVERAGE)</td>
<td>LEVER</td>
<td>WINDLASS</td>
</tr>
<tr>
<td></td>
<td>(LEVERAGE)</td>
<td></td>
<td>PULLEY</td>
<td>WHEEL &amp; AXLE</td>
</tr>
<tr>
<td>(HIGH)</td>
<td>(HIGH) LEVELS OF &quot;ABSTRACTION&quot;</td>
<td>(LOW)</td>
<td>BICYCLE</td>
<td></td>
</tr>
</tbody>
</table>

(54)
FIG. 3. PRODUCT-RELATED TAXONOMY OF TWO MECHANICAL SOURCE FUNCTIONS

<table>
<thead>
<tr>
<th>(LOW)</th>
<th>NOISE</th>
<th>(HIGH)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td>WEDGE ACTION</td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
<tr>
<td><img src="image3.png" alt="Image" /></td>
<td>LIFTING WITH WEDGE</td>
<td><img src="image4.png" alt="Image" /></td>
</tr>
<tr>
<td>FORCE RATIOS</td>
<td>EXPERIMENTAL APPARATUS</td>
<td>SOURCE FUNCTIONS</td>
</tr>
<tr>
<td>(MOMENTS)</td>
<td>(LEVERAGE)</td>
<td>LEVER PULLEY</td>
</tr>
<tr>
<td>(HIGH)</td>
<td>ABSTRACTION</td>
<td>(LOW)</td>
</tr>
</tbody>
</table>
through the many different tools and machines he has developed over the centuries, man has derived the Principle of Moments and the Inclined Plane. These two principles appear, to the writer, to be a recurring feature which are present in most products but in varying degrees of abstraction. Sometimes they form a central and necessary feature of the successful functioning of the product and in other cases they are quite insignificant features of the product's operating characteristics. Whatever their relative merits their evaluation is considered by the writer to be at the very root of the basic design efficacy pursued by this investigation. The Product-Related Taxonomy (Fig. 3) is suggested to be a fundamental 'academic tool' for assisting in the technical appraisal of the functional performance of everyday products. Therefore, within the bounds of this study, both the Lever and Wedge actions are considered to be sound precursors to any future appraisal of existing products.

In her discussion of the role of C D T in schools, Phillips [84] describes the difficulties encountered by teenagers in solving problems that require the application of knowledge towards the solution of practical tasks. She continues by comparing the ease in which the length of the side of a triangle is calculated, and the difficulties found when pupils are shown two sides of a roof resting on the walls of a building, and asked to obtain relevant measurements. The suggested explanation for this lies in the difference between:

(a) having a ready-made abstract formula, and

(b) needing to decide, from the mass of information in real life, which features are significant and relevant to the problem.

Harris [85], in advising of the continuing policy of teaching mathematics in very narrow and arithmetical confinement, believes that such isolation
of basic skills within a two dimensional framework does nothing more than 'kill them dead'. She advocates getting the real context of mathematics back into school and nominates recent practical activity developed by the 'Maths at Work' unit to describe her preference for students to 'do their measurement for a purpose and to degree of accuracy needed by the task and its material' [86]. Harris further argues for the systematic practice in applying what pupils learn in theory to the solution of real problems with careful preservation of all the extraneous information which comes with the practical problems of the real world 'gremlins and all' [87].

It is the writer's belief, therefore, that if children are to engage more meaningfully in an increased involvement with 'noisy' products, then their present capability in successfully carrying out a technical evaluation of products is in need of some improvement. Moreover, it is considered vital to include in this process an appreciation of the Lever and Wedge actions upon which the effective functioning of many products rely. The envisaged resources will, consequently, be 'product-based' and designed to clearly illustrate these basic functions while, simultaneously, retain the ancillary 'noise' which sets them apart from traditional items of science-based apparatus.

In addition, as has been earlier demonstrated, some children may not have acquired the necessary cognitive skill to establish the required quantitative assessment on which an objective technical appraisal relies.

3.4.2 An Objective Appraisal

The case for the desired element of objectivity, which is afforded to any meaningful technical appraisal has already been argued. Clearly, in order to achieve the necessary degree of objectivity, consideration
must first be given to the various quantities involved. Certainly, in order to develop a meaningful understanding of any worth, an objective appraisal will require the ability to quantify the various expressions and concepts used. The following quotation by Lord Kelvin in 1883 will sum this particular point up very well:

"When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind: it may be the beginning of knowledge, but you have scarcely, in your own thoughts, advanced to the state of science".

In addition to the allocation of quantities, decisions will also have to be made about the functional dimensions and propositions which directly affect the operating characteristics of the product. Despite the intended development of a general capability in all children, special note is made here of the comprehensive statement within the well known 'Mechanisms' course in modular technology [88]. The information advises that some basic aspects of Mathematics, Science and Technical Studies was preferred in order to enable the pupil to 'make simple calculations involved in mechanical design' (p. 9). However, it is also noted that, the amount of emphasis which is placed upon a 'quantitative' study is left entirely at the individual teacher's discretion [89] as:

'A quantitative study of mechanisms is not essential, but exercises in the mathematics of mechanisms should be set for the more able pupil.' (p. 6)

Changes in the pupil's ability to make quantitative judgements are, it is assumed to be, more likely achieved through the efforts of those individual teacher's who exhibit a personal enthusiasm and encouragement for such objective assessment. Clearly, the mandatory requirement for a quantitative treatment is not advocated although, it has been
argued throughout this study, to be a vital element in the prediction of functional performance.

The source of the writer's concern, therefore, lies in the view that to disregard the need for such a quantitative study is to condone the negative emphasis of failure which is so often generated from the sole reliance on such post-manufacture testing. Technical appraisals which emphasise only the negative aspects of failure are, in the writer's opinion, associated with the evaluation of too many practical design activities. Clearly such testing is a necessary failure of any product development exercise but to suggest that the ability to quantify be left to the more able pupil, is to deny others of possibly the most satisfying and motivating activity of design efficacy. Moreover, the development of Mechanical Acumen would be more easily achieved from resources which accommodate this particular element and is regarded to be a central feature of this investigation. It would, therefore, appear that a simplified form of quantitative assessment, which does not have recourse to the academic rigours which are presently assumed, would be an appropriate development.

3.5 Resources for Product-Driven Learning

The conclusions drawn, by the writer, from the earlier pilot study suggest the need to address some fundamental principles of engineering science. The two basic functions of LEVER and WEDGE ACTION have already been examined at some length although the pilot study did suggest that the concept of FRICTIONAL RESISTANCE was an additional area of required development. It is argued in this study that the three principles are so general in use as not to render them in any way specialist or appropriate only to the subject of 'design' or
'technology'. Moreover, an emphasis towards design-related activity which focuses on the application of the scientific principles in products is regarded to be the central purpose of the proposed resources.

It was also proposed that the envisaged resources would develop 'the capability to objectively predict the technical performance of existing products'. The development of some product-based hardware was regarded to be the likely solution in order to realise the quantitative appraisal of the functional parameters of specific products. Elements of integrated support were also considered to be vital in structuring the proposed input in order to achieve an accuracy in interpretation. The procedures which were adopted will be fully described in the next chapter and present attention will be directed towards the development of the associated hardware.

3.5.1 Door Closer and Wedge

The particular aspects of design which are of central interest arise from the comparative ease in which specific dimensions can be taken directly from the apparatus in order to establish relevant proportions whilst, simultaneously, using the recognisable products of a door closer and simple door wedge. The selection of these two particular products was not accidental as their close association with LEVERAGE and WEDGE ACTION is clear and their respective 'noise' factors do not distract too much from the ready identification of the Turning Moment and the Inclined Plane.

Some useful experience was also envisaged from modified forms of door closer arm (fig. 5). In addition to the possible variations in length to establish the relationship between force and distance from
FIG 4
DOOR CLOSER AND WEDGE APPARATUS
the fulcrum, there were further illustrations of force variation which could also be practised by arranging for the forces to act through angles other than at ninety degrees to the closer arm (fig. 6). The bent closer arm in fig. 7 was devised to consolidate this particular concept recognition.

It was also envisaged that comparisons between the ratio of the perpendicular sides of various door wedges and the generated vertical and horizontal force components would develop a working understanding of their practical relationship and lead to further predictions of theoretical force output (fig. 8).

Due to the lack of available time, additional attempts to simultaneously address a quantitative account of the associated frictional resistance was not considered by the writer to be a realistic proposition. However, the opportunity to address this particular aspect of the problem was a recurring temptation to him. Furthermore, the targeting of this apparatus to a suitable age range was quite problematic in itself and heralded the development of a second piece of equipment which was designed to develop an early understanding of FRICTIONAL RESISTANCE.

3.5.2 Slip/Grip Apparatus

The Sci-tech '87 exhibition, which was sponsored by the British Association for the Advancement of Science and the Department of Industry, was staged at the Derbyshire College of Higher Education in July 1987 to show the type of work followed by schools in central and south Derbyshire and in order to provide a source of ideas and encouragement for others. An examination of the various exhibits, from over sixty primary and junior schools in the area disclosed a
FIG 5
COMPARISONS OF THE OPERATING PARAMETERS

FIG 6
EFFECTS OF ANGULAR INPUT FORCES
FIG 7
IMPLICATIONS OF A BENT CLOSER ARM

FIG 8
COMPARISONS OF COMPONENT FORCES AND DOOR WEDGE PROPORTIONS

\[ V_1 = \frac{1}{3} \]
great diversity in the work being carried out. In considering those projects which were of more specific interest to this study, the writer concluded that there was little evidence of any quantitative appraisal in the judgements being made. For example, questions which addressed the 'best' conditions for sliding to occur promoted the majority of responses to be subjectively based. It must be said that frictional resistance was sometimes referred to as a function of the time taken to slide down a slope or the force necessary to pull a given material over a surface. Perhaps any further request for quantitative measures would not be appropriate or viable at the primary stages of education. Nevertheless, there were those who would subscribe to Driver's view [90] that 'if learning new ideas depends primarily on what ideas a child already has, then it should be possible, with a suitably designed sequence of instruction, to teach any idea to a child at any age'.

However, there was no reference made in the exhibition to the relationship between the precise measurements of gradient and the evaluation of frictional resistance, despite its potentially practical value to the 'budding' technologist. This is presumed, by the writer, to be a direct result of the academic treatment upon which the subject has relied in the past and the inappropriate design of the available apparatus. Moreover, it was from this deficiency, the process of verification through research and the belief that primary children, given the appropriate input, might develop a more objective understanding of FRICTIONAL RESISTANCE that the notion of the Slip/Grip equipment finally emerged.

The idea of a playground slide appeared to be appropriate although the design needed to include the unusual facility of varying the angle
FIG 9
PLAYGROUND SLIDE OF FIXED INCLINATION

FIG 10
SLIP/GRIP APPARATUS - VARIABLE INCLINATION
of inclination. For the reasons already explained, it was thought necessary also for the angle of inclination to be shown and a protractor and pen recording facility was made available for this purpose and to expedite the production of detachable hard-copies of the inclined surfaces for comparisons of separate gradients to be made (fig. 11).

In addition to this, more useful dimensions were considered to be the lengths of the two perpendiculars which directly governed the individual gradients. Fig 12 shows that the base of the equipment was designed always to retain the unit length of one metre (1 metre) whilst simultaneously accommodating the possible variations in the length of the vertical support and slope. The variations in length of the vertical support are read directly from a corresponding scale which affords the location of the registering mechanism for the support shaft. The vertical locations were pitched at twenty-five millimetre (25 mm) intervals to provide an adequate selection of gradients up to a maximum of forty-five degrees (45°). The proposed investigation into the gripping qualities of individual children's shoes through such active participation and the limited financial resources will, perhaps, help justify the substantial nature of the structure.

3.5.3 Resource Support

Following invitations to support the project, the manufacturing sector was quick to respond through their generous loans and donations. The choice of materials for the construction of the slide were made, to a large extent, from donations to the project from benevolent companies and scrap yards and petty cash funding. The variations between the frictional resistance of different materials were attempted to be realised through a selection of sheet materials which were

(67)
FIG 11
COMPARISIONS OF RECORDED ANGLE WITH PROTRACTOR READING AND REGISTERED SLIDE SETTINGS

FIG 12
SCHEMATIC LAYOUT OF SLIP/GRIP APPARATUS
supported by a strong base of four smooth concrete slabs. Companies, in their generosity, supplied twenty four duplicate sets of requested items of equipment in order to provide for children to simultaneously address, and individually participate in, the planned activities and assessments.

Throughout the planning of resources there were many generated ideas, most of which were accepted although others were shelved due to the limited time available with the sample group. Appendices III and IV include all the supporting resources which were considered to be helpful in the envisaged analysis and examination of inherent mechanical principles in products. It should also be noted that the product range attempts to provide increasing 'noise' levels. They range from the simple door wedge to an assortment of familiar tools which, on close analysis, exhibit a multiplicity of appropriate illustrations for use in the planned activities.

However, in addition to the proposal of encouraging the development of Mechanical Acumen and the suggested need to provide the resources necessary for children to make 'quantitatively' based technical appraisals of existing products, there was now the question of establishing a suitable target group. Trials were therefore undertaken in order to investigate the feasibility of such a quantitative treatment in the primary sector.
CHAPTER 3 REFERENCES


[73] Ibid., p.59.

[74] BULLOCK REPORT (1975) 'A Language for Life'. HMSO. p.141

[75] TIMES EDUCATIONAL SUPPLEMENT (1.1.88) No. 3731 p.18.


(70)


[81] Ibid.


[83] Ibid. para. 3.45 pp. 22-23.


[86] Ibid., p.8.

[87] Ibid., p.9.


[89] Ibid. p.6.

CHAPTER 4
RESEARCH DESIGN AND METHODS

The proposed apparatus was developed to assist children in making objective technical appraisals about existing products. The following arrangements for primary sector trials arose out of the central desire to establish the earliest feasible age for the introduction of such 'quantitative' assessment. However, there were some additional benefits of a much broader significance which arose through the practical work within these primary studies.

4.1 The Primary Trials

Longford School, which has served to educate the 5 to 11 year olds of the village and its surrounding parish since 1875, has places for approximately 50 children. The source of its involvement with the project primarily comes from the headteacher's (request and interest) in developing in the children the type of technological capability as earlier proposed in this study. Discussions with the headmistress showed that much mutual benefit would be gained from involving all fourteen of the top juniors (10-11 yr olds) in a study of frictional resistance. The underlying purpose of the project was to establish if a 'quantitative' appraisal of friction was feasible at the primary stage. This was presented in the form of a proposal which attempted to:

(a) Introduce the notion of the separate technical, economic, aesthetic and moral elements which influence the evaluation of products.

(b) Establish that friction can be stated as one 'technical' element, in numerical terms.
(c) Examine where high/low frictional ratings are used to advantage in various 'well-known' products.

The following programme was, therefore, undertaken to fulfil this request and enable the children to become better equipped to undertake some later topic work which the headmistress was planning to arrange in the following term.

4.1.1 Product Choice (1 x 1.5 hr. session) - (Appendix III)

The aim of the first lesson was to introduce the work and to establish that technical appraisal was one of four possible elements which may influence the choice of product. The initial thrust of the development centred around the personal choices of shoes which children would make from distributed catalogues. It was clear from the very lively discussion, that children were well motivated to the exercise and had little difficulty in identifying the divisions between the AESTHETIC and ECONOMIC responses which were being made. It was also interesting to note that the headteacher did not prefer to use any substitutions for the terms 'aesthetic' and 'economic' as she welcomed the opportunity to develop the children's vocabulary.

There was no reduction in the energy devoted to solving the question of the 'problematic mouse' in design task No. 2 and the reservations, experienced by the writer, in highlighting the demise of mice when using poison and traps was apparently unfounded and is possibly explained through their frequent use and availability in such a rural area. However, the focal point of discussion around the MORAL aspects of design followed this clear illustration.

The 'Alternative' mousetrap was another powerful initiator of some very valuable input in highlighting the need for any product to function
FIG 13

AN ALTERNATIVE MOUSETRAP *

* Ref: A Board Game by the Ideal Toy Co. Ltd. Fishponds Road, Wokingham, Berks.
well in meeting its initial specifications. Further discussion relating to the possible TECHNICAL improvements was concluded by addressing the acronym of T.E.A.M. in serving as a reminder for further requests for the holistic appraisal of any product.

4.1.2 Product Performance (1 x 1.5 hr. session)-Appendix III

The purpose of this second meeting was to emphasis the technical influence which friction had on product performance through an assessment of the varying qualities of grip in the children's shoes. The only equipment available for previous studies of friction in the school was through the creative use by staff of a sloping bench from the range of P.E. equipment. This same exercise was now carried out using the specially devised friction-slide to find the steepest slope on which each child could stand without their shoes sliding. Free access was allowed prior to sudden death screening, in order for everyone to enjoy and experience the problem. Further tests followed with progressively steeper slopes until each child had a measure of grip a clear winner emerged.

The intention was to establish a precise measurement for each child and to state the exact measure in 'quantitative' terms. Children immediately made reference to the 'angle of inclination' as the assessment of grip value. However, this was soon found not to be practical as the scale (in degrees) was not sensitive enough to detect the difference in grip which was experienced. Therefore, each trial was later designated a GRIP NUMBER which represented the Coefficient of Limiting Friction and was read directly from the side of the apparatus. All fourteen results were then listed and choices as to whose were the best shoes for walking up steep slopes or making slides in winter.
The use of the friction-slide not only generated additional motivation for the work but also made the study more relevant. It may be of interest to note that there was no apparent evidence of children questioning the effects of either shoe size or weight on individual performances during these trials.

4.1.3 Prediction of Performance (2 x 1.5 hr. sessions)-Appendix III

The third and fourth lessons of the series were used to consolidate the fact that grip could be stated in numerical terms by 'angle' or 'grip number' and to further practice its quantitative determination. However, it was soon realised that there was an opportunity here to pursue some basic groundwork as a necessary preliminary (see Design Task No. 7).

In order for the work to be of any further use in predicting possible performance, it was necessary for the children to establish the 'proportions' of the adjacent sides of a right angled triangle for the determination of a corresponding value for 'grip number'. The use of similar triangles appeared to be the most suitable method in successfully achieving this, at the primary stage. This was achieved graphically, by using a protractor and drawing the representative triangle from the given angle of inclination on the apparatus. Some of the children experienced difficulty in using the protractor and labelling the diagrams. This indicated to the writer that his earlier assumptions of the children's abilities were over optimistic.

Having achieved this necessary skill, a simple comparison of the proportions of the sides of the two perpendicular sides of the right angled triangle was simply made by counting the number of squares each of them covered. Much use was again made to reinforce basic
concepts of geometry and related vocabulary, which again serves as a reminder of the relevant spin-offs generated by the activity.

The final ratio was then determined by using the class calculators. Meaningful practice and application of decimals promoted considerable purposeful back-up activity to core curriculum studies. There was evidence from the observations made that children were really thinking problems through. The example of the man and the wheelbarrow was the source of such discussion on the different characteristics of rolling and sliding giving rise to further questions of why the wheel did not slide - another opportunity to examine levers in the wheel and axle. However, all the additional work appeared to be well received from both the children and the teaching staff.

4.1.4 Grip Factors (2 x 1.5 hr. sessions) - Appendix III

These two sessions were devoted entirely to the determination of grip numbers for given samples of various combinations of materials. The writer decided, because of the presence of such high levels of enthusiasm by the children, that there was a need to ensure that all children had immediate access to the necessary equipment in order to sustain their individual motivation. This meant the duplication of fourteen sets of a modified form of Nuffield-type apparatus (Fig. 15) with associated sliders offering various combinations of materials in contact.

Observations of the activity suggest, to the writer, that the work undertaken was of interest to all the children and there appeared to be a sense of purpose to the activity which separated it from the earlier 'good fun' aspects when using the friction-slide. A measure of the individual benefits gained by the children, however, is difficult to assess by such subjective appraisal and it was also difficult for the
FIG 14

ASSISTANCE IN READING THE PROTRACTOR

FIG 15

CALCULATION OF 'GRIP FACTORS' FROM OBSERVANCE BEHAVIOUR OF DIFFERENT MATERIALS
writer to establish to what extent the activities were contributory or responsible for their responses. However, there was a particular occasion when one child, a lad considered to be one of the less able members of the class, who exhibited an extraordinary level of commitment. His determination to establish values for the various 'grip numbers' continued throughout playtime and into the lunch period, at his own insistence, having been earlier proved to possess a pair of the 'grippiest' shoes in class with a grip number of 0.7.

4.1.5 Friction in Machines (1 x 1.5 hr. session) - Appendix III

The aim of this lesson was to establish that friction could be advantageous or a limitation to the effective operation of a machine. Following the identification of examples where friction occurred on the bicycle, comparisons were then made between ROAD RACER and BMX designs. Decisions were then prompted in connection with the possible improvements which might be made to the frictional resistance in existing design situations.

4.1.6 Efficient Performance (1 x 1.5 hr session) - Appendix III

Each child was given a rolling machine (Fig. 17) to race along a three metre stretch of the school hall floor. A knockout competition was organised for the various participants to practice their techniques. Individual discussion during the exercise disclosed various aspects of distance, acceleration, energy, power, speed, weight, grip, strength and elasticity. The majority of these elements are outside the confines of the study although they are given here to illustrate the valuable focus of attention which the activities appear to have developed.

Each child was then asked to modify their rolling machine for the purpose of increasing its performance for a second competition. The
FIG 16
COMPARISONS OF EXISTING DESIGNS

FIG 17
THE START OF A THREE METRE RACE
changes in design included modifications to the trailing rod length, elastic band, appearance (various decorations), surface texture and washing/soaking in water. Twelve of the children (86%) did address some technical aspects of design leaving the remaining two children (14%) comprising one child who chose to address only aesthetic aspects and another who did not attempt to change the design. From all the modifications observed there were only four attempts to change frictional properties (29%). It is now realised, with the benefit of hindsight, that more guidance or a restricted response would have promoted a higher proportion of children attempting to change the frictional resistance of some aspect of the basic design (Fig 18).

However, observations of the primary school activities gave clear illustration of cognitive leap between the levels of 'understanding' and 'application'. Some additional input in identifying examples of the inherent functional criteria would, perhaps, be beneficial. Other, more positive, observations were as follows:

(1) A 'quantitative' assessment is feasible at the primary stage, given the appropriate 'resources'.

(2) Levels of excitement can sometimes overshadow the underlying purpose of the exercise.

(3) The integrative nature of design-related activity can be used to illustrate the relevance and give practice in the application of other areas of the curriculum.

(4) The element of objectivity is also required in the assessment of future research instruments.

(5) The cognitive leap between the level of 'understanding' to that of 'application' would benefit from some additional input in identifying examples of the inherent functional criteria.
The time available was considered to be a restraint in limiting the opportunity to further illustrate the integrative nature of design-related activities - and the development of a technological problem-solving capability was regarded by the writer to go beyond the limits of the present investigation.

4.2 Secondary School Case Study

The following case study is also limited, in that the emphasis is specifically focussed upon the identification and appraisal of leverage and wedge actions in selected products. For this reason, the research proposals do not pretend or attempt to accommodate the initial formation of the basic principles addressed.

The aim of this section will be to establish if levels of Mechanical Acumen are influenced by exposure to relevant design-related activity and arrangements were made to access a sample group which had already undertaken a traditional study of the Principle of Moments, Friction and the Inclined Plane.

4.2.1 Subject and Sample Population

The choice of the sample resulted from careful negotiation of suitability of available groups with the head of the CDT department of Ilkeston School and was as follows:

<table>
<thead>
<tr>
<th>Subject</th>
<th>- C D T: Technology - Mechanisms (Midland Examining Group M.E.G.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage</td>
<td>- Fourth year</td>
</tr>
<tr>
<td>Sample</td>
<td>- Fourteen pupils (3 female + 11 male)</td>
</tr>
<tr>
<td>Average age</td>
<td>- 15 years</td>
</tr>
<tr>
<td>Accommodation</td>
<td>- C D T wood/metal workshop which included a study and teaching/demonstration area with O H P facility</td>
</tr>
</tbody>
</table>

The following input was given over a four week period through six consecutive double periods (i.e. 6 x 70 mins) which were normally
allocated to CDT studies in technology. It was considered to be a justifiable input in relation to its alignment with the MEG syllabus in CDT - Technology as it closely followed the need to evaluate given design solutions and to exercise judgement relating to appropriate functional, technological and aesthetic factors.

4.2.2 Product Mechanistics (session 1 - 70 mins) - Appendix IV

This first input session was introduced by making reference to the five ancient machines with which the sample were already familiar and went on to identifying the two inherent functions of leverage and wedge action. Various examples were used to suggest to the group that these two principles were a recurring element in many products to a greater or lesser extent.

The notion of 'noise' was then introduced to disclose the continuum of the development of products at one end and the derived principles at the other. It was this model which formed the basis of discussion around a number of Mechanisms which the sample had been working during previous weeks, prior to this additional input.

However, the confined experiences of the sample appeared to be inadequate and a limiting factor which did not allow for all the examples to be assessed in this way.

4.2.3 Performance of Levers (session 2 - 70 mins) - Appendix IV

The model door (Fig 4) was used to recapitulate the previous lesson by identifying where the two principles could be identified. The door closer's reliance on leverage for its operation was readily identified. This led to the use of the Principle of Moments as a useful concept and was further selected, in their own minds, establishing the force
exerted by the door closer arm. Clearly, an additional learning loop could be devised to develop the Principle of Moments with further practical activity although, in this particular instance was not the central aim.

With the aid of a spring balance attached to different points along the modified door closer (Fig 19) it was accepted by the children that the turning moment remained constant while the distances and forces changed in magnitude. The significance of this basic principle soon gained in appeal when force output predictions at specific arm lengths were requested. Further relevance resulted from requests to establish the precise force necessary to open the door.

4.2.4 Noisy Levers (session 3-70 mins) - Appendix IV

A review of the predictive power of the Principle of Moments gave credence to the later examination of a Crown-Top lifter (Fig. 20). The number of design features which made use of the Principle allowed an introduction to the analysis of the design of a similar Crown-Top lifter which was situated in one of the handles of a can opener (Fig. 21). The review which took place identified the functional criteria, surfaces and dimensions which were necessary considerations in order to establish an output/input amplification factor. This was then related back to the children's earlier studies of Mechanical Advantage. From their exhibited response, it was suggested that the children's studies were regarded to be much more relevant and meaningful through this practical 'hands-on' activity.

After some reflection on what had been achieved there was considerable interest and satisfaction shown by some of the children in their new realisation. Dimensional proportions were now seen in terms of the
FIG 18
THE BASIC AND MODIFIED ROLLING MACHINE

FIG 19
MODIFIED FORM OF DOOR CLOSER
FIG 20
CROWN TOP LIFTERS - A 'LOW LEVEL' EXAMPLE OF A 'NOISY' LEVER

FIG 21
RESOURCES AVAILABLE IN THE KITCHEN
functional criteria which could be used to predict a theoretical output. The possible inefficiencies which were generated by the frictional resistance were neglected at this stage.

The session was concluded by an appraisal of the estimated theoretical performance of a selection of fourteen Crown-Top lifter designs. Each pupil was individually responsible for his/her own individual estimate which promoted some very lively and valuable consolidatory discussion during the evaluation stage.

4.2.5 Performance of the Wedge (session 4 - 70 mins) - Appendix IV

The model door apparatus was used to study the performance of wedges by comparing the vertical and horizontal forces which were generated by different door wedges (Fig 23). It was readily realised, by the group, that the angle of inclination was the determining factor in generating the various proportions of the component forces.

The group experienced little difficulty in realising that an estimate of force amplification could be easily established by measurement and a study of proportions, in a similar way to the method used when earlier predicting leverage forces.

A number of practical design-related activities were then carried out to consolidate and give further practice in establishing estimates of this kind.

4.2.6 Noisy Wedges (session 5 - 70 mins) - Appendix IV

The intention during this session was to develop the group's ability to recognise increasingly 'noisy' examples of wedge action in products and to realise a more meaningful understanding of the performance of screw threads in use.
FIG 22
DECISIONS ON THE RELEVANT DIMENSIONS FOR THE PRODUCTS FUNCTIONAL OPERATION

FIG 23
APPARATUS TO SHOW THE HORIZONTAL/VERTICAL COMPONENT FORCES USING DIFFERENT WEDGES
Following a demonstration of its use on an available pedestal drilling machine, each pupil was given a drill drift to examine. The relationship between the earlier example of a door wedge and a drill drift presented no problem and estimates of theoretical force amplification were soon established.

Discussion was then developed around the various examples of wedge action which occurred on the drilling machine i.e. the Morse taper on the drill chuck, sleeves and taper shanks of drills. There was valuable discussion generated on the difference between the two tapers used in the milling machine stub arbor adaptor (Fig 24) giving additional insight into the reasons for their quite different values.

Examination of the two designs of playground slide (Figs 9 and 25) was used to introduce the geometric form of the helix and with the additional use of cardboard tubes the familiar triangular basis of the wedge action was realised.

It was a small step to follow up this development with an appreciation of the effect which diameter and pitch has on the locking and transmission qualities of screw threads and by the end of the session all children were successfully establishing their estimates of the theoretical mechanical advantage to be gained by given examples of screw thread. An illustration of this work is given in Appendix IV and by the comparisons to be drawn from the examinations of products with different helix angles, as shown in Fig 26. The predicted forces by the use of screws realised much more meaning and relevance from children who were suddenly achieving results for Mechanical Advantage of 40:1 instead of approximately 20:1 resulting from their earlier examination of the cardboard tube. It was at this stage when, in the
FIG 24

WORKSHOP EXAMPLES OF 'NOISY' WEDGE

FIG 25

PLAYGROUND SLIDES (SEE ALSO FIG 9) USED TO INTRODUCE THE GEOMETRY OF THE HELIX
writer's opinion, the development of quantitative assessments were beginning to pay dividends.

At this point the sample had been exposed to a variety of product ranging from the simple door wedge to tools and equipment using screw threads and tapers. The growing emphasis being placed upon the generated component forces in each example Figs. 27, 28 and 29 are given to identify the gradual reduced 'abstraction' or increased 'noise' which is possible.

The terminal objective of all these investigations was to objectively appraise the predicted functional performance by making comparisons of theoretical values of Mechanical Advantage. Comparisons throughout were, therefore, 'quantitative' in terms of the various input/output forces expected, from each of the products.

4.2.7 Product Evaluation (session 6 - 70 mins) - Appendix IV

The final session began by reviewing the salient points from all previous five lessons and the remainder of the time was devoted to the technical appraisal of selected products. This was achieved primarily through four design-related activities and a further selection of spanners and pliers which were additional items available for examination as the four exercises became completed to supplement the experience.

4.3 Limitations of the Case Study

The purpose of the case study was to investigate the effect of an alternative approach to the appraisal of products upon the levels of Mechanical Acumen exhibited by children.

However, due to the limited sample it has already been acknowledged that the findings will be restrictive and, therefore, preclude further
FIG 26
PRODUCT RANGE ILLUSTRATING THE ORIGINS OF THE WEDGE

FIG 27
EXAMPLES OF LOW 'NOISE'/HIGH ABSTRACTED WEDGE
FIG 28
PRACTICAL EXAMPLE OF HORIZONTAL INPUT FORCE BEING USED TO GENERATE AN INCREASED VERTICAL OUTPUT

FIG 29
EXAMPLES OF HIGH 'NOISE'/LOW ABSTRACTED WEDGE
generalisation. However, this limitation will not necessarily discredit or weaken the possible declarations relating to the value of the resources used or the resulting implications for introduction of more objective technical appraisals in schools. Clearly, the purpose of the Case Study is to evaluate the significance and viability of the alternative methods and resources just described. Moreover, the associated statistical analyses will, hopefully, provide a more objective conclusion to the study in establishing if levels of Mechanical Acumen had been modified.
The first task was to establish an objective means of establishing present levels of Mechanical Acumen. The time required in using an interview technique, similar to the Pilot Study, was a limitation which was considered too prohibitive and lead to the search for an alternative method. It was considered vital, however, to ensure that a standard input was preserved and also for each participant to make their individual appraisals using a three dimensional input. Although its dependence upon verbal reasoning skills was recognised, a test in written form appeared, to the writer, to be the most appropriate method in establishing such an assessment in the time available. Having found no test to suitably meet these special requirements, the writer devised an assessment test (Appendix V) for use at the commencement and termination of the design-related activities.

5.1. Data Collection

The test is arranged in three sections to assess diminishing levels of Mechanical Acumen. The first section was devised to establish the extent to which each of the sample responded to the technical issues of assessment. The second concentrates upon the ability in each respondent to identify the relevant inherent criteria and to calculate the theoretical amplifications which are generated by those specific principles. The final section again focusses upon the same principles although the degree of 'noise' generated is reduced to a minimum. In fact the three sections are arranged in diminishing 'noise' levels as it
was thought that an assessment in a reverse order may have suffered from leading the sample towards the required response.

No attempt at responding to the question paper was allowed until the tools and equipment referred to within each section were demonstrated.

All the instructions were given 'verbatim' from previously prepared guidance notes (Appendix V) in order to preserve a standard input between pre- and post-teaching. In addition to this, each pupil in the sample was furnished with examples of the two models of 'Yankee' screwdriver, the three models of Ball-Joint separating tool and the plastic aid to tighten bottle screw-tops in order to, simultaneously satisfy themselves of the operation and function of all tools referred to in the test when the complimentary guidance and instruction was being delivered. It was made clear that no instruction would be given as soon as the test had started.

The newly devised tests were administered in conjunction with the A H 4 Group Test of General Intelligence devised by Alice Hiem [91] and the Mechanical Reasoning Test [92] constructed by the Australian Council for Educational Research (ACER), for the purpose of norm referencing the sample group and to establish possible correlations.

The A H 4 group test of general intelligence is suitable for use with older children and involves a cross-section of interests. As in many tests of intelligence, the emphasis is largely on deductive reasoning and the aim of this test is to incorporate as many biases and principles as is consistent with a reasonably short test of twenty minutes. The test is administered in two equal parts comprising a total of 130 questions, Part I has a verbal/numeric bias and Part II a diagrammatic bias.
FIG. 30 PRODUCT RANGE USED IN THE ASSESSMENT OF MECHANICAL ACUMEN
FIG 31
PRODUCT DEMONSTRATIONS CARRIED OUT PRIOR TO TESTING

FIG 32
INDIVIDUAL ACCESS TO PRODUCTS WAS ACHIEVED THROUGH INDUSTRIAL SPONSORSHIPS
The ACER Mechanical Reasoning Test is designed to assess levels of aptitude for solving problems which require an understanding of mechanical ideas. The test does not attempt to tap mechanical knowledge or information but focusses on the reasoning aspects of mechanical aptitude or, the ability to visualise the relationship between moving parts. The time limit pronounced for all twenty-four questions is again twenty minutes.

5.2 Data Analysis

In order to establish a useful measure of General Intelligence, the AH4 results for the sample group were norm-referenced against known scores of comparable groups from both Secondary Modern and Grammar Schools [93]. However, no such comparison could be made with these groups, for the assessment of Mechanical Reasoning, due to the unavailability of suitable national data. Consequently, the results for this particular assessment were norm-referenced against known scores obtained from applicants for engineering apprenticeships in Britain [94].

A useful way of expressing the scores in relation to performance of a norm group was found to be by means of the percentile rank. The percentile rank was used to indicate the percentage of pupils within the sample group whose score on each test was at or below the corresponding raw score.

A correlation coefficient was also used to provide an estimate of the commonality between different tests. Perfect commonality would result in a correlation coefficient of +1, but in practice this is rarely achieved. Conversely, a coefficient of -1 would be a clear indicator of two tests measuring totally different characteristics i.e. the tests would be negatively correlated.
The statistical significance of any claimed relationship would clearly depend upon the size of the sample population. Larger samples will be given greater credence to the significance of any suggested correlation, but in seeking to establish the statistical significance of the generated Pearson Product-Moment Correlation Coefficients, any errors due to random sampling were accounted for and minimised by using a table of standard errors of measurement (Appendix VI), as a precautionary measure in determining the accuracy of the scores achieved.

5.3 Presentation of Results

A measure of the General Intelligence of the sample population was first established through the individual performance in the A H 4 test and a description of the results is given in Table (8). These results were norm-referenced against scores from groups of fourteen-year-old secondary modern (SM) and grammar school (GS) children and it appears that the sample group was above average ability.

<table>
<thead>
<tr>
<th>Name</th>
<th>Raw Score</th>
<th>(A)</th>
<th>(A-A)(A-A)²</th>
<th>(Za)</th>
<th>%ile(SM)</th>
<th>%ile(GS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Sarah</td>
<td>107</td>
<td>18</td>
<td>324</td>
<td>1.22</td>
<td>87</td>
<td>99</td>
</tr>
<tr>
<td>2. Richard</td>
<td>105</td>
<td>16</td>
<td>256</td>
<td>1.09</td>
<td>85</td>
<td>98</td>
</tr>
<tr>
<td>3. Bridget</td>
<td>102</td>
<td>13</td>
<td>169</td>
<td>0.88</td>
<td>80</td>
<td>98</td>
</tr>
<tr>
<td>4. Martin</td>
<td>98</td>
<td>9</td>
<td>81</td>
<td>0.61</td>
<td>71</td>
<td>97</td>
</tr>
<tr>
<td>5. Neil</td>
<td>97</td>
<td>8</td>
<td>64</td>
<td>0.54</td>
<td>68</td>
<td>97</td>
</tr>
<tr>
<td>6. Simon</td>
<td>88</td>
<td>-1</td>
<td>1</td>
<td>-0.07</td>
<td>48</td>
<td>90</td>
</tr>
<tr>
<td>7. James</td>
<td>86</td>
<td>-3</td>
<td>9</td>
<td>-0.20</td>
<td>43</td>
<td>89</td>
</tr>
<tr>
<td>8. Rachel</td>
<td>85</td>
<td>-4</td>
<td>16</td>
<td>-0.27</td>
<td>41</td>
<td>88</td>
</tr>
<tr>
<td>9. David</td>
<td>79</td>
<td>-10</td>
<td>100</td>
<td>-0.68</td>
<td>27</td>
<td>84</td>
</tr>
<tr>
<td>10. Charles</td>
<td>75</td>
<td>-14</td>
<td>196</td>
<td>-0.95</td>
<td>18</td>
<td>77</td>
</tr>
<tr>
<td>11. Brian</td>
<td>75</td>
<td>-14</td>
<td>196</td>
<td>-0.95</td>
<td>18</td>
<td>77</td>
</tr>
<tr>
<td>12. Anthony</td>
<td>55</td>
<td>-34</td>
<td>1156</td>
<td>-2.31</td>
<td>2</td>
<td>42</td>
</tr>
<tr>
<td>13. Daniel</td>
<td>Absent</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

(99)
However, the respective mean scores of A H 4 General Intelligence suggest a closer alignment with the former group albeit with an age differential of one year to consider. Suitable norms for the ACER Mechanical Reasoning Test proved even more difficult to find as the predominant use of the test, in the past, had apparently, been in vocational counselling and in the selection of apprentices. Nevertheless, the norms selected [88] do suggest, in Table (9) that the sample group was possibly a little above average for a group of fifteen-year-old school children. A statement of these basic abilities is made to assist the verification of the general pertinence of the following appraisal. Moreover, as the prominence of Mechanical Acumen could not be norm-referenced with any other group, all the following analyses make use of the norms which were generated by the group itself, in the hope of realising more useful comparisons.

<table>
<thead>
<tr>
<th>Name</th>
<th>Raw Score</th>
<th>$z$</th>
<th>$z^2$</th>
<th>%ile Group(1)</th>
<th>%ile Group(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Sarah</td>
<td>17</td>
<td>4</td>
<td>0.99</td>
<td>84</td>
<td>79</td>
</tr>
<tr>
<td>(3) Bridget</td>
<td>16</td>
<td>3</td>
<td>0.74</td>
<td>75</td>
<td>72</td>
</tr>
<tr>
<td>(6) Simon</td>
<td>15</td>
<td>2</td>
<td>0.49</td>
<td>67</td>
<td>64</td>
</tr>
<tr>
<td>(4) Martin</td>
<td>14</td>
<td>1</td>
<td>0.25</td>
<td>58</td>
<td>56</td>
</tr>
<tr>
<td>(5) Neil</td>
<td>14</td>
<td>1</td>
<td>0.25</td>
<td>58</td>
<td>56</td>
</tr>
<tr>
<td>(13) Daniel</td>
<td>13</td>
<td>0</td>
<td>0.00</td>
<td>50</td>
<td>48</td>
</tr>
<tr>
<td>(12) Anthony</td>
<td>12</td>
<td>-1</td>
<td>-0.25</td>
<td>42</td>
<td>40</td>
</tr>
<tr>
<td>(11) Brian</td>
<td>12</td>
<td>-1</td>
<td>-0.25</td>
<td>42</td>
<td>40</td>
</tr>
<tr>
<td>(10) Charles</td>
<td>12</td>
<td>-1</td>
<td>-0.25</td>
<td>42</td>
<td>40</td>
</tr>
<tr>
<td>(2) Richard</td>
<td>8</td>
<td>-5</td>
<td>-1.24</td>
<td>13</td>
<td>11</td>
</tr>
<tr>
<td>(7) James</td>
<td>7</td>
<td>-6</td>
<td>-1.49</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>(8) Rachel</td>
<td>7</td>
<td>-6</td>
<td>-1.49</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>(14) Kliener</td>
<td>Absent</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

TABLE (9)

RESULTS OF A C E R MECHANICAL REASONING TEST
(Mean score = 13) (Standard Deviation 4.04)
The case study was initiated and concluded by an assessment of the prominence of Mechanical Acumen in the sample and these findings are given in Tables (10) and (11). The scores were placed in rank order to illustrate individual prominence in capability, although the initial rankings taken from Table (10) illustrate that every individual within the sample showed an improvement. However, the significance of any suggested improvement is clearly in need of further analysis.

**TABLE (10)**

INITIAL ASSESSMENT OF MECHANICAL ACUMEN

(Mean Score = 5.07) (Standard Deviation = 2.33)

<table>
<thead>
<tr>
<th>Name</th>
<th>Raw Score</th>
<th>%age</th>
<th>(Zx)</th>
<th>Group %ile</th>
<th>Group Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>David</td>
<td>11</td>
<td>46</td>
<td>2.54</td>
<td>99</td>
<td>1</td>
</tr>
<tr>
<td>Anthony</td>
<td>7</td>
<td>29</td>
<td>0.83</td>
<td>78</td>
<td>2</td>
</tr>
<tr>
<td>Kliener</td>
<td>6</td>
<td>25</td>
<td>0.40</td>
<td>64</td>
<td>3</td>
</tr>
<tr>
<td>Richard</td>
<td>6</td>
<td>25</td>
<td>0.40</td>
<td>64</td>
<td>3</td>
</tr>
<tr>
<td>Sarah</td>
<td>6</td>
<td>25</td>
<td>0.40</td>
<td>64</td>
<td>3</td>
</tr>
<tr>
<td>Mean Scores</td>
<td>(5.07)</td>
<td>(21)</td>
<td>(0.00)</td>
<td>(50)</td>
<td>(5.3)</td>
</tr>
<tr>
<td>Daniel</td>
<td>5</td>
<td>20</td>
<td>-0.03</td>
<td>49</td>
<td>6</td>
</tr>
<tr>
<td>Neil</td>
<td>5</td>
<td>20</td>
<td>-0.03</td>
<td>49</td>
<td>6</td>
</tr>
<tr>
<td>Rachel</td>
<td>5</td>
<td>20</td>
<td>-0.03</td>
<td>49</td>
<td>6</td>
</tr>
<tr>
<td>Brian</td>
<td>4</td>
<td>17</td>
<td>-0.46</td>
<td>34</td>
<td>9</td>
</tr>
<tr>
<td>Bridget</td>
<td>4</td>
<td>17</td>
<td>-0.46</td>
<td>34</td>
<td>9</td>
</tr>
<tr>
<td>Charles</td>
<td>4</td>
<td>17</td>
<td>-0.46</td>
<td>34</td>
<td>9</td>
</tr>
<tr>
<td>James</td>
<td>2</td>
<td>8</td>
<td>-1.32</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Martin</td>
<td>1</td>
<td>4</td>
<td>-1.74</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>Simon</td>
<td>Absent</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

(101)
Comparison of individual percentile scores and rankings do not indicate any significant relationship between Mechanical Acumen and the other measures of Reasoning Ability. Although, the results given in table (12) herald the need for further comparisons to be made between initial and final scores in Mechanical Acumen and the standard measures of Reasoning Ability through the A H 4 and A C E R ability tests.
### TABLE (12)

**GROUP PERFORMANCE IN ALL MEASURES**

<table>
<thead>
<tr>
<th>Name</th>
<th>Final (Zy)</th>
<th>Initial (Zx)</th>
<th>Mechanical Acumen</th>
<th>Reasoning Ability</th>
<th>ACER (Zb)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%ile (rank)</td>
<td>%ile (rank)</td>
<td></td>
<td></td>
<td>%ile (rank)</td>
</tr>
<tr>
<td>David</td>
<td>90</td>
<td>(1=)</td>
<td>99 (1)</td>
<td>41 (9)</td>
<td>98 (1)</td>
</tr>
<tr>
<td>Sarah</td>
<td>90</td>
<td>(1=)</td>
<td>64 (3)</td>
<td>87 (1)</td>
<td>84 (2)</td>
</tr>
<tr>
<td>Niel</td>
<td>86</td>
<td>(3 )</td>
<td>49 (6=)</td>
<td>71 (5)</td>
<td>58 (5=)</td>
</tr>
<tr>
<td>Anthony</td>
<td>78</td>
<td>(4=)</td>
<td>78 (2 )</td>
<td>18 (11=)</td>
<td>42 (8=)</td>
</tr>
<tr>
<td>Bridget</td>
<td>78</td>
<td>(4=)</td>
<td>84 (9=)</td>
<td>85 (2=)</td>
<td>75 (3=)</td>
</tr>
<tr>
<td>Simon</td>
<td>68</td>
<td>(6 )</td>
<td>Absent N/A</td>
<td>68 (6 )</td>
<td>67 (4=)</td>
</tr>
<tr>
<td>Kliener</td>
<td>46</td>
<td>(7=)</td>
<td>64 (3=)</td>
<td>Absent N/A</td>
<td>Absent N/A</td>
</tr>
<tr>
<td>Richard</td>
<td>46</td>
<td>(7=)</td>
<td>64 (3=)</td>
<td>85 (2=)</td>
<td>13 (11)</td>
</tr>
<tr>
<td>James</td>
<td>35</td>
<td>(9 )</td>
<td>12 (12)</td>
<td>48 (7 )</td>
<td>9 (12=)</td>
</tr>
<tr>
<td>Daniel</td>
<td>24</td>
<td>(10)</td>
<td>49 (6=)</td>
<td>2 (13)</td>
<td>50 (7=)</td>
</tr>
<tr>
<td>Charles</td>
<td>11</td>
<td>(11)</td>
<td>34 (9=)</td>
<td>27 (10)</td>
<td>42 (8=)</td>
</tr>
<tr>
<td>Brian</td>
<td>6</td>
<td>(12=)</td>
<td>34 (9=)</td>
<td>18 (11=)</td>
<td>42 (8=)</td>
</tr>
<tr>
<td>Martin</td>
<td>6</td>
<td>(12=)</td>
<td>6 (13)</td>
<td>80 (4 )</td>
<td>58 (5=)</td>
</tr>
<tr>
<td>Rachel</td>
<td>Absent</td>
<td>N/A</td>
<td>49 (6=)</td>
<td>43 (8 )</td>
<td>9 (12=)</td>
</tr>
</tbody>
</table>

5.4 Interpretation of Results

The suggested paucity in capability, as defined through the earlier pilot study of Mechanical Acumen, was confirmed [21% average in Table (10)] in the secondary sample population. The improvement in performance [48% average in Table (11)] is also suggested to be the result of the design-related activities as propagated through the secondary case study. Indeed, there is evidence to suggest that the internal processes of the sample in spatial reasoning capability and the manipulation of verbal/numeric data, within the parameters of the A h 4 tests, did not appear to be a strong feature during the initial technical judgements made by the sample. A correlation coefficient of +0.43, between measures of Mechanical Acumen at the post-test stage (Zy) and the scores in the A H 4 tests (Za), is also an indication that these later appraisals were more objectively based. However, correlation coefficients of +0.57 do initially suggest that a closer
relationship existed between measures of mechanical reasoning ability and Mechanical Acumen than the verbal/numeric measures of the A H 4 tests. Furthermore, the uniformity of the correlations made between both measures of Mechanical Acumen (Zx and Zy) and the A C E R (Zb) tests is further endorsement to the argument that judgements made in the post-testing of Mechanical Acumen were more closely based on verbal/numeric data input. All this is regarded as clear evidence, by the writer, that the benefits from design-related activities, as nominated through this particular action-research, were quite positively related to the verbal/numeric and diagrammatic reasoning abilities as measured by the A H 4 Group Test of General Intelligence.

Moreover, the recording of a positive correlation of 0.66, between the improvement in Mechanical Acumen (Zd) and scores on the A H 4 tests (Za), gives further credence to the writer's suggestion for additional emphasis to be given in similar design-related activity in schools. This further argues the need for an integration of these, and possibly other, basic principles within the curricula of physics and technology, through the practical examination of manufactured products.

The improvements given in Table (13) might initially suggest that the research activity was directly instrumental in developing levels of Mechanical Acumen although this suggestion would disregard other factors which may have influenced the outcome. Both pre- and post-tests were the same and familiarity with the material presented, and with the general testing situation on the second occasion, could have enhanced performance to some extent. In addition to the suggested increase in Mechanical Acumen, it is interesting to reflect on the changes in the rankings which are displayed in Table (11).
research activities appear to have influenced the group dynamics of the sample although, the results shown in Table (12), do not indicate any clear relationship between these changes and other measures of reasoning ability. This suggests that other measures, such as spatial ability reasoning powers, might have been relevant in establishing the possible reasons for these changes. Additional evidence is gathered in Tables (14) and (15) however, which might suggest a significant correlation between gains in Mechanical Acumen and the reasoning abilities established by the A H 4 test although further examination of the individual performances do introduce an element of doubt as to the significance of this possible correlation (see Appendix VI).

TABLE (13)

IMPROVEMENTS IN MECHANICAL ACUMEN

<table>
<thead>
<tr>
<th>Name</th>
<th>Raw Score</th>
<th>Raw Score</th>
<th>Diff.</th>
<th>Z Score</th>
<th>%ile</th>
<th>Group Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(2)-(1)</td>
<td>(Zd)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bridget</td>
<td>4</td>
<td>13</td>
<td>9</td>
<td>1.43</td>
<td>90</td>
<td>(9)(4)</td>
</tr>
<tr>
<td>Neil</td>
<td>5</td>
<td>14</td>
<td>9</td>
<td>1.43</td>
<td>90</td>
<td>(6)(8)</td>
</tr>
<tr>
<td>Sarah</td>
<td>6</td>
<td>15</td>
<td>9</td>
<td>1.43</td>
<td>90</td>
<td>(8)(1)</td>
</tr>
<tr>
<td>James</td>
<td>2</td>
<td>9</td>
<td>7</td>
<td>0.68</td>
<td>73</td>
<td>(12)(9)</td>
</tr>
<tr>
<td>Anthony</td>
<td>7</td>
<td>13</td>
<td>6</td>
<td>0.31</td>
<td>61</td>
<td>(2)(4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(5.16)</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>David</td>
<td>11</td>
<td>15</td>
<td>4</td>
<td>-0.44</td>
<td>35</td>
<td>(1)(1)</td>
</tr>
<tr>
<td>Kliener</td>
<td>6</td>
<td>10</td>
<td>4</td>
<td>-0.44</td>
<td>35</td>
<td>(3)(7)</td>
</tr>
<tr>
<td>Martin</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>-0.44</td>
<td>35</td>
<td>(13)(12)</td>
</tr>
<tr>
<td>Richard</td>
<td>6</td>
<td>10</td>
<td>4</td>
<td>-0.44</td>
<td>35</td>
<td>(3)(7)</td>
</tr>
<tr>
<td>Daniel</td>
<td>5</td>
<td>8</td>
<td>3</td>
<td>-0.81</td>
<td>22</td>
<td>(6)(10)</td>
</tr>
<tr>
<td>Charles</td>
<td>4</td>
<td>6</td>
<td>2</td>
<td>-1.19</td>
<td>13</td>
<td>(9)(11)</td>
</tr>
<tr>
<td>Brian</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>-1.56</td>
<td>8</td>
<td>(9)(12)</td>
</tr>
<tr>
<td>Rachel</td>
<td>5</td>
<td>Absent</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>(6)(-)</td>
</tr>
<tr>
<td>Simon</td>
<td>Absent</td>
<td>12</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>(-)(6)</td>
</tr>
</tbody>
</table>

(105)
### TABLE (14)
**CORRELATION OF MECHANICAL ACUMEN WITH STANDARD MEASURES**

<table>
<thead>
<tr>
<th>Name</th>
<th>Mechanical Acumen</th>
<th>A H 4</th>
<th>ACER</th>
<th>Product Moment Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Zy)</td>
<td>(Zx)</td>
<td>(Za)</td>
<td>(Zb)</td>
</tr>
<tr>
<td>David</td>
<td>1.47</td>
<td>2.54</td>
<td>-0.27</td>
<td>2.23</td>
</tr>
<tr>
<td>Sarah</td>
<td>1.47</td>
<td>0.40</td>
<td>1.22</td>
<td>0.99</td>
</tr>
<tr>
<td>Neil</td>
<td>1.15</td>
<td>-0.03</td>
<td>0.61</td>
<td>0.25</td>
</tr>
<tr>
<td>Anthony</td>
<td>0.83</td>
<td>0.83</td>
<td>-0.95</td>
<td>-0.25</td>
</tr>
<tr>
<td>Bridget</td>
<td>0.83</td>
<td>-0.46</td>
<td>1.09</td>
<td>0.74</td>
</tr>
<tr>
<td>Simon</td>
<td>0.52</td>
<td>Absent</td>
<td>0.54</td>
<td>0.49</td>
</tr>
<tr>
<td>Kliener</td>
<td>-0.12</td>
<td>0.40</td>
<td>Absent</td>
<td>Absent</td>
</tr>
<tr>
<td>Richard</td>
<td>-0.12</td>
<td>0.40</td>
<td>1.09</td>
<td>-1.24</td>
</tr>
<tr>
<td>James</td>
<td>-0.44</td>
<td>-1.32</td>
<td>-0.07</td>
<td>-1.49</td>
</tr>
<tr>
<td>Daniel</td>
<td>-0.76</td>
<td>-0.03</td>
<td>-2.31</td>
<td>0.00</td>
</tr>
<tr>
<td>Charles</td>
<td>-1.39</td>
<td>-0.46</td>
<td>-0.68</td>
<td>-0.25</td>
</tr>
<tr>
<td>Brian</td>
<td>-1.71</td>
<td>-0.46</td>
<td>-0.95</td>
<td>-0.25</td>
</tr>
<tr>
<td>Martin</td>
<td>-1.71</td>
<td>-1.74</td>
<td>0.88</td>
<td>0.25</td>
</tr>
<tr>
<td>Rachel</td>
<td>Absent</td>
<td>-0.03</td>
<td>-0.20</td>
<td>-1.49</td>
</tr>
</tbody>
</table>

Product-Moment Correlation Coeff's (r)

<table>
<thead>
<tr>
<th></th>
<th>(-1.68)</th>
<th>(6.81)</th>
<th>(5.21)</th>
<th>(6.84)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.14</td>
<td>0.57</td>
<td>0.43</td>
<td>0.57</td>
</tr>
</tbody>
</table>

### TABLE (15)
**CORRELATION OF IMPROVEMENTS IN MECHANICAL ACUMEN WITH STANDARD MEASURES**

(N = 11)

<table>
<thead>
<tr>
<th>Name</th>
<th>Mechanical Acumen Gains</th>
<th>A H 4</th>
<th>ACER</th>
<th>Product Moment Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Zd)</td>
<td>(Za)</td>
<td>(Zb)</td>
<td>(ZdZa)</td>
</tr>
<tr>
<td>Bridget</td>
<td>1.43</td>
<td>1.09</td>
<td>0.74</td>
<td>1.56</td>
</tr>
<tr>
<td>Neil</td>
<td>1.43</td>
<td>0.61</td>
<td>0.25</td>
<td>0.87</td>
</tr>
<tr>
<td>Sarah</td>
<td>1.43</td>
<td>1.22</td>
<td>0.99</td>
<td>1.74</td>
</tr>
<tr>
<td>James</td>
<td>0.68</td>
<td>-0.07</td>
<td>-1.49</td>
<td>-0.05</td>
</tr>
<tr>
<td>Anthony</td>
<td>0.31</td>
<td>-0.95</td>
<td>-0.25</td>
<td>-0.29</td>
</tr>
<tr>
<td>David</td>
<td>-0.44</td>
<td>-0.27</td>
<td>2.23</td>
<td>0.12</td>
</tr>
<tr>
<td>Kliener</td>
<td>-0.44</td>
<td>Absent</td>
<td>Absent</td>
<td>N/A</td>
</tr>
<tr>
<td>Martin</td>
<td>-0.44</td>
<td>0.88</td>
<td>0.25</td>
<td>-0.39</td>
</tr>
<tr>
<td>Richard</td>
<td>-0.44</td>
<td>1.09</td>
<td>-1.24</td>
<td>-0.48</td>
</tr>
<tr>
<td>Daniel</td>
<td>-0.81</td>
<td>-2.31</td>
<td>0.00</td>
<td>1.87</td>
</tr>
<tr>
<td>Charles</td>
<td>-1.19</td>
<td>-0.68</td>
<td>-0.25</td>
<td>0.81</td>
</tr>
<tr>
<td>Brian</td>
<td>-1.56</td>
<td>-0.95</td>
<td>-0.25</td>
<td>1.48</td>
</tr>
<tr>
<td>Rachel</td>
<td>N/A</td>
<td>-0.20</td>
<td>-1.49</td>
<td>N/A</td>
</tr>
<tr>
<td>Simon</td>
<td>N/A</td>
<td>0.54</td>
<td>0.49</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Product-Moment Correlation Coefficients (r)

<table>
<thead>
<tr>
<th></th>
<th>(7.24)</th>
<th>(1.37)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.66</td>
<td>0.12</td>
</tr>
</tbody>
</table>

(106)
There was no evidence of any statistical significance in the Correlation Coefficients between Mechanical Acumen and the standard measures of the A H 4 and ACER tests. It was, therefore, concluded that all three tests were, to a large extent, undertaking measures of quite different types of ability.

The improvement in levels of Mechanical Acumen which were recorded between pre- and post-testing proved, on the other hand, very significant at the 99% level. The results in Table (14) do show that the sample had addressed both tests in quite different ways. The correlations between A H 4 measures (Za) and both tests of Mechanical Acumen (Zx and Zb) showed a marked positive movement in their respective correlations (from -0.14 to +0.43). Simultaneously the relationship between ACER measures and both tests of Mechanical Acumen remained at a constant 0.57.

This again endorses the writers suggestion that the sample did not follow an objective appraisal of the products under examination during the pre-test, and serves as further confirmation of the positive influence which the related activity may have had upon the suggested improvement made in Mechanical Acumen. An indication, perhaps, that the treatment of the subjects in school might benefit from some review. Incidentally, although not well documented, the writer has observed further trials which suggest similar deficiencies exist in the tertiary sector. The ability of students (and some teachers) to 'think on their feet' was rarely demonstrated and serves to further endorse that this investigation has illustrated the need for additional detailed investigation and research. Nonetheless, there are several additional points of significance and interest on which further comment should be made.
CHAPTER (5) REFERENCES


CHAPTER 6
REVIEW

The initial proposal to examine the prevalence of Mechanical Acumen was necessarily very specific in focus and statements of any broad generalisations which might be drawn from any observations made were limited to the samples used in the study. Small-scale action research of this nature has always suffered from this particular limitation although findings from such work can be useful in identifying the possible harbingers for more extensive studies.

The observations which have been made during this study, comprising the initial pilot study, the primary trials and the secondary case study have all, in the writer's view, included evidence of a shortcoming in the children sampled to bring together the knowledge of physics, technology, mathematics and design, in a way that enables them to make coherent and informed judgements about everyday products around them. Through the explicit pursuit of Mechanical Acumen such judgements have emphasised the more 'technical' aspects of design and, as a result of this, the study has advanced the more technically related aspects of the curriculum. Notwithstanding the more 'aesthetic', 'economic', and 'moral' aspects of design, all of which are regarded by the writer to be of equal significance, the initial notion of assessing and developing Mechanical Acumen is regarded as optimistic and not such a clear-cut affair as perhaps first envisaged. Indeed, the pattern of the whole investigation towards product-driven, design-related activity, has been directly instrumental in identifying some interesting
revelations for further study; all of which can be broadly described by the following observations:

There was clear evidence, throughout all parts of the investigation, that initial levels of Mechanical Acumen were low. The pilot study in surveying children throughout the complete school range of technology courses gave an early indication of this deficiency and more objective measures from the remainder of the investigation endorsed the need to further examine the prominence of this capability in other groups.

The proposed improvements in performance which were shown between pre- and post-testing suggests that Mechanical Acumen is not an inherited ability and can, therefore, be acquired and learned by pertinent experience in school. Following the pursuit of design-related activities as promulgated throughout this study, improvements in this capability were in clear evidence. Furthermore, it is suggested that this reformation was the result of individuals changing their judgemental perspectives, having failed initially to address the objective appraisal of products they now employed quantitative criteria in their assessment of the more technical elements of product design.

It can be argued that there are other inherent abilities which are generated by individual experiences prior to pre-testing which would have had their own effect upon the scores. It has already been noted that although levels of Mechanical Acumen did not show a statistically significant relationship with the understanding of mechanical ideas, the improvements which were suggested to be the result of exposure to such design-related activities might equally have been the result of inherent powers of verbal/numeric reasoning. There is a clear relationship between them and the results should, consequently,
be interpreted with some care.

There was no evidence from the analysis of the results that the understanding of scientific concepts was improved by design-related activity. Clearly, the parameters of the investigation did not allow for such an assessment. In review, there were three main points identified for possible action as it was initially suggested that individuals had:

- either (a) NOT established a good grasp of the basic underlying principles.
- and/or (b) NOT appreciated the ways in which the principles were embedded into the products.
- and/or (c) NOT acquired the necessary levels of cognitive functioning to establish a quantitative assessment of each principle.

The time necessary to address all three aspects was a practical constraint which would not allow as comprehensive a treatment to the problem as first envisaged. In fact, the sample's grasp of the underlying principles in the secondary school trials relied totally upon this knowledge being established prior to the development of sections (b) and (c).

Moreover, the capability for pupils to think through the implications of basic geometrical detail upon the functional performance of products did not initially appear to be a priority in the sampled secondary school. Indeed, due to the levels of cognitive functioning necessary, such activity was considered suitable only for fourteen year old's of above average ability. More generally, such appraisals were observed to be positively discouraged in syllabuses of modular technology. Notwithstanding that this investigation has clearly demonstrated that, given an 'alternative' type of apparatus, an early involvement in meaningful and objective technical appraisals is now, perhaps, a feasible remit for children in primary schools.

(111)
The Slip/Grip apparatus was certainly successful in promoting an objective appraisal of frictional resistance. Furthermore, the children did not appear to find the realisation of the concept of a frictional coefficient to be a problem although it must be emphasised that this is a value judgement held by the writer and based entirely upon a total absence of any scientific evidence. However, the concept is argued to have been so graphically illustrated through the mode of practical experience, that any difficulties encountered by children were readily overcome during the directed private study which followed the experiential learning period.

The integrative powers of this practical approach does appear to promote an enthusiasm and purpose for study. The levels of motivation which were generated through such cross-curricula pursuits was no more clearly illustrated than in the primary sector trials during the broad investigation into the 'grippiest' shoes in class. There was additional opportunity, during this activity, to introduce and practice the technical vocabulary, communication skills and personal qualities which have been in the past, perhaps, more normally associated with the 'hidden' curriculum. In addition, there was some related practice of the four basic arithmetic functions and appraisals were objectively based upon quantitative data gleaned from each of the sample's individual personal experience and involvement in purposeful investigation. More specifically, the activity disclosed a practical and working relevance of right-angled and similar triangles, proportion, parallelism, straightness, inclined, horizontal and vertical planes, and an objective understanding of the concept of frictional resistance which may not have been realised by children before.
The evidence emanating from this investigation endorses the view, which is illustrated in many papers and publications, that the present practice of treating the traditional subject areas of physics, mathematics, technology and design in separate and water-tight compartments is of questionable value. Clearly, the suggested process of integration is not regarded here to be more suitable for any one specific or particular ability range. Furthermore, the evidence from this investigation does suggest that the integration of such studies is both a possible and desirable feature of a general education for all children.

This investigation has identified the need for further research into ways in which children's school experiences can be organised and employed to develop their personal levels of Mechanical Acumen. The development of a comprehensive Taxonomy of Mechanical Acumen, in the form of a hierarchial classification of 'noisy' products, is another interesting idea which is worthy of further development. This 'alternative' approach which addresses the children's practical design experience appears to be a most suitable vehicle for achieving a workable integration of subjects. The investigation into this type of activity during this study has clearly illustrated that some of the more able children have not achieved a useful working knowledge of their studies. It could be argued at the general level, therefore, that the treatment of such school subjects as mathematics, science and technology has become too academic and too far removed from the application of such basic concepts to the practical situations found in everyday life.

It is the writer's opinion that an attempt should be made to establish a more meaningful understanding of the basic mechanical concepts which are identified in general education, as an essential feature of national
curriculum reforms. For the present, however, the writer advocates more extensive studies into the development of a structured core of product-driven, design-related activity.

(2) [8] Ibid., p.4.


(4) [60] Ibid., pp. 6-7


(7) [5] Ibid.


(9) [74] BULLOCK REPORT (1975) *A Language for Life*. HMSO. p.141.


(11) [16] Ibid., p.37.

(12) [17] Ibid., p.391.

(13) [18] Ibid., p.394.

(14) [19] Ibid., p.394.

(15) [20] Ibid., p.394.

(16) [21] Ibid., p.468.


(116)
(20) [76] Ibid., para.3.14. p.8.
(21) [82] Ibid., para.3.16, 3.18 and 3.21 pp. 9-11.
(22) [83] Ibid., para.3.45 pp. 22-23.
(24) [81] Ibid.
(26) [77] Ibid.
(32) [43] Ibid., para. 4.8.
(34) [90] Ibid., p.58.
(35) [73] Ibid., p.59.
(36) [72] Ibid., p.79.

(42) [86] Ibid., p.8.

(43) [87] Ibid., p.9.


(46) [28] Ibid., p.5.


(48) [93] Ibid., p.9.


(54) [23] Ibid., pp. 68-70.

(55) [25] Ibid., p.68.

(56) [24] Ibid., p.69.

(57) [26] Ibid., p.69.


(65) [10] Ibid., p.25.


(67) [30] Ibid.


(70) Ibid., pp. 3-14


(72) [47] Ibid., p.14.


(74) [54] Ibid., pp. 9 - 10.

(75) [55] Ibid., p.9.

(76) [56] Ibid., pp. 12 - 15.

(77) [88] Ibid., p.9.

(78) [89] Ibid., p.6.

(80) [36] Ibid., p.2.


(82) [58] Ibid., p.7.


(84) [59] Ibid., pp. 15 - 16.


(87) [40] TIMES EDUCATIONAL SUPPLEMENT. (1.1.85). No. 3618. p.2.

(88) [41] Ibid.

(89) [48] TIMES EDUCATIONAL SUPPLEMENT (27.06.86). No.3652. p.11.

(90) [75] TIMES EDUCATIONAL SUPPLEMENT (1.1.88) No. 3731. p.18.


APPENDIX 1

PILOT STUDY INTERVIEW SCHEDULE
INTERVIEW SCHEDULE

Name: ___________________________ Gender: Male / Female

Birth Date: ______________________

Form: 1st / 2nd / 3rd / 4th / 5th / 6th

Interview Date: ________________ Interview Number: __________

Subject: _________________________

**** Commence RECORDING now ****

Preliminary Introduction

(a) I am talking to a lot of children/students in school/college about the different containers used at home and some of the tools necessary to open them.

(b) The result of these talks will hopefully form the basis of some future projects in school/college.

(c) However, you have my total assurance that the source of our discussion will be regarded as strictly confidential.

Are you happy to continue?
PILOT STUDY PRODUCT RANGE

(i) List of Tools

1.0 Crown Top Lifters

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
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</tr>
<tr>
<td>1.2</td>
<td>Mackeson</td>
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<td>1.3</td>
<td>Monarch</td>
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<tr>
<td>1.4</td>
<td>Kingcraft</td>
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<tr>
<td>1.5</td>
<td>Red Handled</td>
</tr>
<tr>
<td>1.6</td>
<td>Wooden Handled</td>
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2.0 Can Openers (Butterfly)

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>2.1</td>
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</tr>
<tr>
<td>2.2</td>
<td>Reg. Des. 824822 (red)</td>
</tr>
<tr>
<td>2.3</td>
<td>Squires</td>
</tr>
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3.0 Can Openers (Butterfly with Corkscrew)

<p>| | |</p>
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</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Probus</td>
</tr>
<tr>
<td>3.2</td>
<td>English (Tool Steel Tampered)</td>
</tr>
<tr>
<td>3.3</td>
<td>Made in China</td>
</tr>
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</table>

4.0 Can Openers (Rotary)

<p>| | |</p>
<table>
<thead>
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<tbody>
<tr>
<td>4.1</td>
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</tr>
<tr>
<td>4.2</td>
<td>WL Housewares</td>
</tr>
<tr>
<td>4.3</td>
<td>Probus Corniche</td>
</tr>
<tr>
<td>4.4</td>
<td>Probus</td>
</tr>
<tr>
<td>4.5</td>
<td>Skyline</td>
</tr>
<tr>
<td>4.6</td>
<td>Probus (plastic handle)</td>
</tr>
</tbody>
</table>

5.0 Cork Extractors

<p>| | |</p>
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<tr>
<th></th>
<th></th>
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<tbody>
<tr>
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<td>Waiter's</td>
</tr>
<tr>
<td>5.2</td>
<td>Imp</td>
</tr>
<tr>
<td>5.3</td>
<td>Apperlee</td>
</tr>
<tr>
<td>5.4</td>
<td>Corkette</td>
</tr>
<tr>
<td>5.5</td>
<td>Italian (Butterfly lever)</td>
</tr>
<tr>
<td>5.6</td>
<td>T-Bar</td>
</tr>
</tbody>
</table>

6.0 Jar Openers

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1</td>
<td>Sieger</td>
</tr>
<tr>
<td>6.2</td>
<td>Brabantia</td>
</tr>
<tr>
<td>6.3</td>
<td>Japan</td>
</tr>
</tbody>
</table>
(1) Which one of the kitchen tools on display do you use at home?

(2) Are there any others which you have not seen before?

DEMONSTRATE IF NECESSARY

(3) I want you to imagine that you replacing some old kitchen tools. You need some means of opening the following:

(a) Crown Tops
(b) Metal Cans
(c) Corked bottles

**** Choose which articles you would buy ****

<table>
<thead>
<tr>
<th>1.1</th>
<th>1.2</th>
<th>1.3</th>
<th>1.4</th>
<th>1.5</th>
<th>1.6</th>
<th>2.1</th>
<th>2.2</th>
<th>2.3</th>
<th>3.1</th>
<th>3.2</th>
<th>3.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4.1</th>
<th>4.2</th>
<th>4.3</th>
<th>4.4</th>
<th>4.5</th>
<th>4.6</th>
<th>5.1</th>
<th>5.2</th>
<th>5.3</th>
<th>5.4</th>
<th>5.5</th>
<th>5.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
<td>17</td>
<td>18</td>
<td>19</td>
<td>20</td>
<td>21</td>
<td>22</td>
<td>23</td>
<td>24</td>
</tr>
</tbody>
</table>

"3 SEPARATE TOOLS" and "RECORD NOW"
(4) Discuss the reasons for choosing the items selected.

<table>
<thead>
<tr>
<th>ENTER CHOICES HERE</th>
<th>Primary Reference Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aesthetic</td>
</tr>
<tr>
<td>(a)</td>
<td>25</td>
</tr>
<tr>
<td>(b)</td>
<td>29</td>
</tr>
<tr>
<td>(c)</td>
<td>33</td>
</tr>
</tbody>
</table>

(5) Describe how each operates?

(a) .................................................................

(b) .................................................................

(c) .................................................................

(6) Are there any here that you have NOT seen before?

**** DEMONSTRATE IF NECESSARY ****
(7) If your choice of Can Opener was limited to these products, which would you choose?

Butterfly Can Opener (standard)

<table>
<thead>
<tr>
<th></th>
<th>2.1</th>
<th>2.2</th>
<th>2.3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Circle Choice -------

(8) Discuss the reasons for choosing the items selected

<table>
<thead>
<tr>
<th>ENTER CHOICES HERE</th>
<th>Aesthetic</th>
<th>Economic</th>
<th>Moral</th>
<th>Technical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>41</td>
<td>42</td>
<td>43</td>
</tr>
</tbody>
</table>

-6-
(9) If your choice of Can Opener was limited to these products, which would you choose?

<table>
<thead>
<tr>
<th>Butterfly with Corkscrew</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 3.2 3.3</td>
</tr>
</tbody>
</table>

Circle Choice ----------------> 44 45 46

(10) Discuss the reasons for choosing the items selected

<table>
<thead>
<tr>
<th>Primary Reference Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENTER CHOICES HERE</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ENTER CHOICES HERE</th>
<th>Aesthetic</th>
<th>Economic</th>
<th>Moral</th>
<th>Technical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>47</td>
<td>48</td>
<td>49</td>
<td>50</td>
</tr>
</tbody>
</table>
(11) If your choice of Can Opener was limited to these products, which would you choose?

<table>
<thead>
<tr>
<th>Rotary Can Openers</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 4.2 4.3 4.4 4.5 4.6</td>
</tr>
</tbody>
</table>

Circle Choice

(12) Discuss the reasons for choosing the item selected

<table>
<thead>
<tr>
<th>Primary Reference Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENTER CHOICE HERE</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Aesthetic</th>
<th>Economic</th>
<th>Moral</th>
<th>Technical</th>
</tr>
</thead>
<tbody>
<tr>
<td>57</td>
<td>58</td>
<td>59</td>
<td>60</td>
</tr>
</tbody>
</table>
(13) Examine the three examples of kitchen tools to overcome the problem of right screw tops. Which do you prefer.

6.1  6.2  6.3
Circle Choice -----------------> 61  62  63

(14) Discuss the reasons for choosing the item selected.

Primary Preference Criteria

<table>
<thead>
<tr>
<th>Aesthetic</th>
<th>Economic</th>
<th>Moral</th>
<th>Technical</th>
</tr>
</thead>
<tbody>
<tr>
<td>64</td>
<td>65</td>
<td>66</td>
<td>67</td>
</tr>
</tbody>
</table>

(15) Which of the three products do you consider to be the worst?

6.1  6.2  6.3
Circle Choice -----------------> 68  69  70

(16) Discuss the reasons for choosing the item selected.

Primary Preference Criteria

<table>
<thead>
<tr>
<th>Aesthetic</th>
<th>Economic</th>
<th>Moral</th>
<th>Technical</th>
</tr>
</thead>
<tbody>
<tr>
<td>71</td>
<td>72</td>
<td>73</td>
<td>74</td>
</tr>
</tbody>
</table>
(17) How would you improve this product?

<table>
<thead>
<tr>
<th>Primary Preference Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aesthetic</td>
</tr>
<tr>
<td>75</td>
</tr>
</tbody>
</table>
(18) Container lids are sometimes very difficult to remove. Examine the four examples shown and suggest how this problem can be eased in each case.

<table>
<thead>
<tr>
<th>Container</th>
<th>Surface Texture</th>
<th>Materials in Contact</th>
<th>Force Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A)</td>
<td>79</td>
<td>80</td>
<td>81</td>
</tr>
<tr>
<td>(B)</td>
<td>82</td>
<td>83</td>
<td>84</td>
</tr>
<tr>
<td>(C)</td>
<td>85</td>
<td>86</td>
<td>87</td>
</tr>
<tr>
<td>(D)</td>
<td>88</td>
<td>89</td>
<td>90</td>
</tr>
</tbody>
</table>
(19) How do the containers (E), (F), (G) and (H) overcome the problem associated with that found in (D) ?

(E) ..............................................................

(F) ..............................................................

(G) ..............................................................

(H) ..............................................................

(20) Examine container (1):

(i) What makes it difficult to remove the lid without the use of the turn-key?

................................................................................................................

(ii) What would be the possible effect if the key was made to turn off-centre?
(21) Use one of the four spoons to remove the lid from container (J).

7.1  7.2  7.3  7.4
Circle Choice -------->  91  92  93  125

(22) How much force was required to open the tin?

(23) Compare that with the force required to replace the lid.

(24) Which required more effort
Opening / Closing the tin?
95  96

(25) Which required more work
Opening / Closing the lid?
97  98
If same
130
(26) Why did it require more effort to close the lid than to open it?
Hand/palm .... 99     Force Ratio .... 100     Leverage .... 101

(27) How could you make the lid fit tighter?
Size .... 102     Surface Texture .... 103     Materials .... 104

(28) What is the size of the hole in which the lid fits?
55 mm .... 105     55.5 mm .... 106     55.6 mm .... 107

(29) How big would you make the lid to fit tightly?
+1 mm .... 108     +0.5 mm .... 109     +0.05 mm .... 110
(30) From the selection of four Door Wedges, which is the best?

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1</td>
<td>8.2</td>
<td>8.3</td>
<td>8.4</td>
</tr>
<tr>
<td>111</td>
<td>112</td>
<td>113</td>
<td>114</td>
</tr>
</tbody>
</table>

(31) Why?

(32) Give one limitation of your chosen wedge.

<table>
<thead>
<tr>
<th>Friction</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>115</td>
<td>116</td>
</tr>
</tbody>
</table>

(33) How would you improve this product?

<table>
<thead>
<tr>
<th>Surface Texture</th>
<th>Materials in Contact</th>
<th>Force Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>117</td>
<td>118</td>
<td>119</td>
</tr>
</tbody>
</table>
(34) What features of the Door Wedge (K) are superior to your chosen Door Wedge?

<table>
<thead>
<tr>
<th>Friction</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>121</td>
</tr>
</tbody>
</table>

Surface Texture  | Materials in Contact | Force Multiplier
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>122</td>
<td>123</td>
<td>124</td>
</tr>
</tbody>
</table>

(35) What is Velocity (movement) Ratio of your wedge?

<table>
<thead>
<tr>
<th>Formula</th>
<th>Measurements</th>
<th>Substitution</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>125</td>
<td>126</td>
<td>127</td>
<td>128</td>
</tr>
</tbody>
</table>
(36) Will the Mechanical Advantage (Force Ratio), be the same or different?

<table>
<thead>
<tr>
<th>Same</th>
<th>Different</th>
</tr>
</thead>
<tbody>
<tr>
<td>129</td>
<td>130</td>
</tr>
</tbody>
</table>

If different, will the M.A. (F.R.) be larger or smaller?

<table>
<thead>
<tr>
<th>Larger</th>
<th>Smaller</th>
</tr>
</thead>
<tbody>
<tr>
<td>131</td>
<td>132</td>
</tr>
</tbody>
</table>

(37) If you now had to design a wedge to lift a machine which weighed two metric tonnes, what changes might you make to your chosen wedge?

<table>
<thead>
<tr>
<th>Friction</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>133</td>
<td>134</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Surface Texture</th>
<th>Materials in Contact</th>
<th>Force Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>135</td>
<td>136</td>
<td>137</td>
</tr>
</tbody>
</table>

**** STOP RECORDING NOW ****

This brings our little chat to a close, other than enquiring if you have ANY QUESTIONS .................................................................

....... THANK YOU FOR TAKING PART ......
APPENDIX II

PILOT STUDY ANALYSIS
Question No. (3) I want you to imagine that you are replacing some old kitchen tools. You need some means of opening Crown Tops, Metal Cans and Corked Bottles. Choose which articles you would buy.

Question No. (4) Why did you choose these particular items?

---

**CATALOGUE OF RESPONSES**

*Pupil Synopsis of Oral Response Judgement Model*

| * | (1/2M) | Quick/simple. Comfortable. Not fancy. | (A) (E) (M) (T) |
| * | (2/2F) | Safer. Attractive. Easy to use. | (A) (E) (M) (T) |
| * | (3/1M) | Efficient. Shape/colour. Modern/trendy | (A) (E) (M) (T) |
| * | (4/1M) | Simple to use. Fits on wall. Little force. | (A) (E) (M) (T) |
| * | (5/2M) | Looks better/stronger. Easy to use. | (A) (E) (M) (T) |
| * | (7/1) | (no available candidate) | (A) (E) (M) (T) |
| * | (8/1) | (no available candidate) | (A) (E) (M) (T) |
| * | (9/4M) | Simple to use. Looks good. Fits hand well. | (A) (E) (M) (T) |
| * | (10/4M) | Looks nice. Simple to use. Well made. | (A) (E) (M) (T) |
| * | (11/3F) | Multiple use. Good wear/price. Looks nice. | (A) (E) (M) (T) |
| * | (12/3M) | Looks nice. Simple to use. Known product. | (A) (E) (M) (T) |
| * | (13/5M) | Multiple use. More leverage. Easy to use. | (A) (E) (M) (T) |
| * | (14/5M) | Looks different. Nice. Easy to use. Cheap. | (A) (E) (M) (T) |
| * | (15/4M) | Simple. Cheap. Classy looking. | (A) (E) (M) (T) |
| * | (16/4M) | Easy to use. | (A) (E) (M) (T) |
| * | (17/7M) | Easy to use. Straight forward. Holds can. | (A) (E) (M) (T) |
| * | (18/7M) | Easy to operate. Little pressure. | (A) (E) (M) (T) |
| * | (19/6F) | Feels/looks nice. Easy use. Less effort. | (A) (E) (M) (T) |
| * | (20/6M) | Works better. Cuts easy. Easy/safe to use. | (A) (E) (M) (T) |
| * | (21/8M) | Easy to use. Faster. Looks newer. | (A) (E) (M) (T) |
| * | (22/8M) | Good handle. More pressure. Easy to use. | (A) (E) (M) (T) |
| * | (23/5M) | Looks better. Multiple use. | (A) (E) (M) (T) |
| * | (24/5M) | Easy to handle. Sharp/strong. Fits on wall. | (A) (E) (M) (T) |
| * | (25/3M) | Modern. Less effort. Easy to use. Safe. | (A) (E) (M) (T) |
| * | (27/6M) | Looks nice. Strong. Simple to use. Safe. | (A) (E) (M) (T) |
| * | (28/6M) | Sturdy. Wall mounted. Nice to look at. | (A) (E) (M) (T) |
| * | (29/8M) | Does the job. Not fancy. Good price/grip. | (A) (E) (M) (T) |
| * | (30/8M) | Fits on wall. Quick action. Multiple use. | (A) (E) (M) (T) |
| * | (31/7M) | Looks nice. Easy to hold. Doesn’t hurt. | (A) (E) (M) (T) |
| * | (32/7M) | Right price. Looks nice. Non slip. Easy use. | (A) (E) (M) (T) |

The Population of (30) gave (62) Responses --> (20)(6) (6) (30)

*Sample Aesthetic Economic Moral Technical*

| * | ******* | ******* | ******* | ******* |
| * | Population | 20/30 (67%) 6/30 (20%) 6/30 (20%) 30/30 (100%) |
| * | Response 20/62 (32%) 6/62 (10%) 6/62 (10%) 30/62 (48%) |

(Assuming a theoretical total of 120 possible responses, then the returned response was 52%)
Question No.(7) If your choice of Can Opener was limited to the following products (standard butterfly type), which would you choose?

Question No.(8) Discuss the reasons for choosing the item selected.

*******************************************************************************
* CATALOGUE OF RESPONSES *
* **************************** *
* Pupil Synopsis of Oral Response Judgement Model *
* **************************** *
* (1/2M) Safer to use. (A) (-) (-) (M) (-) *
* (2/2F) Attractive.Cleaner/newer looking. (A) (-) (-) (T) *
* (3/1M) Handle colour.Same shape of head. (A) (-) (-) (T) *
* (4/1M) No real reason. (A) (-) (-) (-) *
* (5/2M) Seems strong.Cheaper in price. (A) (-) (-) (T) *
* (6/2M) Thought it was better. (A) (-) (-) (-) *
* (7/1) (no available candidate) (A) (-) (-) (*) *
* (8/1) (no available candidate) (A) (-) (-) (*) *
* (9/4M) Looks better.Comfortable. (A) (-) (-) (T) *
* (10/4M) Looks simple. (A) (-) (-) (-) *
* (11/3F) Multiple use.Hard wearing.Well priced. (A) (-) (-) (T) *
* (12/3M) Used one before. (A) (-) (-) (-) *
* (13/5M) Red handle.Different. (A) (-) (-) (-) *
* (14/5M) Know how to use it. (A) (-) (-) (-) *
* (15/4M) Used one before. (A) (-) (-) (-) *
* (16/4M) Similar to the one used at home. (A) (-) (-) (-) *
* (17/7M) Easy to hold.Simple. (A) (-) (-) (-) *
* (18/7M) Looks easy to open tin. (A) (-) (-) (-) *
* (19/6F) Handle is nice and light.(wt.assumed) (A) (-) (-) (-) *
* (20/6M) Comfortable.Easy to grip. (A) (-) (-) (-) *
* (21/8M) Cheaper.Care and time taken over it. (A) (-) (-) (-) *
* (22/9M) Long handle-more opening space/leverage. (A) (-) (-) (-) *
* (23/5M) Looks better. (A) (-) (-) (-) *
* (24/5M) Reliable. (A) (-) (-) (-) *
* (25/3M) Easy to handle and position on tin. (A) (-) (-) (-) *
* (26/3M) Looks good.Easy to clean.Easy to use. (A) (-) (-) (-) *
* (27/6M) Sharper.Better to get tops off. (A) (-) (-) (-) *
* (28/6M) Riveted.Easier to work. (A) (-) (-) (-) *
* (29/8M) Plastic would melt.Longer lasting. (A) (-) (-) (-) *
* (30/8M) Get cut by handle.Plastic-heat/burns. (A) (-) (-) (-) *
* (31/7M) Easy to open.More room-trapped fingers. (A) (-) (-) (-) *
* (32/7M) Firm end.Handle easily held.Price O.K. (A) (-) (-) (-) *
* The Population of (30) gave (32) Responses --> (7) (4) (3) (18) *
*******************************************************************************
* Sample Aesthetic Economic Moral Technical *
* ******* ************* ******* ******* *
* Population 7/30 (23%) 4/30 (13%) 3/30 (10%) 18/30 (60%) *
* Response 7/32 (22%) 4/32 (13%) 3/32 (9%) 18/32 (56%) *
* (Assuming a theoretical total of 120 possible responses, then the returned response was 27%)
*******************************************************************************
Question No. (9) If your choice of Can Opener was limited to the following products (butterfly with corkscrew), which would you choose?

Question No. (10) Discuss the reasons for choosing the items selected.

**************************************************************************
* Pupil Synopsis of Oral Response Judgement Model *
**************************************************************************
* (1/2M) Looks stronger. (-) (*) (-) (T) *
* (2/2F) Don't know. (-) (*) (-) (-) *
* (3/1M) Shape of head - looks sharper. (-) (*) (-) (T) *
* (4/1M) No reason. (-) (*) (-) (-) *
* (5/2M) Used before. Feels stronger. (-) (*) (-) (T) *
* (6/2M) All the same - no difference. (-) (*) (-) (-) *
* (7/1) (no available candidate) ( ) (*) ( ) ( ) *
* (8/1) (no available candidate) ( ) (*) ( ) ( ) *
* (9/4M) Looks good. Seems better. Seems compact. (A) (*) (-) (-) *
*(10/4M) Different colour. Looks better. (A) (*) (-) (-) *
*(11/3F) Don't know. No reason. (-) (*) (-) (-) *
*(12/3M) Can see how to use it. (A) (*) (-) (-) *
*(13/5M) Longer handle - can hold it better. (-) (*) (-) (T) *
*(14/5M) Longest corkscrew. Like its looks. (A) (*) (-) (T) *
*(15/4M) Looks smarter. Shiny. (A) (*) (-) (-) *
*(16/4M) Like the one at home. (-) (*) (-) (-) *
*(17/7M) Easy to use. (-) (*) (-) (T) *
*(18/7M) Easy to use. Sharper. (-) (*) (-) (T) *
*(19/6F) Spike tin without bending. (-) (*) (-) (T) *
*(20/6M) Looks well made. (-) (*) (-) (T) *
*(21/8M) Black blade. (A) (*) (-) (-) *
*(22/8M) More leverage. (-) (*) (-) (T) *
*(23/5M) More modern. (-) (*) (-) (-) *
*(24/5M) Looks better. Sharper blade. (A) (*) (-) (T) *
*(25/3M) Bigger cutting edge. (-) (*) (-) (T) *
*(26/3M) Poor appearance. Feels better. Good action. (A) (*) (-) (T) *
*(27/6M) Stronger. More leverage. (-) (*) (-) (T) *
*(28/6M) Neater. Better corkscrew/position. Strong. (A) (*) (-) (T) *
*(29/8M) Angle goes in easier. (-) (*) (-) (T) *
*(30/8M) Can see blade easier. (-) (*) (-) (-) *
*(31/7M) Better shape. Big handle. Chinese break. (A) (*) (-) (T) *
*(32/7M) End firm. Thicker rivets. Sharp screw. (A) (*) (-) (T) *
* The Population of (30) gave (29) Responses --> (11) (*) (0) (18) *
**************************************************************************
* Sample Aesthetic Economic Moral Technical *
* ******* **************** ******* ******* ******* *
* Population 11/30 (37%) N/A 0/30 (0%) 18/30 (60%) *
* Response 11/29 (38%) N/A 0/29 (0%) 18/29 (62%) *
* *
*(Assuming a theoretical total of 90 possible responses, then the returned response was 32%)*
**************************************************************************
Question No.(11) If your choice of Can Opener was limited to the following products (Rotary type), which would you choose?

Question No.(12) Discuss the reasons for choosing the item selected.

******************************************************************************
* CATALOGUE OF RESPONSES *
* Pupil Synopsis of Oral Response Judgment Model *
******************************************************************************
* * * * * * * * * * * * * *
* (1/2M) Comfortable to hold. (-) (-) (-) (T) *
* (2/2F) Safe.Easy to store. (-) (-) (M) (T) *
* (3/1M) Shape.Colour. (A) (-) (-) (-) *
* (4/1M) Wall mounted.Easy to use. (-) (-) (-) (T) *
* (5/2M) Reliable. (-) (-) (-) (T) *
* (6/2M) Big and Strong. (-) (-) (-) (T) *
* (7/1) (no available candidate) ( ) ( ) ( ) ( ) *
* (8/1) (no available candidate) ( ) ( ) ( ) ( ) *
* (9/4M) Fits hand well. (-) (-) (-) (T) *
* (10/4M) Well made. (-) (-) (-) (T) *
* (11/3F) Wall mounted. (-) (-) (-) (T) *
* (12/3M) Know the product. (-) (-) (-) (T) *
* (13/5M) More leverage. (-) (-) (-) (T) *
* (14/5M) Cheapest.Easy to use. (-) (E) (-) (T) *
* (15/4M) Cheap.Easy to use. (-) (E) (-) (T) *
* (16/4M) Easy to use.Grandmother has one. (-) (-) (-) (T) *
* (17/7M) Easy to use.Holds can. (-) (-) (-) (T) *
* (18/7M) Easy to open. (-) (-) (-) (T) *
* (19/6F) Easy to open. (-) (-) (-) (T) *
* (20/6M) Easy to use.Sharp.Safe use.Cuts easily. (-) (-) (M) (T) *
* (21/8M) Looks better.Easier to use.Faster.Newer. (A) (-) (-) (T) *
* (22/8M) More pressure.Holds can.Easy to use. (-) (-) (-) (T) *
* (23/5M) Colour.Looks best. (A) (-) (-) (-) *
* (24/5M) Easy to operate.Sharp blade.Fits well. (-) (-) (-) (T) *
* (25/3M) Big/comfortable.Faster.Sharper.Easy use. (-) (-) (-) (T) *
* (26/3M) Colour. Operation good. (A) (-) (-) (T) *
* (27/6M) Simple idea.Safe. (-) (-) (M) (T) *
* (28/6M) Wall mounted - always know where it is. (-) (-) (-) (T) *
* (29/8M) Not expensive. (-) (E) (-) (-) *
* (30/6M) Convenient on wall. (-) (-) (-) (T) *
* (31/7M) Easier to hold.Doesn’t hurt. (-) (-) (M) (T) *
* (32/7M) Price O.K.Steady.Looks nice.Nice action. (A) (E) (-) (-) *
*
* The Population of (30) gave (40) Responses --> (5) (4) (4) (27) *
******************************************************************************
* * * * * * * * * * * * * *
* Sample Aesthetic Economic Moral Technical *
* * * * * * * * * * * * * *
* Population 5/30 (17%) 4/30 (13%) 4/30 (13%) 27/30 (90%) *
* Response 5/40 (13%) 4/40 (10%) 4/40 (10%) 27/40 (68%) *
*
* (Assuming a theoretical total of 120 possible responses, then the returned response was 33%)
Question No.(13) Examine the three examples of kitchen tools to overcome the problem of removing tight screw tops. Which do you prefer?

Question No.(14) Discuss the reasons for choosing the item selected.

*******************************************************************
* CATALOGUE OF RESPONSES *
* ******************************************************
* Pupil Synopsis of Oral Response Judgement Model *
******************************************************
* (1/2M) Easy to snip skin. Simple. No joints. (M) (T) *
* (2/2F) Easier to use (disabled). Looks better. (A) (M) (T) *
* (3/1M) Easier to use. Others look complicated. (A) (T) *
* (4/1M) Looks strong. Easier to use. (T) *
* (5/2M) Large range. (T) *
* (6/2M) Easier to use. (T) *
* (7/1) (no available candidate) (T) *
* (8/1) (no available candidate) (T) *
* (9/4M) Easier to use. Right size. (T) *
* (10/4M) Does job easiest and best. (T) *
* (11/3F) Reasonably priced. Easy to handle. (E) (T) *
* (12/3M) Attractive. Similar action to scissors. (A) (T) *
* (13/5M) Self adjusting. Nice shaped handle. (A) (T) *
* (14/5M) Value for money. Looks nice. (A) (T) *
* (15/4M) Self adjusting. (T) *
* (16/4M) Looks better. (A) (T) *
* (17/7M) Easy to use. (T) *
* (18/7M) Price. (T) *
* (19/6F) Feels more force pressing. (T) *
* (20/6M) Safer to use. (T) *
* (21/8M) Easier to operate. (T) *
* (22/8M) Wide range. Good grip. Not bulky. (T) *
* (23/5M) Looks better. (T) *
* (24/5M) Looks good. No mess. Just put it on. (T) *
* (25/3M) Quick action. (T) *
* (26/3M) Functions well. Good looks. Easy operation. (T) *
* (27/6M) Easy to use. Strongest. (T) *
* (28/6M) Can open a bigger jar. (T) *
* (29/8M) Easier to fit. Easier to turn. (T) *
* (30/8M) Easily adjustable. (T) *
* (31/7M) Easy to hold. (T) *
* (32/7M) Comfortable. Simple operation. Good grip. (T) *

** The Population of (30) gave (40) Responses --> (9) (3) (3) (25) *
*******************************************************************
* Sample Aesthetic Economic Moral Technical *
* ***** ******** ******** ***** ******** ** *
* Population 9/30 (30%) 3/30 (10%) 3/30 (10%) 25/30 (83%) *
* Response 9/40 (22%) 3/40 (8%) 3/40 (8%) 25/40 (62%) *
* (Assuming a theoretical total of 120 possible responses, then the returned response was 33%)*
*******************************************************************
**************
-23-
Question No.(15) Which of the three products do you consider to be the worst?

Question No.(16) Discuss the reasons for choosing the item selected.

Question No.(17) How would you improve this product?

******************************************************************************
* CATALOGUE OF RESPONSES *
******************************************************************************
* Pupil Synopsis of Oral Response Judgement Model *
******************************************************************************
* (1/2M) Don’t like it—plastic safety guard. (-) (-) (M) (-) *
* (2/2F) No response. ( ) ( ) ( ) ( ) *
* (3/1M) Simple shape—Complex action—Colour. (A) (-) (-) (T) *
* (4/1M) Fiddly— make it stronger. (-) (-) (-) (T) *
* (5/2M) Fiddly—no response. (-) (-) (-) (T) *
* (6/2M) Complicated—No response. (-) (-) (-) (T) *
* (7/1) (no available candidate) ( ) ( ) ( ) ( ) *
* (8/1) (no available candidate) ( ) ( ) ( ) ( ) *
* (9/4M) Complicated—Poor looks—More plastic. (A) (-) (-) (-) *
* (10/4M) Poor looks—No response. (A) (-) (-) (-) *
* (11/3F) Too expensive—Slip — Adjustable/Rubber. (-) (E) (-) (T) *
* (12/3M) Looks old fashioned—Chrome/plastic. (A) (-) (-) (-) *
* (13/5M) Awkward—bigger holes to get point in. (-) (-) (-) (T) *
* (14/5M) Limited range—Not attractive—Plastic. (A) (-) (-) (T) *
* (15/4M) Damage to tops—Rubber protection. (-) (-) (-) (T) *
* (16/4M) Long set up time—Quicker adjustment. (-) (-) (-) (T) *
* (17/7M) Too fiddly—Make it look easier to use. (A) (-) (-) (T) *
* (18/7M) Slippage—More grips. (-) (-) (-) (T) *
* (19/6F) Awkward—change shape for better grip. (-) (-) (-) (T) *
* (20/6M) Damage to hand—Rubber protection/grip. (-) (-) (M) (T) *
* (21/8M) Didn’t twist—another adjustment bar. (-) (-) (-) (T) *
* (22/8M) Poor appearance.Rickety assembly. (A) (-) (-) (T) *
* (23/5M) All the same—Rubber to protect tin lid. (-) (-) (-) (T) *
* (24/5M) Don’t like its looks—make simple to use. (A) (-) (-) (T) *
* (25/3M) Poor grip—better lining inc. grip teeth. (-) (-) (-) (T) *
* (26/3M) General poor performance—better friction (-) (-) (-) (T) *
* (27/6M) Liable to slip—Two rubber faces/bobbles. (-) (-) (-) (T) *
* (28/6M) Rubber not secure—knurled and wider. (-) (-) (-) (T) *
* (29/8M) Too big for small children—needs handle. (-) (-) (-) (T) *
* (30/8M) No opinion—No response. ( ) ( ) ( ) ( ) *
* (31/7M) Doesn’t fit sometimes—no response. (-) (-) (-) (T) *
* (32/7M) Slips/flexes—Backward teeth. Thicker. (-) (-) (-) (T) *

The Population of (30) gave (36) Responses --> (8) (1) (2) (25) *

__________________________________________________________
* Sample Aesthetic Economic Moral Technical *
* ****** ******* ********* ****** *
* Population 8/30 (27%) 1/30 (3%) 2/30 (7%) 25/30 (83%) *
* Response 8/36 (22%) 1/36 (3%) 2/36 (6%) 25/36 (69%) *

(Assuming a theoretical total of 120 possible responses, then the returned response was 30%)
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<th>Item</th>
<th>Participants</th>
<th>Frequency</th>
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Analysis Sheet 8

* ANALYSIS OF 8 MOST FREQUENT RESPONSES *

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<th>Item</th>
<th>Participants</th>
<th>Judgements</th>
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<tr>
<td>Bottle Openers</td>
<td>(A) (E) (M) (T)</td>
<td>************</td>
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<tr>
<td>The Population of (10)</td>
<td>gave (24) Responses --&gt; (9) (2) (3) (10)</td>
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<td></td>
<td>Sample</td>
<td>Aesthetic</td>
</tr>
<tr>
<td></td>
<td>9/10 (90%)</td>
<td>2/10 (20%)</td>
</tr>
<tr>
<td>B/F from sheet 1</td>
<td>(67%)</td>
<td>(20%)</td>
</tr>
<tr>
<td>Response</td>
<td>9/24 (38%)</td>
<td>2/24 (8%)</td>
</tr>
<tr>
<td>B/F from sheet 1</td>
<td>(32%)</td>
<td>(10%)</td>
</tr>
<tr>
<td>(Assuming a theoretical total of 40 possible responses, then the returned response was 60%)</td>
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</table>

| Can Openers | (A) (E) (M) (T) | ************ |
| 4.2 | 110100--00-0-0-010001110100000000 |
| The Population of (8) | gave (17) Responses --> (6) (1) (2) (8) |
| Sample | Aesthetic | Economic | Moral | Technical |
| | 6/8 (75%) | 1/8 (13%) | 2/8 (25%) | 8/8 (100%) |
| B/F from sheet 1 | (67%) | (20%) | (20%) | (100%) |
| Response | 6/17 (35%) | 1/17 (6%) | 2/17 (12%) | 8/17 (47%) |
| B/F from sheet 1 | (32%) | (10%) | (10%) | (48%) |
| (Assuming a theoretical total of 32 possible responses, then the returned response was 53%) |

| Cork Extractors | (A) (E) (M) (T) | ************ |
| 5.5 | 11111--000111010110000000101 |
| The Population of (16) | gave (32) Responses --> (9) (4) (3) (16) |
| Sample | Aesthetic | Economic | Moral | Technical |
| | 9/16 (56%) | 4/16 (25%) | 3/16 (19%) | 16/16 (100%) |
| B/F from sheet 1 | (67%) | (20%) | (20%) | (100%) |
| Response | 9/32 (28%) | 4/32 (13%) | 3/32 (9%) | 16/32 (50%) |
| B/F from sheet 1 | (32%) | (10%) | (10%) | (48%) |
| (Assuming a theoretical total of 64 possible responses, then the returned response was 50%) |

-26-
### Analysis Sheet 9

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#### Can Openers - Standard Butterfly Type

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<th>(A) (E) (M) (T)</th>
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2.2 111000--1010100001101101110111

* The Population of (17) gave (24) Responses --> (6) (2) (3) (13) *

#### Sample Aesthetic Economic Moral Technical

<p>| | | |</p>
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Population 6/17 (35%) 2/17 (12%) 3/17 (18%) 13/17 (76%) *

B/F from sheet 2 (23%)------>(13%)------>(10%)------>(60%) *

Response 6/24 (25%) 2/24 (8%) 3/24 (13%) 13/24 (54%) *

B/F from sheet 2 (22%)------>(13%)------>(9%)------>(56%) *

(Assuming a theoretical total of 68 possible responses, then the returned response was 35%)

---

### Continued

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<th>Item</th>
<th>Participants</th>
<th>Judgements</th>
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#### Can Openers - Butterfly with Corkscrew

<table>
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<tr>
<th>(A) (E) (M) (T)</th>
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</table>

3.1 0-0110--010101000111110000100101

* The Population of (13) gave (12) Responses --> (4) (*) (0) (B) *

#### Sample Aesthetic Economic Moral Technical

<p>| | | |</p>
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</table>

Population 4/13 (31%) N/A 0/13 (0%) 8/13 (62%) *

B/F from sheet 3 (37%)---------->(0%)---------->(60%) *

Response 4/12 (33%) N/A 0/12 (0%) 8/12 (67%) *

B/F from sheet 3 (38%)---------->(0%)---------->(62%) *

(Assuming a theoretical total of 52 possible responses, then the returned response was 23%)

---

Continued.............
## Analysis Sheet 10

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<td>(A) (E) (M) (T)</td>
<td><strong>1</strong> --&gt; <strong>5</strong> --&gt; <strong>10</strong> --&gt; <strong>15</strong> --&gt; <strong>20</strong> --&gt; <strong>25</strong> --&gt; <strong>32</strong></td>
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*The Population of (9) gave (12) Responses --> (2) (0) (1) (9)*

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<th>Sample</th>
<th>Aesthetic</th>
<th>Economic</th>
<th>Moral</th>
<th>Technical</th>
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</thead>
<tbody>
<tr>
<td><strong>Population</strong></td>
<td>2/9 (22%)</td>
<td>0/9 (0%)</td>
<td>1/9 (11%)</td>
<td>9/9 (100%)</td>
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<td>B/F from sheet 4</td>
<td>(17%) --&gt; (13%) --&gt; (13%) --&gt; (90%)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Response</strong></td>
<td>2/12 (17%)</td>
<td>0/12 (0%)</td>
<td>1/12 (8%)</td>
<td>9/12 (75%)</td>
</tr>
<tr>
<td>B/F from sheet 4</td>
<td>(13%) --&gt; (10%) --&gt; (10%) --&gt; (68%)</td>
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</table>

*(Assuming a theoretical total of 36 possible responses, then the returned response was 33%)*

<table>
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<th>Economic</th>
<th>Moral</th>
<th>Technical</th>
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<tr>
<td><strong>Population</strong></td>
<td>5/19 (26%)</td>
<td>3/19 (16%)</td>
<td>0/19 (0%)</td>
<td>16/19 (84%)</td>
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<tr>
<td>B/F from sheet 5</td>
<td>(30%) --&gt; (10%) --&gt; (10%) --&gt; (83%)</td>
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<tr>
<td><strong>Response</strong></td>
<td>5/24 (21%)</td>
<td>3/24 (13%)</td>
<td>0/24 (0%)</td>
<td>16/24 (67%)</td>
</tr>
<tr>
<td>B/F from sheet 5</td>
<td>(22%) --&gt; (8%) --&gt; (8%) --&gt; (62%)</td>
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*(Assuming a theoretical total of 76 possible responses, then the returned response was 32%)*

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<tr>
<td><strong>Population</strong></td>
<td>6/14 (43%)</td>
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<td>1/14 (7%)</td>
<td>12/14 (86%)</td>
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<tr>
<td>B/F from sheet 6</td>
<td>(27%) --&gt; (3%) --&gt; (7%) --&gt; (83%)</td>
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<td></td>
</tr>
<tr>
<td><strong>Response</strong></td>
<td>6/19 (32%)</td>
<td>0/19 (0%)</td>
<td>1/19 (5%)</td>
<td>12/19 (63%)</td>
</tr>
<tr>
<td>B/F from sheet 6</td>
<td>(22%) --&gt; (3%) --&gt; (6%) --&gt; (69%)</td>
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</table>

*(Assuming a theoretical total of 56 possible responses, then the returned response was 34%)*
Question No. (3) I want you to imagine that you are replacing some old kitchen tools. You need some means of opening Crown Tops, Metal Cans and Corked Bottles.

Choose which articles you would buy.

Question No. (4) Why did you choose these particular items?

********************************************************************************
* CATALOGUE OF RESPONSES *
********************************************************************************
* Pupil Synopsis of Oral Response Judgement Model *
* (3/1M) Efficient. Shape/colour. Modern/trendy (A) (--) (--) (T) *
* (4/1M) Simple to use. Fits on wall. Little force. (--) (--) (--) (T) *
* (7/1) (no available candidate) ( ) ( ) ( ) ( ) *
* (8/1) (no available candidate) ( ) ( ) ( ) ( ) *
* The Population of (2) gave (3) Responses ---> (1) (0) (0) (2) *
* Sample Aesthetic Economic Moral Technical *
* ----- ------ -------- -------- -------- *
* Population 1/2 (50%) 0/2 (0%) 0/2 (0%) 2/2 (100%) *
* Response 1/3 (33%) 0/3 (0%) 0/3 (0%) 2/3 (67%) *
* *(Assuming a theoretical total of 8 possible responses, then the returned response was 38%)*

********************************************************************************
* CATALOGUE OF RESPONSES *
********************************************************************************
* Pupil Synopsis of Oral Response Judgement Model *
* (1/2M) Quick/simple. Comfortable. Not fancy. (A) (--) (--) (T) *
* (2/2F) Safer. Attractive. Easy to use. (A) (--) (M) (T) *
* (5/2M) Good. Strong. Reliable. Good price. Comfort. (--) (E) (--) (T) *
* (6/2M) Looks better/stronger. Easy to use. (A) (--) (--) (T) *
* The Population of (4) gave (9) Responses ---> (3) (1) (1) (4) *
* Sample Aesthetic Economic Moral Technical *
* ----- ------ -------- -------- -------- *
* Population 3/4 (75%) 1/4 (25%) 1/4 (25%) 4/4 (100%) *
* Response 3/9 (33%) 1/9 (11%) 1/9 (11%) 4/9 (44%) *
* *(Assuming a theoretical total of 16 possible responses, then the returned response was 56%)*

-29- Continued ............
(Analysis Sheet 12)

*******************************************************************
*
* CATALOGUE OF RESPONSES
*
* Pupil Synopsis of Oral Response Judgement Model *
*******************************************************************
*(11/3F) Multiple use.Good wear/price.Looks nice. (A) (E) (-) (T) *
*(12/3M) Looks nice. Simple to use.Known product. (A) (-) (-) (T) *
*(25/3M) Modern.Less effort.Easy to use.Safe. (A) (-) (M) (T) *
*(26/3M) Modern/clean.Sturdy.Comfort.Good action. (A) (-) (-) (T) *
*
* The Population of (4) gave (10) Responses ---> (4) (1) (1) (4) *
*
* Sample Aesthetic Economic Moral Technical *
* ***** ********* ********* **** ******** **
* Population 4/4 (100%) 1/4 (25%) 1/4 (25%) 4/4 (100%) *
* Response 4/10 (40%) 1/10 (10%) 1/10 (10%) 4/10 ( 40%) *
*
*(Assuming a theoretical total of 16 possible responses, then the returned response was 63%)
*
*******************************************************************
*******************************************************************
*(9/4M) Simple to use.Looks good.Fits hand well. (A) (-) (-) (T) *
*(10/4M) Looks nice.Simple to use.Well made. (A) (-) (-) (T) *
*(15/4M) Simple.Cheap.Classy looking. (A) (E) (-) (T) *
*(16/4M) Easy to use. (-) (-) (-) (T) *
*
* The Population of (4) gave ( 8) Responses ---> (3) (1) (0) (4) *
*
* Sample Aesthetic Economic Moral Technical *
* ***** ********* ****** **** **
* Population 3/4 (75%) 1/4 (25%) 0/4 ( 0%) 4/4 (100%) *
* Response 3/8 (38%) 1/8 (13%) 0/8 ( 0%) 4/8 ( 50%) *
*
*(Assuming a theoretical total of 16 possible responses, then the returned response was 50%)
*
*******************************************************************
*******************************************************************
*(13/5M) Multiple use.More leverage.Easy to use. (-) (-) (-) (T) *
*(14/5M) Looks different.Nice.Easy to use.Cheap. (A) (E) (-) (T) *
*(23/5M) Looks better.Multiple use. (A) (-) (-) (T) *
*(24/5M) Easy to handle.Sharp/strong.Fits on wall. (-) (-) (-) (T) *
*
* The Population of (4) gave ( 7) Responses ---> (2) (1) (0) (4) *
*
* Sample Aesthetic Economic Moral Technical *
* ***** ********* ****** **** **
* Population 2/4 (50%) 1/4 (25%) 0/4 ( 0%) 4/4 (100%) *
* Response 2/7 (29%) 1/7 (14%) 0/7 ( 0%) 4/7 (57%) *
*
*(Assuming a theoretical total of 16 possible responses, then the returned response was 44%)
*
*******************************************************************
*******************************************************************

# Analysis Sheet 13

**C A T A L O G U E  O F  R E S P O N S E S**

**Pupil Synopsis of Oral Response Judgement Model**

19/6F) Feels/looks nice. Easy use. Less effort. (A) <-> <-> (T) *

20/6M) Works better. Cuts easy. Easy/ safe to use. (-) <-> <-> (M) (T) *

27/6M) Looks nice. Strong. Simple to use. Safe. (A) <-> <-> (M) (T) *

28/6M) Sturdy. Wall mounted. Nice to look at. (A) <-> <-> (T) *

* The Population of (4) gave (9) Responses ---> (3) (0) (2) (4) *

<table>
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<tr>
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<th>Aesthetic</th>
<th>Economic</th>
<th>Moral</th>
<th>Technical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>3/4 (75%)</td>
<td>0/4 (0%)</td>
<td>2/4 (50%)</td>
<td>4/4 (100%)</td>
</tr>
<tr>
<td>Response</td>
<td>3/9 (33%)</td>
<td>0/9 (0%)</td>
<td>2/9 (22%)</td>
<td>4/9 (44%)</td>
</tr>
</tbody>
</table>

(Assuming a theoretical total of 16 possible responses, then the returned response was 50%)

17/7M) Easy to use. Straight forward. Holds can. (-) <-> <-> (T) *

18/7M) Easy to operate. Little pressure. (-) <-> <-> (T) *

31/7M) Looks nice. Easy to hold. Doesn't hurt. (A) <-> <-> (M) (T) *

32/7M) Right price. Looks nice. Non slip. Easy use. (A) <-> <-> (M) (T) *

* The Population of (4) gave (9) Responses ---> (2) (1) (2) (4) *

<table>
<thead>
<tr>
<th>Sample</th>
<th>Aesthetic</th>
<th>Economic</th>
<th>Moral</th>
<th>Technical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>2/4 (50%)</td>
<td>1/4 (25%)</td>
<td>2/4 (50%)</td>
<td>4/4 (100%)</td>
</tr>
<tr>
<td>Response</td>
<td>2/9 (22%)</td>
<td>1/9 (11%)</td>
<td>2/9 (22%)</td>
<td>4/9 (44%)</td>
</tr>
</tbody>
</table>

(Assuming a theoretical total of 16 possible responses, then the returned response was 50%)

21/8M) Easy to use. Faster. Looks newer. (A) <-> <-> (T) *

22/8M) Good handle. More pressure. Easy to use. (-) <-> <-> (T) *

29/8M) Does the job. Not fancy. Good price/grip. (A) <-> <-> (T) *

30/8M) Fits on wall. Quick action. Multiple use. (A) <-> <-> (T) *

* The Population of (4) gave (7) Responses ---> (2) (1) (0) (4) *

<table>
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<th>Economic</th>
<th>Moral</th>
<th>Technical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>2/4 (50%)</td>
<td>1/4 (25%)</td>
<td>0/4 (0%)</td>
<td>4/4 (100%)</td>
</tr>
<tr>
<td>Response</td>
<td>2/7 (29%)</td>
<td>1/7 (14%)</td>
<td>0/7 (0%)</td>
<td>4/7 (57%)</td>
</tr>
</tbody>
</table>

(Assuming a theoretical total of 16 possible responses, then the returned response was 44%)
Question No.(7)  If your choice of Can Opener was limited to the following products (standard butterfly type), which would you choose?

Question No.(8)  Discuss the reasons for choosing the item selected.

*******************************************************************
* CATALOGUE OF RESPONSES                                     *
* Pupil Synopsis of Oral Response Judgement Model             *
*******************************************************************

* (3/1M) Handle colour. Same shape of head.                   *
(A) (-) (-) (T) *                                              *
* (4/1M) No real reason.                                       *
(-) (-) (-) (--) *                                             *
* (7/1) (no available candidate)                               *
( ) ( ) ( ) ( ) *                                              *
* (8/1) (no available candidate)                               *
( ) ( ) ( ) ( ) *                                              *
* The Population of (2) gave (2) Responses ---> (1) (0) (0) (1) *
*
* Sample Aesthetic Economic Moral Technical                    *
* ------- --------- --------- --------- ------- *
* Population 1/2 (50%) 0/2 (0%) 0/2 (0%) 1/2 (50%) *            *
* Response 1/2 (50%) 0/2 (0%) 0/2 (0%) 1/2 (50%) *              *
*
*(Assuming a theoretical total of 8 possible responses, then the returned response was 25%)*

*******************************************************************
* CATALOGUE OF RESPONSES                                     *
* Pupil Synopsis of Oral Response Judgement Model             *
*******************************************************************

* (1/2M) Safer to use. (-) (-) (M) (-) *                      *
* (2/2F) Attractive. Cleaner/newer looking.                    *
(A) (-) (-) (--) *                                            *
* (5/2M) Seems strong. Cheaper in price.                      *
(-) (E) (-) (T) *                                             *
* (6/2M) Thought it was better.                               *
(-) (-) (-) (--) *                                            *
* The Population of (4) gave (4) Responses ---> (1) (1) (1) (1) *
*
* Sample Aesthetic Economic Moral Technical                    *
* ------- --------- --------- --------- ------- *
* Population 1/4 (25%) 1/4 (25%) 1/4 (25%) 1/4 (25%) *         *
* Response 1/4 (25%) 1/4 (25%) 1/4 (25%) 1/4 (25%) *            *
*
*(Assuming a theoretical total of 16 possible responses, then the returned response was 25%)*

*******************************************************************

Continued ..............
The catalogue of responses

Pupil Synopsis of Oral Response Judgement Model

- (11/3F) Multiple use. Hard wearing. Well priced. (E) (T) *
- (12/3M) Used one before. (E) (T) *
- (25/3M) Easy to handle and position on tin. (E) (T) *
- (26/3M) Looks good. Easy to use. (A) (T) *

The population of (4) gave (5) responses --> (1) (1) (0) (3) *

Sample Aesthetic Economic Moral Technical *
****** ****** ****** ****** ******
* Population 1/4 (25%) 1/4 (25%) 0/4 (0%) 3/4 (75%) *
* Response 1/5 (20%) 1/5 (20%) 0/5 (0%) 3/5 (60%) *

(Assuming a theoretical total of 16 possible responses, then the returned response was 31%)

- (9/4M) Looks better. Comfortable. (A) (E) (T) *
- (10/4M) Looks simple. (A) (E) (T) *
- (15/4M) Used one before. (E) (T) *
- (16/4M) Similar to the one used at home. (E) (T) *

The population of (4) gave (3) responses --> (2) (0) (0) (1) *

Sample Aesthetic Economic Moral Technical *
****** ****** ****** ****** ******
* Population 2/4 (50%) 0/4 (0%) 0/4 (0%) 1/4 (25%) *
* Response 2/3 (66%) 0/3 (0%) 0/3 (0%) 1/3 (33%) *

(Assuming a theoretical total of 16 possible responses, then the returned response was 19%)

- (13/5M) Red handle. Different. (A) (E) (T) *
- (14/5M) Know how to use it. (E) (T) *
- (23/5M) Looks better. (A) (T) *
- (24/5M) Reliable. (E) (T) *

The population of (4) gave (3) responses --> (2) (0) (0) (1) *

Sample Aesthetic Economic Moral Technical *
****** ****** ****** ****** ******
* Population 2/4 (50%) 0/4 (0%) 0/4 (0%) 1/4 (25%) *
* Response 2/3 (66%) 0/3 (0%) 0/3 (0%) 1/3 (33%) *

(Assuming a theoretical total of 16 possible responses, then the returned response was 19%)

-33- Continued ............
CATALOGUE OF RESPONSES

Pupil Synopsis of Oral Response Judgement Model

(19/6M) Handle is nice and light. (wt. assumed)  
(20/6M) Comfortable. Easy to grip.  
(27/6M) Sharper. Better to get tops off.  
(28/6M) Riveted. Easier to work.

The Population of (4) gave (4) Responses --> (0) (0) (0) (4)

Sample Aesthetic Economic Moral Technical

Population 0/4 (0%) 0/4 (0%) 0/4 (0%) 4/4 (100%)
Response 0/4 (0%) 0/4 (0%) 0/4 (0%) 4/4 (100%)

(Assuming a theoretical total of 16 possible responses, then the returned response was 25%)

(17/7M) Easy to hold. Simple.  
(18/7M) Looks easy to open tin.  
(31/7M) Easy to open. More room-trapped fingers.  
(32/7M) Firm end. Handle easily held. Price O.K.

The Population of (4) gave (6) Responses --> (0) (1) (1) (4)

Sample Aesthetic Economic Moral Technical

Population 0/4 (0%) 1/4 (25%) 1/4 (25%) 4/4 (100%)
Response 0/6 (0%) 1/6 (17%) 1/6 (17%) 4/6 (66%)

(Assuming a theoretical total of 16 possible responses, then the returned response was 39%)

(21/8M) Cheaper. Care and time taken over it.  
(22/8M) Long handle—more opening space/leverage.  
(30/8M) Get cut by handle. Plastic—heat/burns

The Population of (4) gave (5) Responses --> (0) (1) (1) (3)

Sample Aesthetic Economic Moral Technical

Population 0/4 (0%) 1/4 (25%) 1/4 (25%) 3/4 (75%)
Response 0/5 (0%) 1/5 (20%) 1/5 (20%) 3/5 (60%)

(Assuming a theoretical total of 16 possible responses, then the returned response was 31%)

-34-
Question No. (9) If your choice of Can Opener was limited to the following products (butterfly with corkscrew), which would you choose?

Question No. (10) Discuss the reasons for choosing the items selected.

******************************************************************************
* CATALOGUE OF RESPONSES *
* Pupil Synopsis of Oral Response Judgement Model *
******************************************************************************
* (3/1M) Shape of head - looks sharper. (¬) (*) (¬) (T) *
* (4/1M) No reason. (¬) (*) (¬) (¬) *
* (7/1) (no available candidate) ( ) (*) ( ) ( ) *
* (8/1) (no available candidate) ( ) (*) ( ) ( ) *

* The Population of (2) gave ( 1 ) Response —> (0) N/A (0) (1) *

* Sample Aesthetic Economic Moral Technical *
* ****** ****** ****** ****** ****** *
* Population 0/2 (0%) N/A 0/2 (0%) 1/2 (50%) *
* Response 0/1 (0%) N/A 0/1 (0%) 1/1 (100%) *

* Sample Aesthetic Economic Moral Technical *
* ****** ****** ****** ****** ****** *
* Population 0/4 (0%) N/A 0/4 (0%) 2/4 (50%) *
* Response 0/2 (0%) N/A 0/2 (0%) 2/2 (100%) *

* (Assuming a theoretical total of 6 possible responses, then the returned response was 17%)

******************************************************************************
* CATALOGUE OF RESPONSES *
* Pupil Synopsis of Oral Response Judgement Model *
******************************************************************************
* (1/2M) Looks stronger. (¬) (*) (¬) (T) *
* (2/2F) Don't know. (¬) (*) (¬) (¬) *
* (5/2M) Used before. Feels stronger. (¬) (*) (¬) (T) *
* (6/2M) All the same - no difference. (¬) (*) (¬) (¬) *

* The Population of (4) gave ( 2 ) Responses —> (0) N/A (0) (2) *

* Sample Aesthetic Economic Moral Technical *
* ****** ****** ****** ****** ****** *
* Population 0/4 (0%) N/A 0/4 (0%) 2/4 (50%) *
* Response 0/2 (0%) N/A 0/2 (0%) 2/2 (100%) *

* (Assuming a theoretical total of 12 possible responses, then the returned response was 17%)

******************************************************************************

Continued .................

-35-
<table>
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<th>Moral</th>
<th>Technical</th>
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<td>N/A</td>
<td>0/4 (0%)</td>
<td>2/4 (50%)</td>
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<tr>
<td>Response</td>
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<td>0/4 (0%)</td>
<td>2/4 (50%)</td>
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(Assuming a theoretical total of 12 possible responses, then the returned response was 33%)

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</thead>
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<tr>
<td>Population</td>
<td>3/4 (75%)</td>
<td>N/A</td>
<td>0/4 (0%)</td>
<td>0/4 (0%)</td>
</tr>
<tr>
<td>Response</td>
<td>3/3 (100%)</td>
<td>N/A</td>
<td>0/3 (0%)</td>
<td>0/3 (0%)</td>
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(Assuming a theoretical total of 12 possible responses, then the returned response was 25%)

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<th>Economic</th>
<th>Moral</th>
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</thead>
<tbody>
<tr>
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<td>N/A</td>
<td>0/4 (0%)</td>
<td>3/4 (75%)</td>
</tr>
<tr>
<td>Response</td>
<td>3/6 (75%)</td>
<td>N/A</td>
<td>0/6 (0%)</td>
<td>3/6 (75%)</td>
</tr>
</tbody>
</table>

(Assuming a theoretical total of 12 possible responses, then the returned response was 50%)

Continued ...............

(Analysis Sheet 18)
Pupils Synopsis of Oral Response Judgement Model

*(19/6F) Spike tin without bending. 
(-) (*) (-) (T)
*(20/6H) Looks well made. 
(-) (*) (-) (T)
*(27/6M) Stronger. More leverage. 
(-) (*) (-) (T)
(A) (*) (-) (T)

* The Population of (4) gave (5) Responses ---> (1) N/A (0) (4) *

* Sample Aesthetic Economic Moral Technical *
* ***** ***** ***** ***** ***** *
* Population 1/4 (25%) N/A 0/4 (0%) 4/4 (100%) *
* Response 1/5 (20%) N/A 0/5 (0%) 4/5 (80%) *

*(Assuming a theoretical total of 12 possible responses, then the returned response was 42%)*

*(17/7M) Easy to use. 
(-) (*) (-) (T)
*(18/7M) Easy to use. Sharper. 
(-) (*) (-) (T)
*(31/7M) Better shape. Big handle. Chinese break. 
(A) (*) (-) (T)
*(32/7M) End firm. Thicker rivets. Sharp screw. 
(-) (*) (-) (T)

* The Population of (4) gave (5) Responses ---> (1) N/A (0) (4) *

* Sample Aesthetic Economic Moral Technical *
* ***** ***** ***** ***** ***** *
* Population 1/4 (25%) N/A 0/4 (0%) 4/4 (100%) *
* Response 1/5 (20%) N/A 0/5 (0%) 4/5 (80%) *

*(Assuming a theoretical total of 12 possible responses, then the returned response was 42%)*

*(21/8M) Black blade. 
(A) (*) (-) (-) *
*(22/8M) More leverage. 
(-) (*) (-) (T)
*(29/8M) Angle goes in easier. 
(-) (*) (-) (T)
*(30/8M) Can see blade easier. 
(-) (*) (-) (-) *

* The Population of (4) gave (3) Responses ---> (1) N/A (0) (2) *

* Sample Aesthetic Economic Moral Technical *
* ***** ***** ***** ***** ***** *
* Population 1/4 (25%) N/A 0/4 (0%) 2/4 (50%) *
* Response 1/3 (33%) N/A 0/3 (0%) 2/3 (66%) *

*(Assuming a theoretical total of 12 possible responses, then the returned response was 25%)*
Question No.(11)  If your choice of Can Opener was limited to the following products (Rotary type), which would you choose?

Question No.(12)  Discuss the reasons for choosing the item selected.

******************************************************************************
*  CATALOGUE OF RESPONSES *
* ****************************
*  Pupil Synopsis of Oral Response Judgement Model *
******************************************************************************

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<th>Shape/Colour.</th>
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<th>(T)</th>
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<tr>
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<td>(-)</td>
<td>(-)</td>
</tr>
<tr>
<td>(4/1M)</td>
<td>(-)</td>
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<thead>
<tr>
<th>Wall mounted/Easy to use.</th>
<th>(no available candidate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(7/1)</td>
<td>( ) ( ) ( ) ( )</td>
</tr>
<tr>
<td>(8/1)</td>
<td>( ) ( ) ( ) ( )</td>
</tr>
</tbody>
</table>

* The Population of (2) gave (2) Responses ---> (1) (0) (0) (1) *

<table>
<thead>
<tr>
<th>Sample</th>
<th>Aesthetic</th>
<th>Economic</th>
<th>Moral</th>
<th>Technical</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>1/2</td>
<td>0/2</td>
<td>0/2</td>
<td>1/2</td>
</tr>
</tbody>
</table>

(Assuming a theoretical total of 8 possible responses, then the returned response was 25%)

******************************************************************************
*  CATALOGUE OF RESPONSES *
* ****************************
*  Pupil Synopsis of Oral Response Judgement Model *
******************************************************************************

<table>
<thead>
<tr>
<th>Comfortable to hold.</th>
<th>(no available candidate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1/2M)</td>
<td>( ) ( ) ( ) ( )</td>
</tr>
<tr>
<td>Safe/Easy to store.</td>
<td>( ) ( ) ( ) ( )</td>
</tr>
<tr>
<td>(2/2F)</td>
<td>( ) ( ) ( ) ( )</td>
</tr>
<tr>
<td>Reliable.</td>
<td>( ) ( ) ( ) ( )</td>
</tr>
<tr>
<td>(5/2M)</td>
<td>( ) ( ) ( ) ( )</td>
</tr>
<tr>
<td>Big and Strong.</td>
<td>( ) ( ) ( ) ( )</td>
</tr>
</tbody>
</table>

* The Population of (4) gave (5) Responses ---> (0) (0) (1) (4) *

<table>
<thead>
<tr>
<th>Sample</th>
<th>Aesthetic</th>
<th>Economic</th>
<th>Moral</th>
<th>Technical</th>
</tr>
</thead>
<tbody>
<tr>
<td>0/4</td>
<td>0/4</td>
<td>0/4</td>
<td>1/4</td>
<td>4/4</td>
</tr>
<tr>
<td>0/5</td>
<td>0/5</td>
<td>0/5</td>
<td>1/5</td>
<td>4/5</td>
</tr>
</tbody>
</table>

(Assuming a theoretical total of 16 possible responses, then the returned response was 31%)

******************************************************************************
* ****************************
*  Pupil Synopsis of Oral Response Judgement Model *
******************************************************************************
### CATALOGUE OF RESPONSES

**Pupil Synopsis of Oral Response Judgement Model**

<table>
<thead>
<tr>
<th>(11/3F) Wall mounted</th>
<th>(-) (-) (-) (T)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(12/3M) Know the product</td>
<td>(-) (-) (-) (T)</td>
</tr>
<tr>
<td>(25/3M) Big/comfortable.Faster.Sharper.Easy use.</td>
<td>(-) (-) (-) (T)</td>
</tr>
<tr>
<td>(26/3M) Colour.Operation good.</td>
<td>(A) (-) (-) (T)</td>
</tr>
</tbody>
</table>

**The Population of 4 gave 5 Responses ---> (1) (0) (0) (4)**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Aesthetic</th>
<th>Economic</th>
<th>Moral</th>
<th>Technical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Population** 1/4 (25%) 0/4 (0%) 0/4 (0%) 4/4 (100%)

**Response** 1/5 (20%) 0/5 (0%) 0/5 (0%) 4/5 (80%)

(Assuming a theoretical total of 16 possible responses, then the returned response was 31%)

---

**Sample Aesthetic Economic Moral Technical**

<table>
<thead>
<tr>
<th>Population</th>
<th>0/4 (0%) 1/4 (25%) 0/4 (0%) 4/4 (100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response</td>
<td>0/5 (0%) 1/5 (20%) 0/5 (0%) 4/5 (80%)</td>
</tr>
</tbody>
</table>

(Assuming a theoretical total of 16 possible responses, then the returned response was 31%)

---

**Sample Aesthetic Economic Moral Technical**

<table>
<thead>
<tr>
<th>Population</th>
<th>1/4 (25%) 1/4 (25%) 0/4 (0%) 3/4 (75%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response</td>
<td>1/5 (20%) 1/5 (20%) 0/5 (0%) 3/5 (60%)</td>
</tr>
</tbody>
</table>

(Assuming a theoretical total of 16 possible responses, then the returned response was 31%)

---

**More leverage**

<table>
<thead>
<tr>
<th>(-) (-) (-) (T)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(23/5M) ColourLooks best.</td>
</tr>
<tr>
<td>(24/5M) Easy to operate.Sharp blade.Fits well.</td>
</tr>
</tbody>
</table>

**The Population of 4 gave 5 Responses ---> (1) (1) (0) (3)**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Aesthetic</th>
<th>Economic</th>
<th>Moral</th>
<th>Technical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Population** 1/4 (25%) 1/4 (25%) 0/4 (0%) 3/4 (75%)

**Response** 1/5 (20%) 1/5 (20%) 0/5 (0%) 3/5 (60%)

(Assuming a theoretical total of 16 possible responses, then the returned response was 31%)

---

Continued ............
Question No.(13) Examine the three examples of kitchen tools to overcome the problem of removing tight screw tops. Which do you prefer?

Question No.(14) Discuss the reasons for choosing the item selected.

*******************************************************************
* CATALOGUE OF RESPONSES *
* Pupil Synopsis of Oral Response Judgement Model *
* (3/1M) Easier to use. Others look complicated. (A) (-) (-) (T) *
* (4/1M) Looks strong. Easier to use. (--) (--) (--) (T) *
* (7/1) (no available candidate) ( ) ( ) ( ) ( ) *
* (8/1) (no available candidate) ( ) ( ) ( ) ( ) *
* The Population of (2) gave (3) Responses ——> (1) (0) (0) (2) *

* Sample Aesthetic Economic Moral Technical *
* ***** ********* ******** ***** ********* *
* Population 1/2 (50%) 0/2 (0%) 0/2 (0%) 2/2 (100%) *
* Response 1/3 (33%) 0/3 (0%) 0/3 (0%) 2/3 (66%) *
* (Assuming a theoretical total of 8 possible responses, then the returned response was 38%) *

*******************************************************************
* CATALOGUE OF RESPONSES *
* Pupil Synopsis of Oral Response Judgement Model *
* (1/2M) Easy to snap skin. Simple. No joints. (-) (-) (M) (T) *
* (2/2F) Easier to use (disabled). Looks better. (A) (-) (M) (T) *
* (5/2M) Large range. (--) (--) (--) (T) *
* (6/2M) Easier to use. (--) (--) (--) (T) *
* The Population of (4) gave (7) Responses ——> (1) (0) (2) (4) *

* Sample Aesthetic Economic Moral Technical *
* ***** ********* ******** ***** ********* *
* Population 1/4 (25%) 0/4 (0%) 2/4 (50%) 4/4 (100%) *
* Response 1/7 (14%) 0/7 (0%) 2/7 (29%) 4/7 (57%) *
* (Assuming a theoretical total of 16 possible responses, then the returned response was 44%) *
CATALOGUE OF RESPONSES

Pupil Synopses of Oral Response Judgement Model

*(11/3F) Reasonably priced. Easy to handle. (-) (E) (-) (T) *
*(12/3M) Attractive. Similar action to scissors. (A) (-) (-) (T) *
*(25/3M) Quick action. (-) (-) (-) (T) *
*(26/3M) Functions well. Good looks. Easy operation (A) (-) (-) (T) *

* The Population of (4) gave (6) Responses --- > (1) (1) (0) (4) *

* Sample Aesthetic Economic Moral Technical *
* ***** ************ ***** ************ *
* Population 1/4 (25%) 1/4 (25%) 0/4 (0%) 4/4 (100%) *
* Response 1/6 (17%) 1/6 (17%) 0/6 (0%) 4/6 (67%) *

*(Assuming a theoretical total of 16 possible responses, then the returned response was 38%)

*******************************************************************
*******************************************************************
*(9/4M) Easier to use. Right size. (-) (-) (-) (T) *
*(10/4M) Does job easiest and best. (-) (-) (-) (T) *
*(15/4M) Self adjusting. (-) (-) (-) (T) *
*(16/4M) Looks better. (A) (-) (-) (T) *

* The Population of (4) gave (4) Responses --- > (1) (0) (0) (3) *

* Sample Aesthetic Economic Moral Technical *
* ***** ************ ***** ************ *
* Population 1/4 (25%) 0/4 (0%) 0/4 (0%) 3/4 (75%) *
* Response 1/4 (25%) 0/4 (0%) 0/4 (0%) 3/4 (75%) *

*(Assuming a theoretical total of 16 possible responses, then the returned response was 25%)

*******************************************************************
*******************************************************************
*(13/5M) Self adjusting. Nice shaped handle. (A) (-) (-) (T) *
*(14/5M) Value for money. Looks nice. (A) (E) (-) (T) *
*(23/5M) Looks better. (A) (-) (-) (T) *
*(24/5M) Looks good. No mess. Just put it on. (A) (-) (-) (T) *

* The Population of (4) gave (7) Responses --- > (4) (1) (0) (3) *

* Sample Aesthetic Economic Moral Technical *
* ***** ************ ***** ************ *
* Population 4/4 (100%) 1/4 (25%) 0/4 (0%) 3/4 (75%) *
* Response 4/7 (57%) 1/7 (14%) 0/7 (0%) 3/7 (43%) *

*(Assuming a theoretical total of 16 possible responses, then the returned response was 44%)

*******************************************************************
*******************************************************************

Continued ...........
CATALOGUE OF RESPONSES

* PupilSynopsis of Oral Response Judgement Model *

*(19/6F) Feels more force pressing. (-) (-) (-) (T) *
*(20/6M) Safer to use. (-) (-) (M) (-) *
*(27/6M) Easy to use. Strongest. (-) (-) (-) (T) *
*(28/6M) Can open a bigger jar. (-) (-) (-) (T) *

* The Population of (4) gave (4) Responses --> (0) (0) (1) (3) *

* Sample Aesthetic Economic Moral Technical *
* ***** ****** ****** ***** ****** *
* Population 0/4 ( 0%) 0/4 ( 0%) 1/4 (25%) 3/4 ( 75%) *
* Response 0/4 ( 0%) 0/4 ( 0%) 1/4 (25%) 3/4 ( 75%) *

*(Assuming a theoretical total of 16 possible responses, then the returned response was 25%)*

*(21/81) Easier to operate. (-) (-) (-) (T) *
*(22/8M) Wide range. Good grip. Not bulky. (-) (-) (-) (T) *
*(29/8M) Easier to fit. Easier to turn. (-) (-) (-) (T) *
*(30/8M) Easily adjustable. (-) (-) (-) (T) *

* The Population of (4) gave (4) Responses --> (0) (0) (0) (4) *

* Sample Aesthetic Economic Moral Technical *
* ***** ****** ****** ***** ****** *
* Population 0/4 ( 0%) 0/4 ( 0%) 0/4 ( 0%) 4/4 (100%) *
* Response 0/4 ( 0%) 0/4 ( 0%) 0/4 ( 0%) 4/4 (100%) *

*(Assuming a theoretical total of 16 possible responses, then the returned response was 25%)*
Question No.(15) Which of the three products do you consider to be the worst?

Question No.(16) Discuss the reasons for choosing the item selected.

Question No.(17) How would you improve this product?

*********************************************************************************
* CATALOGUE OF RESPONSES *
* * *
* Pupil Synopsis of Oral Response Judgement Model *
* *********************************************************************************
* (3/1M) Simple shape. Complex action. Colour. (A) (T) *
* (4/1M) Fiddly - make it stronger. (T) *
* (7/1) (no available candidate) ( ) ( ) ( ) ( ) *
* (8/1) (no available candidate) ( ) ( ) ( ) ( ) *
* *
* The Population of (2) gave (3) Responses ---> (1) (0) (0) (2) *
* *
* Sample Aesthetic Economic Moral Technical *
* ****** ****** ****** ****** *
* Population 1/4 (25%) 0/4 (0%) 0/4 (0%) 2/4 (50%) *
* Response 1/3 (33%) 0/3 (0%) 0/3 (0%) 2/3 (67%) *
* *
* (Assuming a theoretical total of 8 possible responses, then the returned response was 38%) *
* *********************************************************************************

*********************************************************************************
* CATALOGUE OF RESPONSES *
* * *
* Pupil Synopsis of Oral Response Judgement Model *
* *********************************************************************************
* (1/2M) Don't like it - plastic safety guard. (T) *
* (2/2F) No response. ( ) ( ) ( ) ( ) *
* (5/2M) Fiddly - no response. (T) *
* (6/2M) Complicated - No response. (T) *
* *
* The Population of (4) gave (3) Responses ---> (0) (0) (1) (2) *
* *
* Sample Aesthetic Economic Moral Technical *
* ****** ****** ****** ****** *
* Population 0/4 (0%) 0/4 (0%) 1/4 (25%) 2/4 (50%) *
* Response 0/3 (0%) 0/3 (0%) 1/3 (33%) 2/3 (67%) *
* *
* (Assuming a theoretical total of 16 possible responses, then the returned response was 19%) *
* *********************************************************************************
**CATALOGUE OF RESPONSES**

* Pupil Synopsis of Oral Response Judgement Model *

*(11/3F) Too expensive. Slip - Adjustable/Rubber. (-) (E) (-) (T) *
*(12/3M) Looks old fashioned - Chrome/plastic. (A) (-) (-) (-) *
*(25/3H) Poor grip - better lining inc. grip teeth. (-) (-) (-) (T) *
*(26/3H) General poor performance - better friction (-) (-) (-) (T) *

* The Population of (4) gave (5) Responses ----> (1) (1) (0) (3) *

* Sample   Aesthetic   Economic   Moral   Technical *
* *****     *******     *******     *****     ******* *
* Population 1/4 (25%) 1/4 (25%) 0/4 (0%) 3/4 (75%) *
* Response  1/5 (20%) 1/5 (20%) 0/5 (0%) 3/5 (60%) *

*(Assuming a theoretical total of 16 possible responses, then the returned response was 31%)*

* *(9/4M) Complicated. Poor looks - More plastic. (A) (-) (-) (T) *
*(10/4M) Poor looks - No response. (A) (-) (-) (-) *
*(15/4M) Damage to tops - Rubber protection. (-) (-) (-) (T) *
*(16/4M) Long set up time - Quicker adjustment. (-) (-) (-) (T) *

* The Population of (4) gave (5) Responses ----> (2) (0) (0) (4) *

* Sample   Aesthetic   Economic   Moral   Technical *
* *****     *******     *******     *****     ******* *
* Population 2/4 (50%) 0/4 (0%) 0/4 (0%) 3/4 (75%) *
* Response  2/5 (40%) 0/5 (0%) 0/5 (0%) 3/5 (60%) *

*(Assuming a theoretical total of 16 possible responses, then the returned response was 31%)*

* *(13/5M) Awkward - bigger holes to get point in. (-) (-) (-) (T) *
*(14/5M) Limited range. Not attractive - Plastic. (A) (-) (-) (T) *
*(23/5M) All the same - Rubber to protect tin lid. (-) (-) (-) (T) *
*(24/5M) Don’t like its looks - Make simple to use. (A) (-) (-) (T) *

* The Population of (4) gave (6) Responses ----> (2) (0) (0) (4) *

* Sample   Aesthetic   Economic   Moral   Technical *
* *****     *******     *******     *****     ******* *
* Population 2/4 (50%) 0/4 (0%) 0/4 (0%) 4/4 (100%) *
* Response  2/6 (33%) 0/6 (0%) 0/6 (0%) 4/6 (67%) *

*(Assuming a theoretical total of 16 possible responses, then the returned response was 38%)*

-44-
Continued ............
--- Analysis Sheet 28 ---

### Catalogue of Responses

**Synopsis of Oral Response Judgement Model**

* (19/6F) Awkward - change shape for better grip. (-) (-) (-) (T) *
* (20/6M) Damage to hand - Rubber protection/grip. (-) (-) (M) (T) *
* (27/6M) Liable to slip - Two rubber faces/bobbles. (-) (-) (-) (T) *
* (28/6M) Rubber not secure - knurled and wider. (-) (-) (-) (T) *

* The Population of (4) gave (5) Responses ——> (0) (0) (1) (4) *

<table>
<thead>
<tr>
<th>Sample</th>
<th>Aesthetic</th>
<th>Economic</th>
<th>Moral</th>
<th>Technical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>0/4 (0%)</td>
<td>0/4 (0%)</td>
<td>1/4 (25%)</td>
<td>4/4 (100%)</td>
</tr>
<tr>
<td>Response</td>
<td>0/5 (0%)</td>
<td>0/5 (0%)</td>
<td>1/5 (20%)</td>
<td>4/5 (80%)</td>
</tr>
</tbody>
</table>

(Assuming a theoretical total of 16 possible responses, then the returned response was 31%)

---

* (17/7M) Too fiddly - Make it look easier to use. (-) (-) (-) (T) *
* (18/7M) Slippage - More grips. (-) (-) (-) (T) *
* (31/7M) Doesn’t fit sometimes - no response. (-) (-) (-) (T) *
* (32/7M) Slips/flexes - Backward teeth. Thicker. (-) (-) (-) (T) *

* The Population of (4) gave (5) Responses ——> (1) (0) (0) (4) *

<table>
<thead>
<tr>
<th>Sample</th>
<th>Aesthetic</th>
<th>Economic</th>
<th>Moral</th>
<th>Technical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>1/4 (25%)</td>
<td>0/4 (0%)</td>
<td>0/4 (0%)</td>
<td>4/4 (100%)</td>
</tr>
<tr>
<td>Response</td>
<td>1/5 (20%)</td>
<td>0/5 (0%)</td>
<td>0/5 (0%)</td>
<td>4/5 (80%)</td>
</tr>
</tbody>
</table>

(Assuming a theoretical total of 16 possible responses, then the returned response was 31%)

---

* (21/8M) Didn’t twist – another adjustment bar. (-) (-) (-) (T) *
* (22/8M) Poor appearance. Rickety assembly. (-) (-) (-) (T) *
* (29/8M) Too big for small children – needs handle. (-) (-) (-) (T) *
* (30/8M) No opinion - No response. ( ) ( ) ( ) ( ) *

* The Population of (4) gave (4) Responses ——> (1) (0) (0) (3) *

<table>
<thead>
<tr>
<th>Sample</th>
<th>Aesthetic</th>
<th>Economic</th>
<th>Moral</th>
<th>Technical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>1/4 (25%)</td>
<td>0/4 (0%)</td>
<td>0/4 (0%)</td>
<td>3/4 (75%)</td>
</tr>
<tr>
<td>Response</td>
<td>1/4 (25%)</td>
<td>0/4 (0%)</td>
<td>0/4 (0%)</td>
<td>3/4 (75%)</td>
</tr>
</tbody>
</table>

(Assuming a theoretical total of 16 possible responses, then the returned response was 25%)

---

---
Question No. (18) Container lids are sometimes very difficult to remove. Examine the four examples shown and suggest how this problem can be eased in each case.

Keys Proposed changes to

<table>
<thead>
<tr>
<th>(a) Surface Texture</th>
<th>(b) Materials in Contact</th>
<th>(c) Force Applied</th>
<th>(d) Other/s</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Pupil</th>
<th>Synopsis of Oral Response</th>
<th>Technical Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(Specimen A)</td>
</tr>
</tbody>
</table>

| (1/2M) | Grip. Change to screw/press-on type | (-) (-) (c) (d) * |
| (2/2F) | Deeper groove - more lift. | (-) (-) (-) (d) * |
| (3/1M) | Change design- screw, turn-key, tube | (-) (-) (-) (d) * |
| (4/1M) | Change design to a turn-key. | (-) (-) (-) (d) * |
| (5/2M) | Larger gap- flip off - more clearance | (-) (-) (-) (d) * |
| (6/2M) | No idea. | (-) (-) (-) (-) * |
| (7/1) | (no available candidate) | (-) (-) (-) (-) * |
| (8/1) | (no available candidate) | (-) (-) (-) (-) * |
| (9/4M) | Friction - grip between fingers/lid. | (a) (-) (-) (-) * |
| (10/4M) | Change design to screw type. | (-) (-) (-) (d) * |
| (11/3F) | Don't really know. | (-) (-) (-) (-) * |
| (12/3M) | Prize it open. Wider bottom - grip. | (-) (-) (c) (-) * |
| (13/5M) | Turn-key. Bigger lid - looser. | (-) (-) (c) (d) * |
| (14/5M) | Looser - pull it straight off | (-) (-) (c) (-) * |
| (15/4M) | Bigger cut out - press down easier | (-) (-) (-) (d) * |
| (16/4M) | No idea. | (-) (-) (-) (-) * |
| (17/7M) | If design doesn't work- change it. | (-) (-) (-) (-) * |
| (18/7M) | Screw it off. | (-) (-) (-) (-) * |
| (19/6F) | Handles sticking out - grip. | (-) (-) (c) (-) * |
| (20/6M) | Loosen it. Change to screw top. | (-) (-) (c) (d) * |
| (21/8M) | Different design - turn-key | (-) (-) (-) (d) * |
| (22/BM) | Presses down so quick | (-) (-) (-) (-) * |
| (23/5M) | Bottom - smaller diameter. | (-) (-) (c) (-) * |
| (24/5M) | No. | (-) (-) (-) (-) * |
| (25/3M) | Looser fitting top - less friction | (-) (-) (c) (-) * |
| (26/5M) | Friction. Materials. Design change. | (-) (-) (d) (-) * |
| (27/6M) | Don't know. | (-) (-) (-) (-) * |
| (28/6M) | Screw top. | (-) (-) (-) (-) * |
| (29/8M) | Bigger cut out to come down easier | (-) (-) (-) (d) * |
| (30/BN) | Twist type. | (-) (-) (-) (-) * |
| (31/7M) | Screw top. | (-) (-) (-) (d) * |
| (32/7M) | Tie release. Release valve- pressure. | (-) (-) (c) (d) * |

* AGGREGATE OF TOTAL SOLUTIONS GIVEN
(1) (1) (9) (19) *

* (Total number of passes 5) *

---

Continued ........
Question No. (18) Container lids are sometimes very difficult to remove. Examine the four examples shown and suggest how this problem can be eased.

Key: Proposed changes to (a) Surface Texture
(b) Materials in Contact
(c) Force Applied
(d) Other/s

* CATALOGUE OF RESPONSES *
* Pupil Synopsis of Oral Response Technical Solutions *(Specimen B) *

* (1/2M) No ideas. (-) (-) (-) (-) *
* (2/2F) No. (-) (-) (-) (-) *
* (3/1M) Larger movement. Larger container. (-) (-) (c) (-) *
* (4/1M) Don’t know really. (-) (-) (-) (-) *
* (5/2M) Not sure. (-) (-) (-) (-) *
* (6/2M) No idea. (-) (-) (-) (-) *
* (7/1) (no available candidate) (-) (-) (-) (-) *
* (8/1) (no available candidate) (-) (-) (-) (-) *
* (9/4M) More grip. (-) (-) (c) (-) *
*(10/4M) Bigger ridges. Deeper slope. (a) (-) (c) (d) *
*(11/3F) Loosen it-bigger lid diameter. (-) (-) (c) (-) *
*(12/3M) No. (-) (-) (-) (-) *
*(13/5M) No ideas. (-) (-) (-) (-) *
*(14/5M) Not so close fitting. Screw. (-) (-) (c) (d) *
*(15/4M) Sliding material. Chamfer along it. (-) (b) (-) (d) *
*(16/4M) Warm water - expand it. (-) (-) (-) (d) *
*(17/7M) Good design. Lid could be bigger. (-) (-) (c) (-) *
*(18/7M) Clip design is better. (-) (-) (-) (d) *
*(19/6F) Screw it off instead. (-) (-) (-) (d) *
*(20/6M) Screw top. (-) (-) (-) (d) *
*(21/6M) Put bar across-better grip. (-) (-) (-) (d) *
*(22/6M) Friction. (-) (-) (-) (d) *
*(23/5M) Tin smaller. (-) (-) (-) (d) *
*(24/5M) No. (-) (-) (-) (-) *
*(25/3M) Looser fitting. (-) (-) (c) (-) *
*(26/3M) Material. Grip. Less friction if angled. (-) (b) (c) (-) *
*(27/6M) Not sure about that one. (-) (-) (-) (-) *
*(28/6M) L-shaped pins. No surface area. (-) (-) (-) (d) *
*(29/6M) No. (-) (-) (-) (-) *
*(30/6M) Thread. (-) (-) (-) (d) *
*(31/7M) Wheels/balls inside. (-) (-) (-) (d) *
*(32/7M) Like a light bulb fitting instead. (-) (-) (-) (d) *

* AGGREGATE OF TOTAL SOLUTIONS GIVEN (1) (2) (10) (12) *
* (Total number of passes 10) */
Question No. (18) Container lids are sometimes very difficult to remove. Examine the four examples shown and suggest how this problem can be eased in each case.

**Keys:** Proposed changes to (a) Surface Texture (b) Materials in Contact (c) Force Applied. (d) Other/s

---

<table>
<thead>
<tr>
<th>CATALOGUE OF RESPONSES</th>
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<tbody>
<tr>
<td><strong>Pupil</strong> Synopsis of Oral Response</td>
</tr>
<tr>
<td><strong>(Specimen C)</strong></td>
</tr>
</tbody>
</table>

| **1/2M** Press on type. | (-) (-) (-) (d) |
| **2/2F** Pull off. | (-) (-) (-) (d) |
| **3/1M** Larger top. Metal/plastic. Friction | (-) (b) (-) (c) (-) |
| **4/1M** Bigger top. | (-) (-) (c) (-) |
| **5/2M** Larger or square for better grip. | (-) (-) (c) (d) |
| **6/2M** Bigger top - easier to hold | (-) (-) (-) (-) |
| **7/7I** (no available candidate) | (-) (-) (-) (-) |
| **8/1** (no available candidate) | (-) (-) (-) (-) |
| **9/4M** Different plastic. Bigger top. | (-) (b) (c) (-) |
| **10/4M** No. | (-) (-) (-) (-) |
| **11/3F** Rubber around cap (grip) | (-) (b) (-) (-) |
| **12/3M** Two bits sticking out - more pressure. | (-) (-) (c) (-) |
| **13/5M** No idea. | (-) (-) (-) (-) |
| **14/5M** Press on design. | (-) (-) (-) (d) |
| **15/4M** Wider - bigger area to hold on to. | (-) (-) (c) (d) |
| **16/4M** No - use pliers. | (-) (-) (-) (d) |
| **17/7M** Push of type of design. | (-) (-) (-) (-) |
| **18/7M** Pull off. | (-) (-) (-) (d) |
| **19/6F** Screw on cap. | (-) (-) (-) (d) |
| **20/6M** Press on cap. | (-) (-) (-) (-) |
| **21/8M** Rubber grip. | (-) (b) (-) (-) |
| **22/8M** Flick/press cap. | (-) (-) (-) (d) |
| **23/5M** A mechanism. | (-) (-) (c) (-) |
| **24/5M** Press-on cap. | (-) (-) (-) (d) |
| **25/3M** Big cap - more area. Teeth for grip. | (a) (-) (c) (d) |
| **26/3M** Clip-on cap. Bigger dia. Grip bumps | (a) (-) (c) (d) |
| **27/6M** Pull top. | (-) (-) (-) (d) |
| **28/6M** Bigger lid - more grip. | (-) (-) (c) (-) |
| **29/8M** Press type cap. | (-) (-) (-) (d) |
| **30/8M** Pull off cap. | (-) (-) (-) (d) |
| **31/7M** Bigger cap - easier turn (distance) | (-) (-) (-) (c) |
| **32/7M** Bigger top - more grip. | (-) (-) (c) (-) |

---

**ABSCREBE OF TOTAL SOLUTIONS GIVEN**

(2) (4) (13) (17) *

(Total number of passes 2)

---

-48-

Continued ........
Question No. (18) Container lids are sometimes very difficult to remove. Examine the four examples shown and suggest how this problem can be eased in each case.

Key: Proposed changes to (a) Surface Texture (b) Materials in Contact (c) Force Applied. (d) Other/s

******************************************************************************
* CATALOGUE OF RESPONSES *
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AGGREGATE OF TOTAL SOLUTIONS GIVEN

(Total number of passes 9)
Question No. C19: How do containers (E), (F), (G), and (H) overcome the problem associated with that found in container (D)?

Key: Proposed changes to (a) Surface Texture  
(b) Materials in Contact  
(c) Force Applied.  
(d) Other/s

---

### Catalogue of Responses

<table>
<thead>
<tr>
<th>Pupil Synopsis of Oral Response</th>
<th>Technical Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1/2H) Don’t have to twist around so many times.</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(2/2F) Don’t have to keep twisting.</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(3/1M) Stiff- tongues too deep.</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(4/1H) Big lid—less likely to stick.</td>
<td>(-) (-) (c) (-)</td>
</tr>
<tr>
<td>(5/2H) Easier to grip. Only one turn.</td>
<td>(-) (-) (c) (d)</td>
</tr>
<tr>
<td>(6/2H) Turns and lifts off straight away.</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(7/1) (no available candidate)</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>(8/1) (no available candidate)</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>(9/4M) Grip. Less surface. Shorter distance.</td>
<td>(-) (-) (c) (d)</td>
</tr>
<tr>
<td>(10/4M) Not so much metal touching.</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(11/3F) Let air in. Not full turn.</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(12/3M) Small area to screw it on.</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(13/5M) Bigger grip. Surface area.</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(14/5M) One turn.</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(15/4M) Less friction—less contact on screw.</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(16/4M) Shorter movement. Dents for better grip.</td>
<td>(a) (-) (-) (d)</td>
</tr>
<tr>
<td>(17/7M) Shorter screw. Plastic coated. Grip mottles.</td>
<td>(a) (b) (-) (d)</td>
</tr>
<tr>
<td>(18/7M) Short movement.</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(19/6F) Comes off easier—no reason given.</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>(20/6M) Shorter movement.</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(21/8M) No. It could stick.</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>(22/8M) Reduced movement.</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>(23/5M) Less movement—steep slope.</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(24/5M) No.</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>(25/3M) Less contact—less friction.</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(26/3M) Size. Stronger material. Smooth.</td>
<td>(a) (-) (c) (d)</td>
</tr>
<tr>
<td>(27/6M) Better—can be put on at any place.</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(28/6M) Smaller area.</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(29/6M) Rubber seal grips.</td>
<td>(-) (-) (c) (-)</td>
</tr>
<tr>
<td>(30/6M) Don’t have to twist so much.</td>
<td>(-) (-) (c) (d)</td>
</tr>
<tr>
<td>(31/7M) Shorter distance—jumps.</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(32/7M) Bigger. Quick release. Ability to flex.</td>
<td>(-) (-) (c) (d)</td>
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**Aggregate of Total Solutions**

(3) (1) (9) (24) *

**Total number of passes 4**

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Continued .........
(Analysis Sheet 34)

Question No. (19)  How do containers (E), (F), (G), and (H) overcome the problem associated with that found in container (D)?

Key:  Proposed changes to
(a) Surface Texture
(b) Materials in Contact
(c) Force Applied.
(d) Other/s

<table>
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<tr>
<th>Question Number</th>
<th>Description</th>
<th>Category</th>
<th>Solution</th>
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<tbody>
<tr>
<td>(1/2)</td>
<td>Less 'things' on the top.</td>
<td>(a)</td>
<td>(-) (-) (-) (d)</td>
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<tr>
<td>(2/2)</td>
<td>Still one movement.</td>
<td>(a)</td>
<td>(-) (-) (-) (d)</td>
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<tr>
<td>(3/1)</td>
<td>Less grip. Less leverage.</td>
<td>(a)</td>
<td>(-) (-) (c) (-)</td>
</tr>
<tr>
<td>(4/1)</td>
<td>Stiffer.</td>
<td>(a)</td>
<td>(-) (-) (-) (c)</td>
</tr>
<tr>
<td>(5/2)</td>
<td>Small grips (irregular shaped cap)</td>
<td>(a)</td>
<td>(-) (-) (-) (d)</td>
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<tr>
<td>(6/2)</td>
<td>Slopes.</td>
<td>(a)</td>
<td>(-) (-) (-) (d)</td>
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<tr>
<td>(7/1)</td>
<td>(no available candidate)</td>
<td>(a)</td>
<td>(-) (-) (-) (c)</td>
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<tr>
<td>(8/1)</td>
<td>(no available candidate)</td>
<td>(a)</td>
<td>(-) (-) (-) (d)</td>
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<tr>
<td>(9/4)</td>
<td>Less friction-surfaces in contact.</td>
<td>(a)</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(10/4)</td>
<td>Less ridges.</td>
<td>(a)</td>
<td>(-) (-) (-) (d)</td>
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<tr>
<td>(11/3)</td>
<td>Same idea. (let air in. Not full turn)</td>
<td>(a)</td>
<td>(-) (-) (c) (d)</td>
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<tr>
<td>(12/3)</td>
<td>Quicker.</td>
<td>(a)</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(13/5)</td>
<td>No.</td>
<td>(a)</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(14/5)</td>
<td>Same as before. (One turn)</td>
<td>(a)</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(15/4)</td>
<td>Same sort of thing - not so many teeth.</td>
<td>(a)</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(16/4)</td>
<td>Shorter movement.</td>
<td>(a)</td>
<td>(-) (-) (-) (c)</td>
</tr>
<tr>
<td>(17/7)</td>
<td>Paint/plastic shorter movement.</td>
<td>(a)</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(18/7)</td>
<td>Same sort of thing. (short movement)</td>
<td>(a)</td>
<td>(-) (-) (-) (d)</td>
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<tr>
<td>(19/6)</td>
<td>Lid forces it off.</td>
<td>(a)</td>
<td>(-) (-) (-) (c)</td>
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<tr>
<td>(20/6)</td>
<td>Worse for sticking.</td>
<td>(a)</td>
<td>(-) (-) (-) (-)</td>
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<tr>
<td>(21/8)</td>
<td>Bar across - better grips</td>
<td>(a)</td>
<td>(-) (-) (c) (-)</td>
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<tr>
<td>(22/8)</td>
<td>Friction.</td>
<td>(a)</td>
<td>(-) (-) (-) (c)</td>
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<tr>
<td>(23/5)</td>
<td>Smaller tin.</td>
<td>(a)</td>
<td>(-) (-) (c) (-)</td>
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<tr>
<td>(24/5)</td>
<td>No.</td>
<td>(a)</td>
<td>(-) (-) (-) (c)</td>
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<tr>
<td>(25/3)</td>
<td>Less contact - less friction</td>
<td>(a)</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(26/3)</td>
<td>Same(size. stronger material. smooth)</td>
<td>(a)</td>
<td>(-) (-) (c) (d)</td>
</tr>
<tr>
<td>(27/6)</td>
<td>Same(better can be put on any place)</td>
<td>(a)</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(28/6)</td>
<td>Same(smaller area)</td>
<td>(a)</td>
<td>(-) (-) (-) (d)</td>
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<tr>
<td>(29/8)</td>
<td>Double seal</td>
<td>(a)</td>
<td>(-) (-) (-) (d)</td>
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<tr>
<td>(30/8)</td>
<td>Justs twists off. No idea why.</td>
<td>(a)</td>
<td>(-) (-) (-) (d)</td>
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<tr>
<td>(31/7)</td>
<td>Same(shorter distance-jumps)</td>
<td>(a)</td>
<td>(-) (-) (-) (d)</td>
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<tr>
<td>(32/7)</td>
<td>Same but slightly smaller.</td>
<td>(a)</td>
<td>(-) (-) (-) (c)</td>
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</tbody>
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* CATALOGUE OF RESPONSES

* Pupil

Synopsis of Oral Response

Technical Solution

(Specimen F)
How do containers (E), (F), (G), and (H) overcome the problem associated with that found in container (D)?

**Key:** Proposed changes to (a) Surface Texture  
(b) Materials in Contact  
(c) Force Applied.  
(d) Other/s

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**CATALOGUE OF RESPONSES**

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<th>Pupil</th>
<th>Synopsis of Oral Response</th>
<th>Technical Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1/2M)</td>
<td>More turn - screwdriver action</td>
<td>(-) (-) (c) (-)</td>
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<tr>
<td>(2/2F)</td>
<td>Smoother</td>
<td>(a) (-) (-) (-)</td>
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<td>(3/1M)</td>
<td>Half-turn</td>
<td>(-) (-) (-) (d)</td>
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<tr>
<td>(4/1M)</td>
<td>Materials</td>
<td>(-) (b) (-) (-)</td>
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<tr>
<td>(5/2M)</td>
<td>Plastic materials clash</td>
<td>(-) (b) (-) (-)</td>
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<tr>
<td>(6/2M)</td>
<td>No</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>(7/1)</td>
<td>(no available candidate)</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>(8/1)</td>
<td>(no available candidate)</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>(9/4M)</td>
<td>More mechanical advantage</td>
<td>(-) (-) (c) (-)</td>
</tr>
<tr>
<td>(10/4M)</td>
<td>Something to grab hold of</td>
<td>(-) (-) (c) (-)</td>
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<tr>
<td>(11/3F)</td>
<td>Increased force of grip</td>
<td>(-) (-) (c) (-)</td>
</tr>
<tr>
<td>(12/3M)</td>
<td>Different dia.-more area to hold-fits hand</td>
<td>(-) (-) (c) (d)</td>
</tr>
<tr>
<td>(13/5M)</td>
<td>Plastic doesn't stick</td>
<td>(-) (b) (-) (-)</td>
</tr>
<tr>
<td>(14/5M)</td>
<td>Few turns.Fingers slip on plastic</td>
<td>(-) (b) (-) (d)</td>
</tr>
<tr>
<td>(15/4M)</td>
<td>Bigger lid with bigger threads-more effort</td>
<td>(-) (-) (c) (-)</td>
</tr>
<tr>
<td>(16/4M)</td>
<td>No</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>(17/7M)</td>
<td>Plastic-very little friction</td>
<td>(-) (b) (-) (-)</td>
</tr>
<tr>
<td>(18/7M)</td>
<td>Don’t have to screw as far</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(19/6F)</td>
<td>Materials don’t stick</td>
<td>(-) (b) (-) (-)</td>
</tr>
<tr>
<td>(20/6M)</td>
<td>One thread-gap is bigger</td>
<td>(-) (-) (c) (-)</td>
</tr>
<tr>
<td>(21/8M)</td>
<td>Better but no reason given</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>(22/8M)</td>
<td>Not better-more friction</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>(23/5M)</td>
<td>No</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>(24/5M)</td>
<td>No</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>(25/3M)</td>
<td>Wider thread. Less turns</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(26/3M)</td>
<td>Plastic materials.Diff.Dias.an advantage</td>
<td>(-) (b) (c) (-)</td>
</tr>
<tr>
<td>(27/6M)</td>
<td>Warm it to expand it</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(28/6M)</td>
<td>Better - more area to hold on to</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(29/8M)</td>
<td>Double seal</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(30/8M)</td>
<td>Materials-less friction</td>
<td>(-) (b) (-) (-)</td>
</tr>
<tr>
<td>(31/7M)</td>
<td>Easier-smaller distance inside</td>
<td>(-) (-) (c) (-)</td>
</tr>
<tr>
<td>(32/7M)</td>
<td>Flex more.Coarse threads-less force</td>
<td>(-) (-) (-) (d)</td>
</tr>
</tbody>
</table>

**AGGREGATE OF TOTAL SOLUTIONS**

<table>
<thead>
<tr>
<th>(1) (8) (10) (10)</th>
</tr>
</thead>
</table>

(Total number of passes 6)

---

Continued ..............
Question No. (19) How do containers (E), (F), (B), and (H) overcome the problem associated with that found in container (D)?

Key: Proposed changes to (a) Surface Texture
(b) Materials in Contact
(c) Force Applied.
(d) Other/s

<table>
<thead>
<tr>
<th>CATALOGUE OF RESPONSES</th>
<th>Technical Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pupil</strong></td>
<td>Synopsis of Oral Response</td>
</tr>
<tr>
<td>******</td>
<td>******</td>
</tr>
<tr>
<td>(1/2M) Grip with hands better—plastic</td>
<td>(a)</td>
</tr>
<tr>
<td>(2/2F) Smoother</td>
<td>(-)</td>
</tr>
<tr>
<td>(3/1M) Half a turn. No stickiness.</td>
<td>(-)</td>
</tr>
<tr>
<td>(4/1M) Less likely to stick—plastic lid</td>
<td>(-)</td>
</tr>
<tr>
<td>(5/2M) Plastic/glass—less friction</td>
<td>(-)</td>
</tr>
<tr>
<td>(6/2M) Plastic top—easier to grip</td>
<td>(-)</td>
</tr>
<tr>
<td>(7/1) (no available candidate)</td>
<td>(-)</td>
</tr>
<tr>
<td>(8/1) (no available candidate)</td>
<td>(-)</td>
</tr>
<tr>
<td>(9/4M) Less friction—plastic lid</td>
<td>(-)</td>
</tr>
<tr>
<td>(10/4M) Don’t know</td>
<td>(-)</td>
</tr>
<tr>
<td>(11/3F) Not much turn for sticking</td>
<td>(-)</td>
</tr>
<tr>
<td>(12/3M) No</td>
<td>(-)</td>
</tr>
<tr>
<td>(13/5M) Both different materials</td>
<td>(-)</td>
</tr>
<tr>
<td>(14/5M) Normal type of top</td>
<td>(-)</td>
</tr>
<tr>
<td>(15/4M) One thread—one line—small movement</td>
<td>(-)</td>
</tr>
<tr>
<td>(16/4M) Plastic top—stretch. Wouldn’t press hard.</td>
<td>(-)</td>
</tr>
<tr>
<td>(17/7M) Shorter thread. Plastic top</td>
<td>(-)</td>
</tr>
<tr>
<td>(18/10M) Doesn’t turn it as far</td>
<td>(-)</td>
</tr>
<tr>
<td>(19/6F) Plastic lid</td>
<td>(-)</td>
</tr>
<tr>
<td>(20/6M) Turn once—one thread</td>
<td>(-)</td>
</tr>
<tr>
<td>(21/8M) Easy—plastic top won’t bend</td>
<td>(-)</td>
</tr>
<tr>
<td>(22/8M) Better—not so much contact</td>
<td>(-)</td>
</tr>
<tr>
<td>(23/3M) No</td>
<td>(-)</td>
</tr>
<tr>
<td>(24/5M) Lines on the glass—comes off easy</td>
<td>(-)</td>
</tr>
<tr>
<td>(25/3M) Less turns—more contact—more friction</td>
<td>(-)</td>
</tr>
<tr>
<td>(26/3M) Materials. Smooth finish on lid.</td>
<td>(a)</td>
</tr>
<tr>
<td>(27/6M) Plastic/glass might slip in hands</td>
<td>(-)</td>
</tr>
<tr>
<td>(28/6M) Small amount of thread</td>
<td>(-)</td>
</tr>
<tr>
<td>(29/8M) Plastic—no hand grip. Smoother but not sure</td>
<td>(a)</td>
</tr>
<tr>
<td>(30/8M) Tomato makes it stick. Not apparently stuck</td>
<td>(-)</td>
</tr>
<tr>
<td>(31/7M) Same (smaller distance inside)</td>
<td>(-)</td>
</tr>
<tr>
<td>(32/7M) Single thread. Flex a little. Less force</td>
<td>(-)</td>
</tr>
</tbody>
</table>

AGGREGATE OF TOTAL SOLUTIONS (3) (12) (5) (9) (*)

(Total number of passes 4)

Continued ........
Question No.(30) From the selection of four door wedges, which is the best?

Question No.(31) Why?

Key to accredited responses: (a) Range/size for gap under door
(b) Locking qualities of taper
(c) Strength/wear resistance
(d) Area of Contact

*******************************************************************************
* CATALOGUE OF RESPONSES
*
* Pupil Selection Synopsis of Oral Responses Accredited Response
* **** ************ ************ ************
*******************************************************************************

* (1/2M) (8.2) Slip under door. Jam/slip away (a) (b) ( ) ( ) *
* (2/2F) (8.3) Too big/too small (a) ( ) ( ) ( ) *
* (3/1M) (8.4) Larger—can apply more force ( ) ( ) (c) ( ) *
* (4/1M) (8.2) Others too big/too small (a) ( ) ( ) ( ) *
* (5/2M) (8.3) Largest wouldn’t stay. Sturdier ( ) (b) (c) ( ) *
* (6/2M) (8.2) Right size (a) ( ) ( ) ( ) *
* (7/1) (no available candidate) ( ) ( ) ( ) ( ) *
* (8/1) (no available candidate) ( ) ( ) ( ) ( ) *
* (9/4M) (8.2) Less angle—won’t wedge if steep ( ) (b) ( ) ( ) *
* (10/4M) (8.1) Not so big/easy to get under (a) ( ) ( ) ( ) *
* (11/3F) (8.4) Height of door—different space (a) ( ) ( ) ( ) *
* (12/3M) (8.3) Med. size—just right (a) ( ) ( ) ( ) *
* (13/5M) (8.3) Not too steep—not too straight (a) ( ) ( ) ( ) *
* (14/5M) (8.2) Smallest would go under door (a) ( ) ( ) ( ) *
* (15/4M) (8.1) Others fasten on a smaller piece ( ) ( ) ( ) (d) *
* (16/4M) (8.1) Better grip to remove it ( ) ( ) ( ) ( ) *
* (17/7M) (8.2) Right size (a) ( ) ( ) ( ) *
* (18/7M) (8.4) Stops it better. Goes over some. (a) ( ) ( ) ( ) *
* (19/6F) (8.1) Fits more of it under the door (a) ( ) ( ) (d) *
* (20/6M) (8.3) Thinnest snaps. Thickest wouldn’t fit (a) ( ) (c) ( ) *
* (21/8M) (8.2) Size of some too small (a) ( ) ( ) ( ) *
* (22/8M) (8.4) Big back for grip ( ) ( ) ( ) ( ) *
* (23/5M) (8.3) Others would slip over (a) ( ) ( ) ( ) *
* (24/5M) (8.4) Better—would last ( ) ( ) (c) ( ) *
* (25/3M) (8.3) Go under door too far (a) ( ) ( ) ( ) *
* (26/3M) (8.4) Depends how well door is hung. (a) (b) ( ) ( ) *
* (refers to inc. plane and ancient machines) *
* (27/6M) (8.3) Firnest. Best size (a) ( ) (c) ( ) *
* (28/6M) (8.2) More area on bottom of door ( ) ( ) ( ) (d) *
* (29/8M) (8.2) Greater angle makes it too big (a) ( ) ( ) ( ) *
* (30/8M) (8.2) Goes under without going through (a) ( ) ( ) ( ) *
* (31/7M) (8.2) Too small/too big (a) ( ) ( ) ( ) *
* (32/7M) (8.3) Smallest chamfer without going over (a) (b) ( ) ( ) *
*******************************************************************************
* AGGREGATE OF TOTAL SELECTIONS (22)(5) (5) (3) *
*
* Choices of wedge were as follows: 8.1 8.2 8.3 8.4 *
* (4) (11) (9) (6) *
Question No. (32)  Give one limitation of your chosen wedge

Question No. (33)  How would you improve this product?

Proposed changes to (a) Structure  
(b) Form  
(c) Material  
(d) Dimension  
(e) Surface

<table>
<thead>
<tr>
<th>Question No.</th>
<th>Synopsis of Oral Response</th>
<th>Technical Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>(no available candidate)</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>(no available candidate)</td>
<td></td>
</tr>
</tbody>
</table>

(Catalogue of Responses)

<table>
<thead>
<tr>
<th>Pupil</th>
<th>(1/2M) Wood might damage door. Grips on bottom</th>
<th>(e)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(2/2F) Colour. Weight. Harder wood</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(3/1M) Gap under doors changes - no improvement</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(4/1M) No change - more fancy, different colours</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(5/2M) Shorten it. Softer plastic.</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(6/2M) Varnish it.</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(7/1) (no available candidate)</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(8/1) (no available candidate)</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(9/4M) No</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(10/4M) Shorten it</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(11/3F) Paint it</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(12/3M) No</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(13/5M) No</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(14/5M) Longer but less angle</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(15/4M) No</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(16/4M) Slope lower but end as high. Gib headed</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(17/7M) Size. Rubber top and bottom to stop slip</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(18/7M) No</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(19/6F) Metal piece for strength</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(20/6M) Rubber for grip</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(21/8M) Width to make door more secure</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(22/8M) Metal to slide. Ridges for grip</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(23/5M) Handles/Finger grips. Varnish.</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(24/5M) Bigger</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(25/3M) Size. Rubber. Gripping teeth.</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(26/3M) Too big. Shape-rounded edges. Varnish.</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(27/6M) Metal with rubber strip.</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(28/6M) Handle. More attractive.</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(29/8M) Top and bottom - rubber</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(30/8M) No change</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(31/7M) Grain of wood - snap. Rubber</td>
<td>(e)</td>
</tr>
<tr>
<td></td>
<td>(32/7M) Shorten but same angle</td>
<td>(e)</td>
</tr>
</tbody>
</table>

(Aggregate of Total Selections)

<table>
<thead>
<tr>
<th>(Total number of passes 7)</th>
</tr>
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<tbody>
<tr>
<td>(0) (4) (11) (10) (10)</td>
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</tbody>
</table>

-55-
**Question No. (30)**

Compare your chosen wedge with door wedge (K).

**Key to responses:**
(a) Range/size for gap under door  
(b) Locking qualities of taper  
(c) Materials  
(d) Surface Texture  
(e) Area of Contact  
(f) Other/s

<table>
<thead>
<tr>
<th>Pupil Synopsis of Oral Response</th>
<th>Technical Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1/2M) Rubber would give more.Holes let it squash</td>
<td>(10/4M) Worse-big and wont do job right</td>
</tr>
<tr>
<td>(2/2F) Wouldn’t snap/spoil carpet.Heavier</td>
<td>(11/3F) Looks better shape-more expensive</td>
</tr>
<tr>
<td>(3/1M) Flexible-will push back harder</td>
<td>(12/3M) Modern.Stick better on rubber.Looks better</td>
</tr>
<tr>
<td>(4/1M) Better-not slide</td>
<td>(13/5M) Better rubber(dog chews wood)Less stable</td>
</tr>
<tr>
<td>(5/2M) Rubber would mould into door and hold firm</td>
<td>(14/5M) Rubber for better grip.</td>
</tr>
<tr>
<td>(6/2M) Rubber-better grip-sticks better</td>
<td>(15/4M) Better grip with rubber</td>
</tr>
<tr>
<td>(7/1) (no available candidate)</td>
<td>(16/4M) Rubber - more friction</td>
</tr>
<tr>
<td>(8/1) (no available candidate)</td>
<td>(17/7M) More area/writing on face stop door</td>
</tr>
<tr>
<td>(9/4M) Material is lighter/cheaper/gives friction</td>
<td>(18/7M) Stick better with rubber</td>
</tr>
<tr>
<td>(10/4H) Worse-big and wont do job right</td>
<td>(19/6F) Won’t slide.Base shape better for sticking</td>
</tr>
<tr>
<td>(11/3F) Looks better shape-more expensive</td>
<td>(20/6M) Rubber for better grip.Hollows for give.to stop splitting.</td>
</tr>
<tr>
<td>(12/3M) Modern.Stick better on rubber.Looks better</td>
<td></td>
</tr>
<tr>
<td>(13/5M) Better rubber(dog chews wood)Less stable</td>
<td></td>
</tr>
<tr>
<td>(14/5M) Rubber for better grip.</td>
<td></td>
</tr>
<tr>
<td>(15/4M) Better grip with rubber</td>
<td></td>
</tr>
<tr>
<td>(16/4M) Rubber - more friction</td>
<td></td>
</tr>
<tr>
<td>(17/7M) More area/writing on face stop door.</td>
<td></td>
</tr>
<tr>
<td>(18/7M) Stick better with rubber</td>
<td></td>
</tr>
<tr>
<td>(19/6F) Won’t slide.Base shape better for sticking</td>
<td></td>
</tr>
<tr>
<td>(20/6M) Rubber for better grip.Hollows for give.to stop splitting.</td>
<td></td>
</tr>
<tr>
<td>(21/8M) Rubber would stick.</td>
<td></td>
</tr>
<tr>
<td>(22/8M) Rubber gives better contact-holds firmly</td>
<td></td>
</tr>
<tr>
<td>(23/5M) Lighter helps when pushing it</td>
<td></td>
</tr>
<tr>
<td>(24/5M) Rubber is stronger</td>
<td></td>
</tr>
<tr>
<td>(25/3M) Rubber-friction.Flexible-less chance of it breaking</td>
<td></td>
</tr>
<tr>
<td>(26/3M) More friction(mat).Apply a larger force on a smaller area. Surface texture better</td>
<td></td>
</tr>
<tr>
<td>(27/6M) Rubber-non slip.Easier to fit door on</td>
<td></td>
</tr>
<tr>
<td>(28/6M) Rubber gives/holds firm.More area.Grips on bottom</td>
<td></td>
</tr>
<tr>
<td>(29/8M) Won’t burn,rot or wear so easily.</td>
<td></td>
</tr>
<tr>
<td>(30/8M) Less slip.More give and bend.</td>
<td></td>
</tr>
<tr>
<td>(31/7M) Rubber doesn’t slip</td>
<td></td>
</tr>
</tbody>
</table>

**Aggregate of Total Selections**

| (0) | (3) | (10)* |
| (2) | (24) | (5)* |
| (Total number of passes) | * | **56** |
**Question No. (35)**

What is the Velocity Ratio of your chosen wedge?

<table>
<thead>
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<th>Synopsis of Oral Response</th>
</tr>
</thead>
<tbody>
<tr>
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<td>No quantitative response</td>
</tr>
<tr>
<td>(2/2F)</td>
<td>No quantitative response</td>
</tr>
<tr>
<td>(3/1M)</td>
<td>No quantitative response</td>
</tr>
<tr>
<td>(4/1M)</td>
<td>No quantitative response</td>
</tr>
<tr>
<td>(5/2M)</td>
<td>No quantitative response</td>
</tr>
<tr>
<td>(6/2M)</td>
<td>No quantitative response</td>
</tr>
<tr>
<td>(7/1)</td>
<td>(no available candidate)</td>
</tr>
<tr>
<td>(8/1)</td>
<td>(no available candidate)</td>
</tr>
<tr>
<td>(9/4H)</td>
<td>No quantitative response</td>
</tr>
<tr>
<td>(10/4H)</td>
<td>No quantitative response</td>
</tr>
<tr>
<td>(11/3F)</td>
<td>No quantitative response</td>
</tr>
<tr>
<td>(12/3M)</td>
<td>No quantitative response</td>
</tr>
<tr>
<td>(13/5M)</td>
<td>No quantitative response</td>
</tr>
<tr>
<td>(14/5M)</td>
<td>No quantitative response</td>
</tr>
<tr>
<td>(15/4H)</td>
<td>No quantitative response</td>
</tr>
<tr>
<td>(16/4M)</td>
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</tr>
<tr>
<td>(17/7M)</td>
<td>No quantitative response</td>
</tr>
<tr>
<td>(18/7H)</td>
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</tr>
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</tr>
<tr>
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</tr>
<tr>
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</tr>
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</tr>
<tr>
<td>(23/5M)</td>
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<td>(24/5M)</td>
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</tr>
<tr>
<td>(25/3H)</td>
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</tr>
<tr>
<td>(26/3H)</td>
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</tr>
<tr>
<td>(27/6H)</td>
<td>No quantitative response</td>
</tr>
<tr>
<td>(28/6H)</td>
<td>No quantitative response</td>
</tr>
</tbody>
</table>

**TOTAL RESPONSES GIVEN -----> (0)**

---

N.B. Participant 29/8M later calculated a Mechanical Advantage of 6 using the formula for Velocity Ratio.
Question No.(37) If you now had to design a wedge to lift a machine tool which weighed two metric tonnes, what changes might you make to your chosen wedge?

Proposed changes to: (a) Structure (b) Form (c) Materials (d) Dimension (e) Surface

**CATALOGUE OF RESPONSES**

- Pupil Synopsis of Oral Response

  - **Technical Responses**

<table>
<thead>
<tr>
<th>No.</th>
<th>Change Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1/2M)</td>
<td>Wider-spread weight. Inc. a track on top</td>
</tr>
<tr>
<td>(2/2F)</td>
<td>Thicker/stronger. Double chamfer</td>
</tr>
<tr>
<td>(3/1M)</td>
<td>Different angles to suit uneven floor</td>
</tr>
<tr>
<td>(4/1M)</td>
<td>Reduce the angle-less force</td>
</tr>
<tr>
<td>(5/2M)</td>
<td>Coat with rubber to help it stick better</td>
</tr>
<tr>
<td>(6/2M)</td>
<td>No changes</td>
</tr>
<tr>
<td>(7/1)</td>
<td>(no available candidate)</td>
</tr>
<tr>
<td>(8/1)</td>
<td>(no available candidate)</td>
</tr>
<tr>
<td>(9/4M)</td>
<td>Stronger material</td>
</tr>
<tr>
<td>(10/4M)</td>
<td>No changes</td>
</tr>
<tr>
<td>(11/3F)</td>
<td>No changes</td>
</tr>
<tr>
<td>(12/3M)</td>
<td>No changes</td>
</tr>
<tr>
<td>(13/5M)</td>
<td>Steel for greater strength</td>
</tr>
<tr>
<td>(14/5M)</td>
<td>Big angle but more gradual</td>
</tr>
<tr>
<td>(15/4M)</td>
<td>No changes</td>
</tr>
<tr>
<td>(16/4M)</td>
<td>No changes</td>
</tr>
<tr>
<td>(17/7M)</td>
<td>Rollers/casters</td>
</tr>
<tr>
<td>(18/7M)</td>
<td>No changes</td>
</tr>
<tr>
<td>(19/6F)</td>
<td>No changes</td>
</tr>
<tr>
<td>(20/6M)</td>
<td>Might snap-make thicker or curved</td>
</tr>
<tr>
<td>(21/8M)</td>
<td>No changes</td>
</tr>
<tr>
<td>(22/8M)</td>
<td>Less slanted—may be too much height</td>
</tr>
<tr>
<td>(23/5M)</td>
<td>No changes</td>
</tr>
<tr>
<td>(24/5M)</td>
<td>No changes</td>
</tr>
<tr>
<td>(25/3M)</td>
<td>No changes</td>
</tr>
<tr>
<td>(26/3M)</td>
<td>Less angle. Harder material. Smoother</td>
</tr>
<tr>
<td>(27/6M)</td>
<td>Stronger material. Two angles perhaps</td>
</tr>
<tr>
<td>(28/6M)</td>
<td>Curved wedge. Alum. sheet to go in easier</td>
</tr>
<tr>
<td>(29/8M)</td>
<td>Crush wood—change to steel. Rubber grip.</td>
</tr>
<tr>
<td>(30/8M)</td>
<td>No changes</td>
</tr>
<tr>
<td>(31/7M)</td>
<td>No changes</td>
</tr>
<tr>
<td>(32/7M)</td>
<td>Metal—harder. Between Tungsten and steel</td>
</tr>
</tbody>
</table>

**AGGREGATE OF TOTAL SELECTIONS**

- (2) (3) (11) (5) (1)
- (Total number of passes 14) 47%
Partial Transcripts from a Selection of Interviews with respect to Questions (35), (36) and (37).

Example (1). Pupil 3/1M taking Mathematics, Physics and Engineering

**Drawing at 'A' level.**

**Interviewer:** What is Velocity Ratio?

**Pupil:** Velocity Ratio?

**Interviewer:** Yes. Have you heard of it?

**Pupil:** Not really - no. Unless you mean the ratio of two velocities between two separate things.

**Interviewer:** Right. Have you heard of Movement Ratio?

**Pupil:** As in ratio of distances moved - displacement?

**Interviewer:** Has that (chosen wedge) got a Velocity Ratio?

**Pupil:** Em - On its own it has not got a Velocity Ratio.

**Interviewer:** Has it got a Mechanical Advantage?

**Pupil:** An advantage to what?

**Interviewer:** Well - have you heard of Mechanical Advantage?

**Pupil:** No.

**Interviewer:** Let's put it this way. You have got a big machine tool which has just been delivered - say a big lathe which weighs two metric tonnes. You have the problem of lifting the machine to put packing pieces underneath it to level it up. You are going to drive wedges under the feet of the machine to lift it sufficiently to do this.

Would a dozen of these wedges (chosen) do the job or would you change them at all?

**Pupil:** Well, if I was doing that, I'd change them all for these (reduced angle - sample 8.1).

**Interviewer:** Why is that?

**Pupil:** Because you are using less force actually shoving it under the lathe........ because of the angle there..... resolving the angle........ Sin 0...... sine of the angle.

**Interviewer:** Anything else you would change /

**Pupil:** No. (end)
Example (2). Pupil 3/1M taking Mathematics, Physics, Engineering Drawing and General Studies at 'A' level.

Interviewer: What is Velocity Ratio? Have you heard of it?

Pupil: Ratio of one velocity to another velocity. One body against another.

Interviewer: Has that (door wedge) got a Velocity Ratio?

Pupil: It's not moving.

Interviewer: Has it got one?

Pupil: Compared to what? It has compared to something that is moving.

Interviewer: O.K. - What is its Velocity Ratio?

Pupil: Something to zero.

Interviewer: Something to zero. Has it got a Mechanical Advantage?

Pupil: Yes..... the angle the block is.

Interviewer: The angle. So if I asked you what the Mechanical Advantage was, could you tell me?

Pupil: No.

Interviewer: Why not?

Pupil: Not without a bit of research.

Interviewer: What research would you...........?

Pupil: Get a Physics book.

Interviewer: Now supposing we had a big machine tool there (in the workshop) and we had the problem of levelling it up... ....... We are going to use wedges to drive under the feet of the machine to lift it sufficiently to allow packing pieces to be placed underneath it.......... I will give you eight of those (chosen wedges) to do the job - would you be happy with that or would you change the design at all?

Pupil: I think that I'd use different angles .... eight should be sufficient.

Interviewer: Why would you want eight different angles?

Pupil: Depends on the bow of the floor.....you may not reach it by quite a lot and at the other end very little.

Interviewer: I see - yes. Anything else you would change?

Pupil: No. (end)
Example (3). Pupil 28/8M taking 4th yr Design & Communication

Interviewer: Have you ever heard of Velocity Ratio?

Pupil: Well, vaguely - yes.

Interviewer: Do you know what it is?

Pupil: Well it's.... Mr. xxxx will kill me if I don't get this right........

Interviewer: Have you done this recently with him or...?

Pupil: No or .. LOAD over EFFORT isn't it?

Interviewer: LOAD over EFFORT? Has that wedge (chosen) got a Velocity Ratio? Does it have one?

Pupil: Well it would because of the weight that it has on the floor and how much it has got on the top of it.

Interviewer: What is the Velocity Ratio of that wedge?

Pupil: I don't know.

Interviewer: Do you know what Mechanical Advantage is?

Pupil: Yes! Distance moved by effort over distance moved by load.

Interviewer: Has that (chosen wedge) got a Mechanical Advantage?

Pupil: Yes!

Interviewer: What is it?

Pupil: How far the door would move up the actual wedge.

Interviewer: Can you tell me what the Mechanical Advantage will be?

Pupil: Well I'll have to know the measurements.

(he went on to successfully take the necessary measurements and calculate a quantity of 6 for the M.A. of the wedge, although this was really a calculated assessment of the V.R. of the wedge)
Question No.(18) Container lids are sometimes very difficult to remove. Examine the four examples shown and suggest how this problem can be eased in each case.

Key: Proposed changes to (a) Surface Texture
(b) Materials in Contact
(c) Force Applied.
(d) Other/s

<table>
<thead>
<tr>
<th>Pupil Synopsis of Oral Response</th>
<th>Technical Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3/1) Change design- screw, turn-key, tube</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(3/1) Larger movement, larger container.</td>
<td>(-) (-) (c) (-)</td>
</tr>
<tr>
<td>(3/1) Larger top, metal/plastic, friction</td>
<td>(-) (b) (c) (-)</td>
</tr>
<tr>
<td>(3/1) Thicker metal-less turns to help shift it.</td>
<td>(0) (-) (c) (-)</td>
</tr>
<tr>
<td>Total response (31%) effective</td>
<td>0% 25% 75% 25%</td>
</tr>
<tr>
<td>(4/1) Change design to a turn-key.</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(4/1) Don’t know really.</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>(4/1) Bigger top.</td>
<td>(-) (-) (c) (-)</td>
</tr>
<tr>
<td>(4/1) No.</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>Total response (13%) effective</td>
<td>0% 0% 25% 25%</td>
</tr>
<tr>
<td>(7/1) (no available candidate)</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>(7/1) (no available candidate)</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>(7/1) (no available candidate)</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>Total response (**%) effective</td>
<td>0% 0% 25% 25%</td>
</tr>
<tr>
<td>(8/1) (no available candidate)</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>(8/1) (no available candidate)</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>(8/1) (no available candidate)</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>(8/1) (no available candidate)</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>Total response (**%) effective</td>
<td>0% 0% 25% 25%</td>
</tr>
</tbody>
</table>

Total Technical Responses for Group (1) was 22% effective

Aggregates of Technical Solutions

Total Technical Responses for Group ( ) was % effective
Question No. (18) Container lids are sometimes very difficult to remove. Examine the four examples shown and suggest how this problem can be eased in each case.

Key: Proposed changes to (a) Surface Texture
****
(b) Materials in Contact
(c) Force Applied.
(d) Other/s

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<th>Synopsis of Oral Response</th>
<th>Technical Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>**----</td>
<td>---------------------------</td>
<td>-------------------</td>
</tr>
</tbody>
</table>

**CATALOGUE OF RESPONSES*

* (1/2M) Grip. Change to screw/press-on type: (-) (-) (c) (d) *
* (1/2M) No ideas. (-) (-) (-) (-) *
* (1/2M) Press on type. (-) (-) (-) (d) *
* (1/2M) Comfortable to fit the hand - leverage. (-) (-) (c) (-) *
* Total response (25 %) effective. 0% 0% 50% 50% *
* (2/2F) Deeper groove - more lift. (-) (-) (-) (d) *
* (2/2F) No. (-) (-) (-) (-) *
* (2/2F) Pull off. (-) (-) (-) (d) *
* (2/2F) Pull-off lid. (-) (-) (-) (d) *
* Total response (19 %) effective 0% 0% 0% 75% *
* (5/2M) Larger gap - flip off - more clearance. (-) (-) (-) (d) *
* (5/2M) Not sure. (-) (-) (-) (-) *
* (5/2M) Larger or square for better grip. (-) (-) (c) (d) *
* (5/2M) Fewer turns. (-) (-) (-) (d) *
* Total response (25 %) effective 0% 0% 25% 75% *
* (6/2M) No idea. (-) (-) (-) (-) *
* (6/2M) No idea. (-) (-) (-) (-) *
* (6/2M) Bigger top - easier to hold. (-) (-) (c) (-) *
* (6/2M) Smaller thread. (-) (-) (c) (-) *
* Total response (13 %) effective 0% 0% 50% 0% *

Aggregates of Technical Solutions 0% 0% 31% 50% *
Total Technical Responses for Group (2) was 21% effective *
Question No.(18) Container lids are sometimes very difficult to remove. Examine the four examples shown and suggest how this problem can be eased in each case.

Keys: Proposed changes to (a) Surface Texture
(b) Materials in Contact
(c) Force Applied.
(d) Other/s

---

CATALOGUE OF RESPONSES

Pupil Synopsis of Oral Response Technical Solution

*(11/3F) Don’t really know. (-) (-) (-) (-)
*(11/3F) Loosen it—bigger lid diameter. (-) (-) (c) (-)
*(11/3F) Rubber around cap (grip) (-) (b) (-) (-)
*(11/3F) Holes to allow the air to escape. (-) (-) (c) (-)
* Total response (19 %) effective --------> 0% 25% 50% 0%
*(12/3M) Prize it open. Wider bottom—grip. (-) (-) (c) (-)
*(12/3M) No. (-) (-) (-) (-)
*(12/3M) Two bits sticking out—more pressure. (-) (-) (c) (-)
*(12/3M) No. (-) (-) (-) (-)
* Total response (13 %) effective --------> 0% 0% 50% 0%
*(25/3M) Looser fitting top—less friction. (-) (-) (c) (-)
*(25/3M) Looser fitting. (-) (-) (c) (-)
*(25/3M) Big cap—more area. Teeth for grip. (a) (-) (c) (d)
*(25/3M) Wider area to grip. Teeth for grip. (a) (-) (-) (d)
* Total response (44 %) effective --------> 50% 0% 75% 50%
*(26/3M) Friction. Materials. Design change. (-) (b) (-) (d)
*(26/3M) Material. Grip. Less friction if angled. (-) (b) (c) (-)
*(26/3M) Clip-on cap. Bigger dia. Grip bumps (a) (-) (c) (d)
*(26/3M) Better grip on edge. Material. Diameter. (a) (b) (c) (-)
* Total response (63 %) effective --------> 50% 75% 75% 50%
* Aggregates of Technical Solutions --------> 25% 25% 63% 25%
* Total Technical Responses for Group (3) was 35% effective
Question No. (18) Container lids are sometimes very difficult to remove. Examine the four examples shown and suggest how this problem can be eased in each case.

Key: Proposed changes to (a) Surface Texture  
(b) Materials in Contact  
(c) Force Applied.  
(d) Other/s

<table>
<thead>
<tr>
<th>Key</th>
<th>Proposed Changes</th>
<th>Total Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>Friction-grip between fingers/lid.</td>
<td>25% 25% 50% 0%</td>
</tr>
<tr>
<td>(b)</td>
<td>More grip.</td>
<td></td>
</tr>
<tr>
<td>(c)</td>
<td>Different plastic. Bigger top.</td>
<td></td>
</tr>
<tr>
<td>(d)</td>
<td>No.</td>
<td></td>
</tr>
<tr>
<td>Total response (25%) effective</td>
<td>25% 25% 50% 0%</td>
<td></td>
</tr>
</tbody>
</table>

| (a) | Change design to screw type. |  | |
| (b) | Bigger ridges. Deeper slope. |  | |
| (c) | No. |  | |
| (d) | No. |  | |
| Total response (25%) effective | 25% 0% 25% 50% |

| (a) | Bigger cut out-press down easier |  | |
| (b) | Slidier material. Chamfer along it. |  | |
| (c) | Wider-bigger area to hold on to. |  | |
| (d) | Bigger grooves. Better grip. |  | |
| Total response (44%) effective | 25% 25% 50% 75% |

| (a) | No idea. |  | |
| (b) | Warm water - expand it. |  | |
| (c) | No - use pliers. |  | |
| (d) | No. |  | |
| Total response (13%) effective | 0% 0% 0% 50% |

Aggregates of Technical Solutions | 19% 13% 31% 44% |

Total Technical Responses for Group (4) was 27% effective
Container lids are sometimes very difficult to remove. Examine the four examples shown and suggest how this problem can be eased in each case.

**Key:** Proposed changes to
(a) **Surface Texture**
(b) **Materials in Contact**
(c) **Force Applied.**
(d) **Other/s**

### Catalogue of Responses

<table>
<thead>
<tr>
<th>Pupil</th>
<th>Synopsis of Oral Response</th>
<th>Technical Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>(13/5H)</em></td>
<td>Turn-key. Bigger lid - looser.</td>
<td>(--) (--) (c) (d) *</td>
</tr>
<tr>
<td><em>(13/5M)</em></td>
<td>No ideas.</td>
<td>(--) (--) (--) (--) *</td>
</tr>
<tr>
<td><em>(13/5M)</em></td>
<td>No idea.</td>
<td>(--) (--) (--) (--) *</td>
</tr>
<tr>
<td><em>(13/5M)</em></td>
<td>Push-on lid.</td>
<td>(--) (--) (--) (d) *</td>
</tr>
<tr>
<td>*</td>
<td>Total response (19 %) effective</td>
<td>0% 0% 25% 50% *</td>
</tr>
<tr>
<td><em>(14/5M)</em></td>
<td>Looser - pull it straight off</td>
<td>(--) (--) (c) (--) *</td>
</tr>
<tr>
<td><em>(14/5M)</em></td>
<td>Not so close fitting. Screw.</td>
<td>(--) (--) (c) (d) *</td>
</tr>
<tr>
<td><em>(14/5M)</em></td>
<td>Press on design.</td>
<td>(--) (--) (--) (d) *</td>
</tr>
<tr>
<td><em>(14/5M)</em></td>
<td>Press-on cap.</td>
<td>(0) (0) (1) (2) *</td>
</tr>
<tr>
<td>*</td>
<td>Total response (31 %) effective</td>
<td>0% 0% 50% 75% *</td>
</tr>
<tr>
<td><em>(23/5M)</em></td>
<td>Bottom - smaller diameter.</td>
<td>(--) (--) (c) (--) *</td>
</tr>
<tr>
<td><em>(23/5M)</em></td>
<td>Tin smaller.</td>
<td>(--) (--) (c) (--) *</td>
</tr>
<tr>
<td><em>(23/5M)</em></td>
<td>A mechanism.</td>
<td>(--) (--) (c) (--) *</td>
</tr>
<tr>
<td><em>(23/5M)</em></td>
<td>No.</td>
<td>(0) (0) (3) (0) *</td>
</tr>
<tr>
<td>*</td>
<td>Total response (19 %) effective</td>
<td>0% 0% 75% 0% *</td>
</tr>
<tr>
<td><em>(24/5M)</em></td>
<td>No.</td>
<td>(--) (--) (--) (--) *</td>
</tr>
<tr>
<td><em>(24/5M)</em></td>
<td>No.</td>
<td>(--) (--) (--) (--) *</td>
</tr>
<tr>
<td><em>(24/5M)</em></td>
<td>Press-on cap.</td>
<td>(--) (--) (--) (d) *</td>
</tr>
<tr>
<td><em>(24/5M)</em></td>
<td>Like a medicine bottle.</td>
<td>(--) (--) (--) (d) *</td>
</tr>
<tr>
<td>*</td>
<td>Total response (13 %) effective</td>
<td>0% 0% 0% 50% *</td>
</tr>
<tr>
<td>*</td>
<td>Aggregates of Technical Solutions</td>
<td>0% 0% 38% 44% *</td>
</tr>
<tr>
<td>*</td>
<td>Total Technical Responses for Group (5) was 21% effective</td>
<td>*</td>
</tr>
</tbody>
</table>
Question No.(18)  Container lids are sometimes very difficult to remove. Examine the four examples shown and suggest how this problem can be eased in each case.

Key: Proposed changes to (a) Surface Texture  
****  
(b) Materials in Contact  
(c) Force Applied.  
(d) Other/s

***************************************************************
* CATALOGUE OF RESPONSES  *
*  ***************************************************************
* Pupil  Synopsis of Oral Response  Technical Solution  *
*  ****************************************************************
*(19/6F) Handles sticking out - grip.  (-) (c) (-)  *
*(19/6F) Screw it off instead.  (-) (d) (-)  *
*(19/6F) Screw on cap.  (-) (-) (d) (-)  *
*(19/6F) Better fit.  (-) (c) (-) (-)  *
* Total response (25 %) effective  ----> 0% 0% 50% 50%  *
* *(20/6M) Loosen it. Change to screw top.  (-) (c) (d)  *
*(20/6M) Screw top.  (-) (-) (-)  *
*(20/6M) Press on cap.  (-) (-) (-)  *
*(20/6M) Looser. Smaller thread.  (-) (-) (d) (-)  *
* Total response (31 %) effective  ----> 0% 0% 50% 75%  *
*(27/6M) Not sure about that one.  (-) (-) (-) (d)  *
*(27/6M) Pull top.  (-) (-) (-) (d)  *
*(27/6M) More thread. Pull top.  (2) (2)  *
* Total response (13 %) effective  ----> 0% 0% 50%  *
* *(28/6M) Screw tap.  (-) (-) (-)  *
*(28/6M) L-shaped pins. No surface area.  (-) (-) (-)  *
*(28/6M) Bigger lid - more grip.  (-) (-) (d) (-)  *
*(28/6M) No idea.  (-) (-) (-) (-)  *
* Total response (19 %) effective  ----> 0% 0% 25% 50%  *
* Aggregates of Technical Solutions  ----> 0% 0% 31% 56%  *
* Total Technical Responses for Group (6) was 22% effective  
* ****************************************************************
Question No.(18)

Container lids are sometimes very difficult to remove. Examine the four examples shown and suggest how this problem can be eased in each case.

Key: Proposed changes to (a) Surface Texture
(b) Materials in Contact
(c) Force Applied.
(d) Other/s

<table>
<thead>
<tr>
<th>CATALOGUE OF RESPONSES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pupil</strong></td>
</tr>
<tr>
<td>* ******</td>
</tr>
</tbody>
</table>

* (17/71) If design doesn’t work—change it. (-) (-) (-) (d) *
* (17/71) Good design. Lid could be bigger. (-) (-) (c) (-) *
* (17/71) Push-off type of design. (-) (-) (-) (d) *
* (17/71) Bigger lid. Plastic. (-) (b) (c) (-) *

* Total response (31%) effective -------> 0% 25% 50% 50% *

* (18/71) Screw it off. (-) (-) (-) (d) *
* (18/71) Clip design is better. (-) (-) (-) (d) *
* (18/71) Pull off. (-) (-) (-) (d) *
* (18/71) Pull-off lid. (-) (-) (-) (d) *

* Total response (25%) effective -------> 0% 0% 0% 100% *

* (31/71) Screw top (-) (-) (-) (d) *
* (31/71) Wheels/balls inside. (-) (-) (-) (d) *
* (31/71) Bigger cap—easier turn (distance) (-) (-) (c) (-) *
* (31/71) No. (-) (-) (-) (-) *

* Total response (19%) effective -------> 0% 0% 25% 50% *

* (32/71) Tie release. Release valve—pressure. (-) (-) (c) (d) *
* (32/71) Like a light bulb fitting instead. (-) (-) (-) (d) *
* (32/71) Bigger top—more grip. (-) (-) (c) (-) *
* (32/71) Spring release. Release valve for pressure. (-) (-) (c) (d) *

* Total response (38%) effective -------> 0% 0% 75% 75% *

* Aggregates of Technical Solutions -------> 0% 6% 38% 69% *

* Total Technical Responses for Group (7) was 28% effective *
Container lids are sometimes very difficult to remove. Examine the four examples shown and suggest how this problem can be eased in each case.

Key: Proposed changes to (a) Surface Texture  
    **** (b) Materials in Contact  
    (c) Force Applied.  
    (d) Other/s

---

**CATALOGUE OF RESPONSES**
---

* **Pupil** Synopsis of Oral Response | Technical Solution *
* **** 

---

*(21/BM)* Different design - turn-key  
(-) (-) (-) (d) *  
*(21/BM)* Put bar across - better grip.  
(-) (-) (c) (-) *  
*(21/BM)* Rubber grip.  
(-) (b) (-) (-) *  
*(21/BM)* Two bars on cap to twist better.  
(0) (1) (2) (1) *  

---

* Total response (25 %) effective  
0% 25% 50% 25% *
---

*(22/BM)* Presses down so quick  
(-) (-) (-) (d) *  
*(22/BM)* Friction.  
(-) (-) (-) (d) *  
*(22/BM)* Flick/press cap.  
(a) (-) (-) (d) *  
*(22/BM)* Smooth. Big.  
(1) (0) (1) (3) *  

---

* Total response (31 %) effective  
25% 0% 25% 75% *
---

*(29/BM)* Bigger cut out to come down easier  
(-) (-) (-) (d) *  
*(29/BM)* No.  
(-) (-) (-) (d) *  
*(29/BM)* Press type cap.  
(-) (-) (-) (d) *  
*(29/BM)* Press type top.  
(0) (0) (0) (3) *  

---

* Total response (19 %) effective  
0% 0% 0% 75% *
---

*(30/BM)* Twist type.  
(-) (-) (-) (d) *  
*(30/BM)* Thread.  
(-) (-) (-) (d) *  
*(30/BM)* Pull off cap.  
(-) (-) (-) (-) *  
*(30/BM)* No.  
(0) (0) (0) (3) *  

---

* Total response (19 %) effective  
0% 0% 0% 75% *

---

* Aggregates of Technical Solutions  
6% 6% 19% 63% *

---

* Total Technical Responses for Group (8) was 24% effective
Question No. (19)  How do containers (E), (F), (G), and (H) overcome the problem associated with that found in container (D)?

Key:  Proposed changes to (a) Surface Texture  
(b) Materials in Contact  
(c) Force Applied.  
(d) Other/s

---

### Catalogue of Responses

<table>
<thead>
<tr>
<th>Key</th>
<th>Proposed Changes</th>
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</thead>
<tbody>
<tr>
<td>(a)</td>
<td>Surface Texture</td>
</tr>
<tr>
<td>(b)</td>
<td>Materials in Contact</td>
</tr>
<tr>
<td>(c)</td>
<td>Force Applied</td>
</tr>
<tr>
<td>(d)</td>
<td>Other/s</td>
</tr>
</tbody>
</table>

---

### Pupil Synopsis of Oral Response

<table>
<thead>
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<th>Technical Solution</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

#### (3/1M) Stiff- tongues too deep.
- (-) (-) (-) (d) *

#### (3/1M) Less grip. Less leverage.
- (-) (-) (c) (-) *

#### (3/1M) Half-turn
- (-) (-) (-) (d) *

#### (3/1M) Half a turn. No stickiness.
- (0) (0) (1) (3) *

#### Total response (25%) effective
- 0% 0% 25% 75% *

---

#### (4/1M) Big lid- less likely to stick.
- (-) (-) (c) (-) *

#### (4/1M) Stiffer.
- (-) (-) (c) (-) *

#### (4/1M) Materials
- (-) (b) (-) (-) *

#### (4/1M) Less likely to stick—plastic lid
- (-) (b) (-) (-) *

#### Total response (25%) effective
- 0% 50% 50% 0% *

---

#### (7/1) (no available candidate)
- (-) (-) (-) (-) *

#### (7/1) (no available candidate)
- (-) (-) (-) (-) *

#### (7/1) (no available candidate)
- (-) (-) (-) (-) *

#### (7/1) (no available candidate)
- (-) (-) (-) (-) *

#### Total response (***) effective
- % % % % *

---

#### (8/1) (no available candidate)
- (-) (-) (-) (-) *

#### (8/1) (no available candidate)
- (-) (-) (-) (-) *

#### (8/1) (no available candidate)
- (-) (-) (-) (-) *

#### (8/1) (no available candidate)
- (-) (-) (-) (-) *

#### Total response (***) effective
- % % % % *

---

### Aggregates of Technical Solutions

- 0% 25% 38% 38%

### Total Technical Responses for Group (1) was 25% effective
Question No. (19)  How do containers (E), (F), (G), and (H) overcome the problem associated with that found in container (D)?

Key:  Proposed changes to (a) Surface Texture  
(b) Materials in Contact  
(c) Force Applied.  
(d) Other/s

<table>
<thead>
<tr>
<th>Catalogue of Responses</th>
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<tbody>
<tr>
<td><strong>Pupil Synopsis of Oral Response</strong></td>
</tr>
<tr>
<td><strong>Technical Solution</strong></td>
</tr>
</tbody>
</table>

| **(1/2H)** | Don't have to twist around so many times. (-) (-) (-) (d) * |
| **(1/2M)** | Less 'things' on the top.  (-) (-) (-) (d) * |
| **(1/2M)** | More turn - screwdriver action  (-) (-) (c) (-) * |
| **(1/2M)** | Grip with hands better - plastic  (-) (b) (-) (-) * |
| **Total response (25 %) effective** | 0% 25% 25% 50% * |
| **(2/2F)** | Don't have to keep twisting.  (-) (-) (-) (d) * |
| **(2/2F)** | Still one movement.  (-) (-) (-) (d) * |
| **(2/2F)** | Smoother  (a) (-) (-) (-) * |
| **(2/2F)** | Smoother  (a) (-) (-) (-) * |
| **Total response (25 %) effective** | 50% 0% 0% 50% * |
| **(5/2H)** | Easier to grip. Only one turn.  (a) (-) (c) (d) * |
| **(5/2M)** | Small grips (irregular shaped cap)  (a) (-) (-) (-) * |
| **(5/2M)** | Plastic materials clash  (a) (-) (b) (-) (c) (-) * |
| **(5/2M)** | Plastic/glass-less friction  (a) (-) (b) (-) (-) * |
| **Total response (31 %) effective** | 25% 50% 25% 25% * |
| **(6/2M)** | Turns and lifts off straight away.  (-) (-) (-) (d) * |
| **(6/2M)** | Slopes.  (-) (-) (-) (d) * |
| **(6/2M)** | No  (-) (-) (-) (d) * |
| **(6/2M)** | Plastic top - easier to grip  (a) (-) (-) (-) * |
| **Total response (19 %) effective** | 0% 25% 0% 50% * |

Total Technical Responses for Group (2) was 25% effective.
Question No. (19) How do containers (E), (F), (G), and (H) overcome the problem associated with that found in container (D)?

Key: Proposed changes to (a) Surface Texture
(b) Materials in Contact
(c) Force Applied.
(d) Other/s

---

**CATALOGUE OF RESPONSES**

<table>
<thead>
<tr>
<th>Pupil Synopsis of Oral Response</th>
<th>Technical Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>(11/3F) Let air in. Not full turn.</td>
<td>(-) (-) (c) (d) *</td>
</tr>
<tr>
<td>(11/3F) Same idea. (let air in. Not full turn)</td>
<td>(-) (-) (c) (d) *</td>
</tr>
<tr>
<td>(11/3F) Increased force of grip</td>
<td>(-) (-) (c) (-) *</td>
</tr>
<tr>
<td>(11/3F) Not much turn for sticking</td>
<td>(-) (-) (c) (-) *</td>
</tr>
</tbody>
</table>

* Total response (38 %) effective ————> 0% 0% 100% 50% *

| (12/3M) Small area to screw it on | (-) (-) (-) (d) * |
| (12/3M) Quicker. | (-) (-) (-) (d) * |
| (12/3M) Different dia.—more area to hold—fits hand | (-) (-) (c) (d) * |
| (12/3M) No | (-) (-) (-) (-) * |

* Total response (25 %) effective ————> 0% 0% 25% 75% *

| (25/3M) Less contact—less friction. | (-) (-) (-) (d) * |
| (25/3M) Less contact—less friction | (-) (-) (-) (d) * |
| (25/3M) Wider thread. Less turns | (-) (-) (-) (d) * |
| (25/3M) Less turns—more contact—more friction | (-) (-) (-) (d) * |

* Total response (25 %) effective ————> 0% 0% 0% 100% *

| (26/3M) Size. Stronger material. Smooth. | (a) (-) (c) (d) * |
| (26/3M) Same (size. stronger material. Smooth) | (a) (-) (c) (d) * |
| (26/3M) Plastic materials. Diff. Dia. an advantage | (a) (b) (c) (-) * |
| (26/3M) Materials. Smooth finish on lid. | (3) (2) (3) (2) * |

* Total response (63 %) effective ————> 75% 50% 75% 50% *

---

Total Technical Responses for Group (3) was 38% effective

---
Question No.(19) How do containers (E), (F), (B), and (H) overcome the problem associated with that found in container (D) ?

Key: Proposed changes to (a) Surface Texture **** (b) Materials in Contact (c) Force Applied. (d) Other/s

| Proposed changes | Container D
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(9/4M) Grip. Less surface, shorter distance.</td>
<td>(-) (-) (c) (d) *</td>
</tr>
<tr>
<td>(9/4M) Less friction—surfaces in contact.</td>
<td>(-) (-) (-) (d) *</td>
</tr>
<tr>
<td>(9/4M) More mechanical advantage</td>
<td>(-) (-) (c) (-)</td>
</tr>
<tr>
<td>(9/4M) Less friction—plastic lid</td>
<td>(0) (1) (2) (2) *</td>
</tr>
<tr>
<td><strong>Total response (31 %) effective</strong></td>
<td>0% 25% 50% 50% *</td>
</tr>
<tr>
<td>(10/4M) Not so much metal touching.</td>
<td>(-) (-) (-) (d) *</td>
</tr>
<tr>
<td>(10/4M) Less ridges.</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(10/4M) Something to grab hold of</td>
<td>(-) (-) (c) (-)</td>
</tr>
<tr>
<td>(10/4M) Don’t know</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td><strong>Total response (19 %) effective</strong></td>
<td>0% 0% 25% 50% *</td>
</tr>
</tbody>
</table>
| (15/4M) Less friction—less contact on screw. | (-) (-) (-) (d) *
| (15/4M) Same sort of thing—not so many teeth. | (-) (-) (-) (d) |
| (15/4M) Bigger lid with bigger threads—more effort | (-) (c) (-) |
| (15/4M) One thread—one line—small movement | (1) (0) (1) (3) |
| **Total response (25 %) effective** | 0% 0% 25% 75% * |
| (16/4M) Shorter movement. Dents for better grip. | (a) (-) (-) (d) * |
| (16/4M) Shorter movement. | (-) (-) (-) (d) |
| (16/4M) No | (-) (-) (-) (-) |
| (16/4M) Plastic top—stretch. Wouldn’t press hard. | (-) (-) (c) (-) |
| * | (1) (0) (1) (2) |
| **Total response (25 %) effective** | 25% 0% 25% 50% * |
| **Aggregates of Technical Solutions** | 6% 6% 31% 56% * |
| **Total Technical Responses for Group (4) was 25% effective** | * |
Question No.(19) How do containers (E), (F), (G), and (H) overcome the problem associated with that found in container (D)?

Key: Proposed changes to
(a) Surface Texture
(b) Materials in Contact
(c) Force Applied.
(d) Other/s

<table>
<thead>
<tr>
<th>Pupil Synopsis of Oral Response</th>
<th>Technical Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>*(13/5M) Bigger grip. Surface area.</td>
<td>(--) (--) (c) (d)</td>
</tr>
<tr>
<td>*(13/5M) No.</td>
<td>(--) (--) (--) (--)</td>
</tr>
<tr>
<td>*(13/5M) Plastic doesn’t stick</td>
<td>(--) (b) (--) (--)</td>
</tr>
<tr>
<td>*(13/5M) Both different materials</td>
<td>(--) (b) (--) (--)</td>
</tr>
<tr>
<td>* Total response (25%) effective</td>
<td>0% 50% 25% 25%</td>
</tr>
<tr>
<td>*(14/5M) One turn.</td>
<td>(--) (--) (--) (d)</td>
</tr>
<tr>
<td>*(14/5M) Same as before. (One turn)</td>
<td>(--) (--) (--) (d)</td>
</tr>
<tr>
<td>*(14/5M) Few turns. Fingers slip on plastic</td>
<td>(--) (b) (--) (d)</td>
</tr>
<tr>
<td>*(14/5M) Normal type of top</td>
<td>(--) (--) (--) (--)</td>
</tr>
<tr>
<td>* Total response (25%) effective</td>
<td>(0) (2) (1) (1)</td>
</tr>
<tr>
<td>*(23/5M) Less movement—steep slope.</td>
<td>(--) (--) (--) (d)</td>
</tr>
<tr>
<td>*(23/5M) Smaller tin.</td>
<td>(--) (--) (c) (--)</td>
</tr>
<tr>
<td>*(23/5M) No</td>
<td>(--) (--) (--) (--)</td>
</tr>
<tr>
<td>*(23/5M) No</td>
<td>(--) (--) (--) (--)</td>
</tr>
<tr>
<td>* Total response (13%) effective</td>
<td>(0) (0) (1) (1)</td>
</tr>
<tr>
<td>*(24/5M) No.</td>
<td>(--) (--) (--) (--)</td>
</tr>
<tr>
<td>*(24/5M) No.</td>
<td>(--) (--) (--) (--)</td>
</tr>
<tr>
<td>*(24/5M) No</td>
<td>(--) (--) (--) (--)</td>
</tr>
<tr>
<td>*(24/5M) Lines on the glass—comes off easy</td>
<td>(--) (--) (--) (d)</td>
</tr>
<tr>
<td>* Total response (6%) effective</td>
<td>(0) (0) (0) (1)</td>
</tr>
<tr>
<td>* Aggregates of Technical Solutions</td>
<td>0% 19% 13% 38%</td>
</tr>
<tr>
<td>* Total Technical Responses for Group (5) was 18% effective</td>
<td></td>
</tr>
</tbody>
</table>
Question No.(19) How do containers (E), (F), (G), and (H) overcome the problem associated with that found in container (D)?

Key: Proposed changes to (a) Surface Texture
(b) Materials in Contact
(c) Force Applied.
(d) Other/s

<table>
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<tr>
<th>Pupil</th>
<th>Synopsis of Oral Response</th>
<th>Technical Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>*(19/6F) Comes off easier—no reason given.</td>
<td>(-) (-) (-) (-) *</td>
<td>*</td>
</tr>
<tr>
<td>*(19/6F) Lid forces it off.</td>
<td>(-) (-) (c) (-) *</td>
<td>*</td>
</tr>
<tr>
<td>*(19/6F) Materials don’t stick</td>
<td>(-) (b) (-) (-) *</td>
<td>*</td>
</tr>
<tr>
<td>*(19/6F) Plastic lid</td>
<td>(-) (b) (-) (-) *</td>
<td>*</td>
</tr>
<tr>
<td>* Total response (19 %) effective</td>
<td>-------&gt; 0% 50% 25% 0% *</td>
<td></td>
</tr>
<tr>
<td>*(20/6M) Shorter movement.</td>
<td>(-) (-) (-) (d) *</td>
<td>*</td>
</tr>
<tr>
<td>*(20/6M) Worse for sticking.</td>
<td>(-) (-) (-) (-) *</td>
<td>*</td>
</tr>
<tr>
<td>*(20/6M) One thread—gap is bigger</td>
<td>(-) (-) (c) (-) *</td>
<td>*</td>
</tr>
<tr>
<td>*(20/6M) Turn once—one thread</td>
<td>(-) (-) (-) (d) *</td>
<td>*</td>
</tr>
<tr>
<td>* Total response (19 %) effective</td>
<td>-------&gt; 0% 0% 25% 50% *</td>
<td></td>
</tr>
<tr>
<td>*(27/6M) Better—can be put on at any place.</td>
<td>(-) (-) (-) (d) *</td>
<td>*</td>
</tr>
<tr>
<td>*(27/6M) Same (better can be put on any place)</td>
<td>(-) (-) (-) (d) *</td>
<td>*</td>
</tr>
<tr>
<td>*(27/6M) Warm it to expand it</td>
<td>(-) (-) (-) (d) *</td>
<td>*</td>
</tr>
<tr>
<td>*(27/6M) Plastic/glass might slip in hands</td>
<td>(-) (b) (-) (-) *</td>
<td>*</td>
</tr>
<tr>
<td>* Total response (19 %) effective</td>
<td>-------&gt; 0% 25% 0% 75% *</td>
<td></td>
</tr>
<tr>
<td>*(28/6M) Smaller area.</td>
<td>(-) (-) (-) (d) *</td>
<td>*</td>
</tr>
<tr>
<td>*(28/6M) Same (smaller area)</td>
<td>(-) (-) (-) (d) *</td>
<td>*</td>
</tr>
<tr>
<td>*(28/6M) Better—more area to hold on to</td>
<td>(-) (-) (-) (d) *</td>
<td>*</td>
</tr>
<tr>
<td>*(28/6M) Small amount of thread</td>
<td>(-) (-) (-) (d) *</td>
<td>*</td>
</tr>
<tr>
<td>* Total response (25 %) effective</td>
<td>-------&gt; 0% 0% 0% 100% *</td>
<td></td>
</tr>
<tr>
<td>* Aggregates of Technical Solutions</td>
<td>-------&gt; 0% 19% 13% 56% *</td>
<td></td>
</tr>
<tr>
<td>* Total Technical Responses for Group (6) was 22% effective</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>
Question No.(19) How do containers (E), (F), (G), and (H) overcome the problem associated with that found in container (D)?

Key: Proposed changes to (a) Surface Texture (b) Materials in Contact (c) Force Applied. (d) Other/s

<table>
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<th>Catalogue of Responses</th>
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<tbody>
<tr>
<td><strong>Pupil</strong></td>
</tr>
<tr>
<td><strong>...</strong></td>
</tr>
</tbody>
</table>

| Pupil | **...** | **...** |

* *(17/7M)* Shorter screw. Plastic coated. Grip mottles. (a) (b) (-) (d) *
* *(17/7M)* Paint/plastic. shorter movement. (-) (b) (-) (d) *
* *(17/7M)* Plastic. very little friction. (-) (b) (-) (-) *
* *(17/7M)* Shorter thread. Plastic top. (1) (4) (0) (3) *

**Total response (50 %) effective** 

---

| Pupil | **...** | **...** |

* *(18/7M)* Short movement. (-) (-) (-) (d) *
* *(18/7M)* Same sort of thing. (short movement). (-) (-) (-) (d) *
* *(18/7M)* Don't have to screw as far. (-) (-) (-) (-) *
* *(18/7M)* Doesn't turn it as far. (-) (-) (-) (d) *

**Total response (25 %) effective** 

---

| Pupil | **...** | **...** |

* *(31/7M)* Shorter distance - jumps. (-) (-) (-) (d) *
* *(31/7M)* Same (shorter distance - jumps). (-) (-) (-) (-) *
* *(31/7M)* Easier - smaller distance inside. (-) (-) (c) (-) *
* *(31/7M)* Same (smaller distance inside). (0) (0) (0) (4) *

**Total response (25 %) effective** 

---

| Pupil | **...** | **...** |

* *(32/7M)* Bigger. Quick release. Ability to flex. (-) (-) (c) (d) *
* *(32/7M)* Same but slightly smaller. (-) (-) (c) (-) *
* *(32/7M)* Flex more. Coarse threads. Less force. (-) (-) (-) (d) *
* *(32/7M)* Single thread. Flex a little. Less force. (0) (0) (3) (2) *

**Total response (31 %) effective** 

---

| Pupil | **...** | **...** |

* *(Aggregates of Technical Solutions)** 

---

* Total Technical Responses for Group (7) was 33% effective
Question No.(19) How do containers (E), (F), (G), and (H) overcome the problem associated with that found in container (D)?

Key: Proposed changes to (a) Surface Texture  
      (b) Materials in Contact  
      (c) Force Applied.  
      (d) Other/s

<table>
<thead>
<tr>
<th>Proposed Changes</th>
<th>Container (D)</th>
<th>(E)</th>
<th>(F)</th>
<th>(G)</th>
<th>(H)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Surface Texture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Materials in Contact</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c) Force Applied</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(d) Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Catalogue of Responses

* Pupil Synopsis of Oral Response  
  Technical Solution

<table>
<thead>
<tr>
<th>Pupil Synopsis</th>
<th>Technical Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>(21/8M) No. It could stick.</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>(21/8M) Bar across- better grips.</td>
<td>(-) (-) (c) (-)</td>
</tr>
<tr>
<td>(21/8M) Better (but no reason given).</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>(21/8M) Easy- plastic top won’t bend.</td>
<td>(0) (0) (2) (0)</td>
</tr>
<tr>
<td><strong>Total response (13 %) effective</strong></td>
<td>0 % 0 % 50% 0 %</td>
</tr>
<tr>
<td>(22/8M) Reduced movement.</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>(22/8M) Friction</td>
<td>(-) (-) (-) (-)</td>
</tr>
<tr>
<td>(22/8M) Not better—more friction.</td>
<td>(-) (-) (c) (-)</td>
</tr>
<tr>
<td>(22/8M) Better — not so much contact.</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td><strong>Total response (13 %) effective</strong></td>
<td>0 % 0 % 25% 25%</td>
</tr>
<tr>
<td>(29/8M) Rubber seal — grips.</td>
<td>(-) (-) (c) (-)</td>
</tr>
<tr>
<td>(29/8M) Double seal.</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(29/8M) Double seal.</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(29/8M) Plastic-no hand grip.Smooth but not sure(a) (b) (-) (-)</td>
<td>(1) (1) (1) (2)</td>
</tr>
<tr>
<td><strong>Total response (31 %) effective</strong></td>
<td>25% 25% 50%</td>
</tr>
<tr>
<td>(30/8M) Don’t have to twist so much.</td>
<td>(-) (-) (c) (d)</td>
</tr>
<tr>
<td>(30/8M) Just twists off. No idea why.</td>
<td>(-) (-) (-) (d)</td>
</tr>
<tr>
<td>(30/8M) Materials—less friction.</td>
<td>(-) (b) (-) (-)</td>
</tr>
<tr>
<td>(30/8M) Tomato makes it stick. Not apparently stuck(-) (b) (-) (-)</td>
<td>(0) (2) (1) (2)</td>
</tr>
<tr>
<td><strong>Total response (31 %) effective</strong></td>
<td>0 % 50% 25% 50%</td>
</tr>
</tbody>
</table>

---

Aggregates of Technical Solutions  

<table>
<thead>
<tr>
<th>Technical Solutions</th>
<th>Group (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Technical Responses for Group (B)</strong> was 22% effective</td>
<td>6% 19% 31% 31%</td>
</tr>
</tbody>
</table>
Question No. (20) Examine container (I):

(i) What makes it difficult to remove the lid without the use of the turn-key?

*****************************************************************************
* CATALOGUE OF RESPONSES *
* Pupil Synopsis of Oral Response Judgement Emphasis *
*****************************************************************************
* *(2/2F) Small and nowhere to lever it off. Input / *
* *(3/1H) Tight fit. Metal to metal. Shallow fit. / Output *
* *(4/1H) No leverage. No grip. Input / *
* *(5/2H) Tightly fitted. / Output *
* *(6/2H) Don’t know. / *
* *(7/1) (no available candidate) ( )/ ( ) *
* *(8/1) (no available candidate) ( )/ ( ) *
* *(9/4H) Nothing to grip. Tight lid. No leverage. Input / Output *
* *(10/4H) They haven’t made a good job of it. / *
* *(11/3F) Tight. / Output *
* *(12/3M) Sealed. Air pressure. / Output *
* *(13/5M) On tight. / Output *
* *(14/5M) No grip on the sides. Input / *
* *(15/4M) Nothing to hold on to. Slippery. Input / *
* *(16/4M) Not very big – nothing to grab hold of. Input / *
* *(17/7H) No recess for coin. No grip. Input / *
* *(18/7M) Polish inside makes it stick / Output *
* *(19/6F) How its fixed on already. / Output *
* *(20/6H) Lid is smaller than tin. / Output *
* *(21/8M) Can’t twist or pull it – no grip Input / *
* *(22/8H) No grip or leverage. Input / *
* *(23/5M) Poor grip – no thread. Input / Output *
* *(24/5M) (no response) / *
* *(25/3M) No grip. Friction between sides of lid. Input / Output *
* *(26/3M) No grip. Tight fit. Input / Output *
* *(27/6H) Too tight. Better grip. Input / Output *
* *(28/6M) Angled – forms a seal. / Output *
* *(29/8H) Nowhere to grip. Smooth sides. Input / *
* *(30/8M) Tight. No ledge. No thread. Input / Output *
* *(31/7H) Turn-key brings the sides together / *
* *(32/7H) No grip. No lever. No screw thread. Input / Output *
*****************************************************************************
* AGGREGATE OF TOTAL JUDGEMENTS MADE (17) (17) *
* 57 % 57 % *
* 8 % of sample made a response to both Input/Output *
Question No. (22) How much force was required to open the tin?

Question No. (23) Compare that with the force required to replace the lid.

***************************************************************************************
* CATALOGUE OF RESPONSES *
* ***************************************************************************************
* Pupil Summary of Oral Response Judgement Model *
* ***************************************************************************************
* (1/2M) Not really very much/twice as much subjective/objective *
* (2/2F) Not that much/more to push it on subjective/objective* 
* (3/1M) Very little/a lot more subjective/objective*
* (4/1M) Not much/ harder subjective/objective*
* (5/2M) A fair amount/a lot more force subjective/objective*
* (6/2M) Not much needed/more than that subjective/objective*
* (7/1) (no available candidate)
* (8/1) (no available candidate)
* (9/4M) Not much/ a lot more subjective/objective*
*(10/4M) Stiff/ even worse subjective/objective*
*(11/3F) Not a lot/ a lot subjective/objective*
*(12/3M) Not much/difficult to push back on subjective/objective*
*(13/5M) Not much/quite a bit more subjective/objective*
*(14/5M) Not much/a lot more subjective/objective*
*(15/4M) Not a lot/twice the difference subjective/objective *
*(16/4M) Quite a bit/not as much subjective/objective*
*(17/7M) Very hard/equal subjective/objective *
*(18/7M) Quite a lot/ more force subjective/objective*
*(19/6F) Easy to open/more subjective/objective*
*(20/6M) Quite a lot/More-seems stronger subjective/objective*
*(21/8M) Easy/harder subjective/objective*
*(22/8M) Quite a lot/ less force subjective/objective*
*(23/5M) Not much/harder subjective/objective*
*(24/5M) Not much/quite a bit subjective/objective*
*(25/3M) Very little/Greater subjective/objective*
*(26/3M) Considerable force/More force subjective/objective*
*(27/6M) Quite a lot/a bit more subjective/objective*
*(28/6M) Not a lot/ a lot more subjective/objective*
*(29/8M) Not a lot/ easier to put back in subjective/objective*
*(30/8M) Quite a bit/ harder subjective/objective*
*(31/7M) Bit of effort/more harder subjective/objective*
*(32/7M) Reasonable amount/about the same subjective/objective*
* ***************************************************************************************
* AGGREGATE OF TOTAL JUDGEMENTS MADE 57 sub’s + 3 Ob’s *
* (95 %) (5 %) *
* ***************************************************************************************
PRODUCT CHOICE

PRODUCT DESIGN 1.1

AIMS

(a) To establish the existence of our broad areas of reference for future use when making value judgements.

(b) To identify them as AESTHETIC, ECONOMIC, MORAL AND TECHNICAL.

(c) To examine the prominence of these four elements in products.

(d) To establish that the four elements are given varying degrees of emphasis when product choices are made.

INTRODUCTION

DATER group research project

Research and development of standard science and technology equipment.

Discussions with Mrs. Greer and earlier trials last term.

Repeat - in order for you to catch up with the other group.

* Today - Terminology and background information.
* Next week - Test some apparatus which has been developed.
* Remainder of the time - Join the rest of the group.

AIM OF TODAY'S LESSON - TO EXTEND YOUR VOCABULARY IN DESIGN BY FOCUSSING ON 4 IMPORTANT TERMS.

DEVELOPMENT

(1) FORM FOUR GROUPS ----------------------> Separate if possible and designate groups T.E.A. and M

(2) INITIATE TASK NO. 1 ----------------------> Tasksheet No. 1
Mail Order Catalogues

(3) LIST RESPONSES --------------------------> Chalkboard

(4) FORMULATE FAMILIES ----------------------> eg. Beauty, style or taste
eg. Cost or value for money
1. AESTHETIC and
2. ECONOMIC RESPONSES

Tasksheet No. 2
(maintain groupings)

Mousetrap Poison

Mouse dies

Mouse lives

3. MORAL RESPONSE

1. AESTHETIC
2. ECONOMIC
3. MORAL

AESTHETIC, ECONOMIC AND MORAL ISSUES ALL AFFECT CHOICE

Any MORAL issues?

What about priorities?

What is the order of importance of AESTHETIC, ECONOMIC and MORAL issues when buying a pair of shoes?

INITIATE DEMONSTRATION OF 'ALTERNATIVE MOUSETRAP'

(A) FUNCTION

(B) FITNESS FOR PURPOSE/PERFORMANCE

4. TECHNICAL RESPONSE

RECAPITULATION

Task sheet No.3

CONSOLIDATION

THE FOUR TYPES OF RESPONSE OF T.E.A.M.

THEIR EFFECT ON PRODUCT CHOICE

THE POSSIBLE VARIANCE OF EMPHASIS
Technical, Economic, Aesthetic and Moral Factors may have an effect upon Product Choice.
YOU ARE LOOKING FOR A NEW PAIR OF SHOES AND DECIDE TO ORDER A PAIR THROUGH A MAIL ORDER CATALOGUE.

(A) IDENTIFY THE SHOES WHICH YOU WOULD BUY

...................................................................................

(B) WHAT TYPE OF SHOE ARE THEY ?

<PLIMSOLL, TRAINER, FASHION, BOOT, SANDAL>

...................................................................................

(C) WHAT SIZE ARE THEY ?

...................................................................................

(D) WHAT COLOUR ARE THEY ?

...................................................................................

(E) HOW MUCH DO THEY COST ?

...................................................................................

(F) WHY DID YOU CHOOSE THESE PARTICULAR SHOES ?

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YOU HAVE BEEN INTRODUCED TO THE MEANING AND INFLUENCE OF FOUR DIFFERENT TYPES OF RESPONSE WHICH CAN BE USED TO MANIPULATE OUR CHOICE OF PRODUCT.

THESE ARE THE AESTHETIC, ECONOMIC, MORAL AND TECHNICAL VALUES WITH WHICH WE ASSESS THE QUALITY OF PRODUCTS.

COMPLETE THE FOLLOWING NOTES BY INSERTING THE CORRECT TYPE OF RESPONSE WHICH IS BEING DESCRIBED.

................... VALUES:

- Concerned with an appreciation of efficiency and fitness for purpose.

................... VALUES:

- Concerned with an awareness of multitude of issues raised in the phrase 'value for money'.

................... VALUES:

- Concerned with the appreciation and awareness of beauty in all aspects of the natural and man-made world.

................... VALUES:

- Concerned with human relationships (eg. social or religious) and their impact on the world.
YOU SHOULD NOW BE AWARE THAT ANY FUTURE CHOICE OF PRODUCT CAN BE INFLUENCED IN FOUR SEPARATE WAYS.

SUCH INFLUENCES ARE USED BY PROFESSIONAL MARKETING AGENCIES TO INFLUENCE OUR CHOICE OF PRODUCT. HOWEVER, ALL THEIR PERSUASIVE TACTICS WILL FALL WITHIN THE SAME FOUR POINTS OF REFERENCE.

THESE ARE NOT STATED IN ANY PRIORITY ORDER BUT ARE EASILY REMEMBERED BY USING THE ACRONYM OF T.E.A.M.

THESE POINTS OF REFERENCE DESCRIBE THE VALUES WHICH CAN INFLUENCE OUR CHOICE OF PRODUCT AND STAND FOR:

T . . . . . . . . .
E . . . . . . .
A . . . . . . .
M . . . . . . .

YOUR GROUP WAS EARLIER GIVEN THE LETTER ...... WHICH DESCRIBES THE VALUE JUDGEMENTS WHICH YOU ARE ASSIGNED.

YOU ARE ABOUT TO REVIEW A SHORT PROMOTIONAL VIDEO RECORDING OF A NEW TYPE OF CORKSCREW.

AS YOU WATCH THE PRESENTATION YOU ARE TO MAKE A JUDGEMENT OF THE PRODUCT BASED ONLY ON YOUR ASSIGNED POINT OF REFERENCE.

YOUR ASSIGNED JUDGEMENT WILL THEREFORE BE BASED ONLY ON THE ISSUES RAISED.

-----------------------

NOTES : ..............................................................

..............................................................................

..............................................................................
YOU ARE ABOUT TO REPLACE SOME OF YOUR OLD KITCHEN TOOLS AND NEED SOME MEANS OF OPENING CROWN TOPPED BOTTLES.

THE BOTTLE OPENERS GIVEN TO YOUR GROUP ARE THE ONLY EXAMPLES WHICH ARE AVAILABLE IN THE SHOP.

CHOOSE WHICH BOTTLE OPENER YOU WOULD BUY?

(a) WHAT SIZE IS IT?

(b) WHAT COLOUR IS IT?

(c) WHAT MATERIALS ARE USED?

(d) WHAT DID IT COST?

(e) WHERE WAS IT MADE?

(f) HOW DOES IT WORK?

(g) THINK CAREFULLY ABOUT THE POINTS OF REFERENCE WHICH HAVE INFLUENCED YOUR CHOICE OF BOTTLE OPENER AND PLACE THEM IN PRIORITY ORDER.

(1) .................. (most influence)

(2) ..................

(3) ..................

(4) .................. (least influence)

Ref: destask(5)
PRODUCT PERFORMANCE

PRODUCT DESIGN 1.2

AIMS

(a) To review that Technical, Economic, Aesthetic and Moral reference points may be used to influence product choice.

(b) To review that the use of the acronym T.E.A.M. does not suggest any priority influence given to product choice.

(c) To emphasize that Technical values are the most important influence on product performance.

(d) To establish the various grip capabilities of children's shoes.

(e) To establish that grip can be stated in numerical terms by angle and grip factor.

INTRODUCTION

(1) RE-ASSEMBLE the four groups and return tasksheets 1 - 5

   Review of previous lesson --------> Q & A using Tasksheets 2 to 4 as a basic guide.

(2) REVIEW OF TASKSHEET NO. 1 --> assess top responses!

   Number of T ........ ?
   Number of E ........ ?
   Number of A ........ ?
   Number of M ........ ?

(3) RE-AFFIRM THAT T.E.A.M. DOES NOT SUGGEST ANY PRIORITY INFLUENCE

(7) WHICH ISSUES WITHIN T.E.A.M. GIVE THE MOST INFLUENCE ON THE PERFORMANCE OF THE PRODUCT?

(8) TODAY'S LESSON WILL DEAL WITH PERFORMANCE OR FITNESS FOR PURPOSE

DEVELOPMENT

(9) CHALKBOARD -------------> PRODUCT PERFORMANCE

(10) MAKE THE STATEMENT : A SEARCH FOR THE SHOES WITH THE BEST GRIP?

(11) DESCRIBE THE APPARATUS -----> Omit to mention 'Grip Factor'

(12) INITIATE TASKSHEET NO. 6 ----> Tasksheet No.6

(13) CONDUCT TRIALS

-88-
RECAPITULATION

(14) TECHNICAL issues are the most important influence upon PRODUCT PERFORMANCE

(15) GRIP can be stated in numerical terms in two ways:

   (a) Angle of Inclination in degrees
   
   (b) Grip Number

(16) Different shoes have different grip ratings.

CONSOLIDATION

(17) INITIATE TASKSHEET NO. 7

Andrew's shoes appeared to give the best grip. The recorded Angle of Inclination was 35° with a corresponding Grip Scale reading of 0.7.
SLIP/GRIP APPARATUS

(1) Label the diagram: (a) Protractor Reading
    (b) Angle of Inclination

(2) Examine the apparatus and ESTIMATE the steepest slope
    which you will stand upon without slipping.
    My estimate of the maximum angle is ........ degrees.
    The actual result was an angle of ..... degrees.

(3) Examine the apparatus further and suggest a more accurate
    method of identifying the point at which slip occurs.

(4) Label the diagram: 'Grip Factor'.

(5) My shoes have a grip factor of ......

Ref: destask(6)
(6) Do all the shoes tested have the same 'Grip factor'? 

<table>
<thead>
<tr>
<th>Name</th>
<th>Grip factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name (1)</td>
<td></td>
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<tr>
<td>Name (2)</td>
<td></td>
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<td>Name (3)</td>
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<td>Name (4)</td>
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<td>Name (11)</td>
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<td>Name (12)</td>
<td></td>
</tr>
</tbody>
</table>

(7) Whose shoes would you choose for walking up a steep slope?
Name: Grip Factor: 

(8) Whose would you choose for making slides in the winter?
Name: Grip Factor: 

(9) Examine the part of the shoe which affects Grip.
(Remove one of your shoes for close analysis)

(10) Place your shoe on the squared paper provided and draw around it to produce the exact shape of your shoe.
Compare your shoe with others and suggest why some shoes performed better than others.
A man is about to load sand onto his pick-up truck by running a wheelbarrow up a plank of wood. If the tailgate is only 1 metre high, will the man be successful or will he slip on the plank as he climbs the slope?

Help!

(a) On the squared paper provided, draw the triangle to scale by letting one small square represent 40 mm.
(b) Measure the angle very carefully.
(c) The angle of inclination of the plank is ..... degrees.
(d) Using the results recorded on Design Tasksheet No. 6, do you think that the man will be successful?
(e) Give reasons for your answer on the same sheet as drawing.
(f) What suggestions can you make to improve the man's performance.
PREDICTION OF PERFORMANCE

PRODUCT DESIGN 1.3

AIMS

(a) To review that Technical values are the most important influence on product performance.

(b) To review that individual grip characteristics can be dissimilar.

(c) To review that grip can be stated in numerical terms of angle and grip factor.

(d) To understand the meaning of 'Proportion' in relation to gradient.

(e) To evaluate the probable 'Grip Factors' for given limiting angles of inclination.

INTRODUCTION

(1) REVIEW LAST WEEK'S LESSON ON 'PRODUCT PERFORMANCE'

to include: (a) Angle of Inclination

(b) Grip Factor

(c) Variance detected in different shoes

(d) Suited to various applications

(e) Range of angles of inclination (20 - 35 degrees)

(f) Range of Grip Factors between 0.3 and 0.7

(2) FAILED TO TEST THE GRIP FACTOR OF MRS. HECTOR'S SHOES

(3) INITIATE TEST

DEVELOPMENT

(4) TODAY'S LESSON WILL DEAL WITH THE PREDICTION OF PERFORMANCE

(5) REVIEW DESIGN TASK NO. 7

(6) REVIEW THE DIFFICULTIES ......... No angle given

........ No grip factor given

(7) Supplementary work on ANGLES AND TRIANGLES

If required DISTRIBUTE TRIANGLES (A) AND (B) larger slope?
INTIATE DESIGN TASK NO. 7 (SUPPLEMENTARY)

(8) DEMONSTRATION OF TRIANGLE CONSTRUCTION ON SLIP/GRIP APPARATUS

(a) SET UP ON 0.5
(b) Describe the primary axes
(c) Record slope with pen recorder
(d) Remove board for examination and development
(e) Insert secondary axes
(f) Measure and record secondary angle of inclination
(g) Compare secondary and primary angles of inclination

(9) INITIATE DESIGN TASK NO. 7 (CONTD)

(10) CONCLUDE THAT....
by drawing the TRIANGLE to the correct PROPORTIONS
we can PREDICT the probable PERFORMANCE.

(11) REVIEW THE GIVEN TRIANGLE ON THE BOARD .... Slip/Grip apparatus

(a) Take measurements of the secondary axes
(b) Enter these values onto the board
(c) State the proportions of the secondary axes (2 : 1)
(d) State the proportions of the primary axes (2 : 1)
(e) Establish the size of the vertical axes in relation to their respective horizontal axes (1 : 2)
(f) Converting to a decimal is 0.5 (ie the 'GRIP FACTOR')
(g) Practice this with calculators if available

RECAPITULATION

(12) CONCLUDE THAT ....
by drawing the TRIANGLE to the correct PROPORTIONS
we can PREDICT the probable PERFORMANCE.

by drawing we can establish the ANGLE OF INCLINATION
by calculation we can establish the GRIP FACTOR
CONSOLIDATION

(13) PREDICT THE POSSIBLE EFFECT OF PARKING ON A 10 DEGREE SLOPE SIMILAR TO THE PROBLEM DESCRIBED IN DESIGN TASK NO. 7.

(14) INITIATE DESIGN TASK NO. 8

(do not collect ................required for next lesson)
Using the scissors provided, cut out and compare all eight of the right-angled triangles shown below.
Which of the following pairs of angles is the larger?

(1)

(a) <---- OR ----> (b)

Which of the following slopes is the larger?

(3)

(e) <---- OR ----> (f)

(4)

(g) <---- OR ----> (h)
(1) Insert the following terms in their correct place.

INCLINATION, GRIP, ANGLE, TECHNICAL, PREDICT, PROPORTIONS, CHOICE, PROTRACTOR, DRAWING, FUNCTION.

( BE CAREFUL THERE ARE ONLY 6 SPACES FOR 10 TERMS )

It is possible to ..................... the probable performance of a product by producing a ...............
of the working example to exact ..........................

By using this method to establish the ..................
of ......................... of a slope, we can calculate the necessary ..................... factor which will be required to prevent slip.

(2) The designers of hospitals are always aware of the need to avoid the use of steps and staircases. Slopes and ramps are therefore preferred to enable easier access for the infirmed and the more practical transportation of patients in wheelchairs.

It is proposed to use a ramp of 10 : 1 to mount a 200 mm step into the casualty building.

You are to draw the ramp and predict its probable performance - in other words, will it work?

- Will it promote slip?
It might help if you draw the ramp in position up to the step shown.

BE CAREFUL! Draw the ramp in the same proportion as the height of the step.
GRIP FACTORS

PRODUCT DESIGN 1.4

AIMS

(a) To determine the probable grip factors for given angles of limiting friction, by drawing and calculation.

(b) To evaluate the grip factors for given examples of different materials.

INTRODUCTION

(1) REVIEW the need to evaluate angles of inclination and grip factors without the use of slip/grip equipment.

(2) REVIEW the method of determining the angle by drawing a triangle to the correct proportions.

(3) DISTRIBUTE the returned design tasksheet No. 7 and discuss the method of establishing the sizes of the triangle.

(4) REVIEW that by measuring the angle with a protractor and making comparisons with our own tests we then made an assessment of the possible outcome of the problem.

(5) WE KNEW that the problem required a grip factor of 0.5 to ensure that the man would not slip.

(6) BUT HOW DID WE KNOW THIS ? ............. from the slip/grip equipment

(7) TODAY WE SHALL SEE HOW TO CALCULATE THE GRIP FACTOR ACCURATELY WITHOUT THE USE OF THE SLIP/GRIP EQUIPMENT.

DEVELOPMENT

(8) EXAMINE the slip/grip equipment when set at 0.5

(9) REVIEW THE PROPORTIONS OF 2:1 .................. display card

(10) EXPLAIN that it can be written 2/1 .................. display card

(11) HOWEVER, SUGGEST that this is reversed ie. 1/2

(12) USING A CALCULATOR this is 0.5 ie. the grip factor

(13) REVIEW DESTASK (8)

(14) What material could be used for this job?

(15) Which would give the better grip?

(16) REVIEW the problems associated earlier in destask (7)
(17) INITIATE DEMONSTRATION OF DIFFERENT MATERIALS AND NOTE THE GRIP FACTORS FOR:

(a) shoes on wood ........grip factor ?  
(b) shoes on hardboard ...grip factor ?  
(c) shoes on plastic ........grip factor ?  
(d) socks on plastic ........grip factor ?

(18) INITIATE EXPERIMENT with slip/grip boards + Destask (9)

RECAPITULATION

(19) REVIEW THAT GRIP FACTOR CAN BE CALCULATED

(20) REMIND group to bring different materials for high/low grip for next week's lesson.

(21) DISTRIBUTE DESTASK (10) Wordsearch to be handed in for next week.
### PRODUCT DESIGN 1.4
### DESIGN TASK NO. 9

<table>
<thead>
<tr>
<th>SLIDER MATERIAL - sliding on</th>
<th>BASE MATERIAL</th>
<th>Grip factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Wood</td>
<td>* Wood</td>
<td>*</td>
</tr>
<tr>
<td>(2) Aluminium</td>
<td>* Wood</td>
<td>*</td>
</tr>
<tr>
<td>(3) Steel</td>
<td>* Wood</td>
<td>*</td>
</tr>
<tr>
<td>(4) Copper</td>
<td>* Wood</td>
<td>*</td>
</tr>
<tr>
<td>(5) Brass</td>
<td>* Wood</td>
<td>*</td>
</tr>
<tr>
<td>(6) Wood</td>
<td>* Aluminium</td>
<td>*</td>
</tr>
<tr>
<td>(7) Aluminium</td>
<td>* Aluminium</td>
<td>*</td>
</tr>
<tr>
<td>(8) Steel</td>
<td>* Aluminium</td>
<td>*</td>
</tr>
<tr>
<td>(9) Copper</td>
<td>* Aluminium</td>
<td>*</td>
</tr>
<tr>
<td>(10) Brass</td>
<td>* Aluminium</td>
<td>*</td>
</tr>
<tr>
<td>(11) Wood</td>
<td>* Steel</td>
<td>*</td>
</tr>
<tr>
<td>(12) Aluminium</td>
<td>* Steel</td>
<td>*</td>
</tr>
<tr>
<td>(13) Steel</td>
<td>* Steel</td>
<td>*</td>
</tr>
<tr>
<td>(14) Copper</td>
<td>* Steel</td>
<td>*</td>
</tr>
<tr>
<td>(15) Brass</td>
<td>* Steel</td>
<td>*</td>
</tr>
<tr>
<td>(16) Wood</td>
<td>* Copper</td>
<td>*</td>
</tr>
<tr>
<td>(17) Aluminium</td>
<td>* Copper</td>
<td>*</td>
</tr>
<tr>
<td>(18) Steel</td>
<td>* Copper</td>
<td>*</td>
</tr>
<tr>
<td>(19) Copper</td>
<td>* Copper</td>
<td>*</td>
</tr>
<tr>
<td>(20) Brass</td>
<td>* Copper</td>
<td>*</td>
</tr>
<tr>
<td>(21) Wood</td>
<td>* Brass</td>
<td>*</td>
</tr>
<tr>
<td>(22) Aluminium</td>
<td>* Brass</td>
<td>*</td>
</tr>
</tbody>
</table>

Ref: destask(9) (DRH 280987)
**PRODUCT DESIGN 1.4**

**DESIGN TASK NO. 9 (contd)**

**PRODUCT DESIGN**

**TASK NO. 9**

<table>
<thead>
<tr>
<th>SLIDER MATERIAL - sliding on</th>
<th>BASE MATERIAL</th>
<th>Grip factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>Brass</td>
<td>*</td>
</tr>
<tr>
<td>Copper</td>
<td>Brass</td>
<td>*</td>
</tr>
<tr>
<td>Brass</td>
<td>Brass</td>
<td>*</td>
</tr>
</tbody>
</table>

Now try some materials of your own!

(a) Which combination of materials would you choose to promote good gripping qualities?

(b) Which materials would you choose for parts of a machine which are required to continuously slide upon each other?

(c) Can you think of any other materials which might have higher and lower grip factors than those already tested? Why not try them out with your equipment?

Ref: destask(9)
Listed here are 10 terms which have been used in the previous lessons on Product Design. These terms, written as one word, can be found in the square overleaf by reading in straight lines. The lines can go in any direction: forwards, backwards, up, down or diagonally, as long as they are straight. There is no need to use every letter in the square and any letters can used as often as you want.

AESTHETIC, CHOICE, ECONOMIC, GRIP FACTOR, MORAL, PERFORMANCE, PREDICT, PRODUCT, PURPOSE AND TECHNICAL.

The following clues might be of help in finding another 10 terms which are hidden in the same square:

(1) Not exactly the same but similar (12 letters)
(2) NEGAL is not its correct spelling (5 letters)
(3) This triangle has the 'correct' angle (5 letters)
(4) An instrument used to measure angles (10 letters)
(5) This must be done very accurately to ensure good estimates of the grip factor (7 letters)
(6) There are 90 of these in one right angle (7 letters)
(7) The angle to the horizontal (11 letters)
(8) Well designed running shoes would resist this (4 letters)
(9) Purpose (8 letters)
(10) This is a force which resists motion (8 letters)
FRICITION IN MACHINES

PRODUCT DESIGN 1.5

AIMS

To review: (a) the significance of the acronym T.E.A.M. when making judgements about any product.
(b) the isolation of 'technical' issues when examining the performance of products.
(c) that the 'gripping' qualities will vary with a change in the materials in contact.
(d) that Grip/Friction can be identified numerically.
(e) that the amount of friction can be established by drawing and calculation

To appreciate that:

(f) friction can be both an advantage and disadvantage in machines

To suggest

(g) possible solutions to problems of friction.

INTRODUCTION

(1) Question and answer session to review aims (a) to (e)

(2) TODAY we shall

(a) Examine some machines where friction will have an effect upon their operation.
(b) Suggest possible solutions to some of the problems identified.

DEVELOPMENT

(3) Distribute FORCES 9
Ref:
Science Scene Setters
British Gas Education Service
P O Box 46
Hounslow
Middlesex TW4 6NF

(4) Divide class up into four groups for the "BMX DEMONSTRATION"

(5) List
(a) Where FRICITION occurs
(b) Where FRICITION is advantageous
(c) Where FRICITION is problematic

(6) Make comparisons with the "RACER DEMONSTRATION"
(a) Which machine is the "better" performer?

RECAPITULATION

Discussion, with Q & A, to emphasis the main points which emanated from the demonstrations.

CONSOLIDATION

Initiate Design Task (11)
The drivers do not want their cars to slide on the ice. What has one driver done to make it easier for his car to grip the ice?

Peter wants his toboggan to slide easily. What is he doing to the runners of his toboggan?
**PRODUCT DESIGN 1.5**

**DESIGN TASK NO. 11.**

**NAME**

**ANSWER THE FOLLOWING QUESTIONS ON THE REVERSE SIDE OF THIS SHEET**

(1) Explain why we cannot walk without friction between our shoes and the ground.

(2) Why do we use a sledge on snow and ice only?

(3) List another five examples of when
   (a) you want things to slide
   (b) you want things to grip

(4) Why would oil spill on the motorway be dangerous?

(5) Why are muddy country lanes dangerous?

(6) The drawing below shows a cycle sledge which was designed in 1905.

   How would you improve the grip of the rear wheel?
   How would you make the runners slide more easily?

(7) Draw a wheelbarrow and show where friction is an advantage and also a dis-advantage

(8) Describe how you would improve the wheelbarrows performance.
EFFICIENT PERFORMANCE

PRODUCT DESIGN 1.6

AIMS

(a) To show the need to resist sliding when rolling

(b) To modify the existing design of a machine in order to increase its resistance to slide (when rolling or stationary).

(c) To arrange an opportunity for pupils to apply previous knowledge of frictional resistance to a practical situation.

(d) To encourage pupils to experiment with their own personal 'machine' and record their findings.

(e) To observe the extent of knowledge transfer to changing frictional resistance which pupils include in (d).

INTRODUCTION

(1) Review the various grip factors established for different materials

(2) Announce the need to examine machines which roll

DEVELOPMENT

(3) Introduce the group to the "Rolling Machine"

(a) Main roller
(b) Rubber band
(c) Short leg
(d) Nail stop
(e) Washer
(f) Trailing leg

(4) Initiate Design Task (12) - How far will your machine roll?

(a) Wind up your roller 10 times. Let it roll and record your observations

* Q & A to establish a recorded length and to discuss some of the difficulties experienced.

(b) Wind up your roller 20 times. Let it roll and record your observations

* Did it travel twice as far? Why/Why not?

(c) Complete the following table

<table>
<thead>
<tr>
<th>Number of winds</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance travelled</td>
<td>10</td>
<td>15</td>
<td>20</td>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>
(d) What is the maximum distance that your roller can travel?

(e) What are the limiting factors?
* Elastic band fracture
* Wheel spin

(f) What is the maximum gradient that your roller can climb?

RECAPITULATION

(1) List the problems experienced

* Steering
* Elastic band fracture
* Wheel spin

(2) What can be done to make your roller travel further?

(3) What can be done to make your roller travel faster?

(4) What can be done to make your roller travel up steeper slopes?

CONSOLIDATION

(5) TAKE YOUR ROLLER HOME in order to modify. Bring it back next week to find the fastest roller.
PRE-TEST

PRODUCT DESIGN 2.1

AIMS

(a) To establish an initial measure of the prominence of Mechanical Acumen.

INTRODUCTION (15 mins)

Research programme Loughborough.
Invitation from Mr. Byers (Head).
Follow up work on Mechanisms.
Establish what is already known.
Organise Test Administration Procedures.

DEVELOPMENT (50 mins)

(See Guidance Notes and Test in Appendix V)

RECAP CONSOLIDATION (10 mins)

Information about next lesson.
PRODUCT MECHANISTICS

PRODUCT DESIGN 2.2

AIMS

(a) To identify where the lever and wedge act as the primary mechanism of the functional performance of given products.

(b) To establish the basic source of mechanical functioning to be:

(i) Turning Moments

and

(ii) Inclined Plane

INTRODUCTION (15 mins)

(c) Explanation of previous week's test

eg expected results
expected responses
indicates a bright group
product analysis
no right or wrong answers. Initiate Design Task (12).

(d) Discussion of various products to disclose the T.E.A.M. format of judgement model.

(single mousetrap, double mousetrap, poison, adhesive, alternative mousetrap).

(e) Initiate Design Task No. 13.

(f) Emphasis the type of work during the next three weeks will be on:

PRODUCT FUNCTIONAL PERFORMANCE

(Technical Aspects)

(g) Today's Title: PRODUCT MECHANISTICS

DEVELOPMENT (50 mins)

Q & A SESSION

(1) Review Mechanisms module which group has already completed and ask for 12 examples of different machines.  
List on chalkboard

(2) What is a machine? What does it do?

"A device which does work by converting or transmitting energy"
(3) All machines are made up of **MECHANISMS** - Give some examples of mechanism?

"Lever, pulley, gearbox, cams, screw and ratchet are all basic mechanical devices".

(4) What is a mechanism? What does it do?

"A mechanism transforms a given input motion and force into a desired output motion and force".

(5) The ancient civilization considered there to be only 5 basic mechanisms for moving loads. What are they?

"Lever, windlass, pulley, wedge and screw"

(6) Let us now **ANALYSE** these closely in order to clarify our thinking.

Initiate OHP's 1 - 10

Initiate Design Task No. 14

(a) PRODUCT MECHANISTIC RATINGS

\[
\begin{array}{c}
\text{LOW} \quad \rightarrow \quad \text{HIGH} \\
\text{NOISE} \quad \rightarrow \quad \text{NOISE}
\end{array}
\]

(b) 5 ANCIENT MECHANISMS

\[
\begin{array}{c}
\text{HIGH} \quad \rightarrow \quad \text{LOW} \\
\text{ABSTRACTION} \quad \rightarrow \quad \text{ABSTRACTION}
\end{array}
\]

(c) MECHANISMS

- Pulley
- Wheel and Axle
- Windlass
- Lever

DEVELOPMENTS

- Curtain track/Vacuum cleaner
- Egg whisk/Bicycle
- Fishing Reel
- Crane Winch

(d) OTHER - screw

MECHANISMS

- self locking taper
- cutting tools

(8) **BASIC FUNCTION SERVED BY 1ST GROUP**

\[
\text{L E V E R A G E}
\]
9) BASIC FUNCTION SERVED BY 2ND GROUP
WEDGE ACTION

10) Basic derived principles of mechanical performance are established through:

(a) Turning Moments
(b) Inclined Plane

THESE TWO RECURRING PRINCIPLES ARE THE FOUNDATIONS ON WHICH WE SHALL BE MAKING FUTURE TECHNICAL APPRAISALS

RECAPITULATION (5 mins)

(a) T.E.A.M.
(b) Machines, Mechanisms, Products and Principles
(c) Primary functions \( \rightarrow \) LEVERAGE AND WEDGE ACTION
(d) Primary Principles \( \rightarrow \) TURNING MOMENTS AND INCLINED PLANE

CONSOLIDATION (15 mins)

(12) Disclose OH II (include demonstration of "Classy Cutters" and "Apple Core Remover").

(13) Initiate Design Task No. 15.

(14) Collect in Design Tasks 12 - 15.
ON YOUR RETURN HOME FROM SCHOOL YOU FEEL TOO HUNGRY TO WAIT FOR TEA AND SO DECIDE TO MAKE YOURSELF A CHEESE SANDWICH.

TO YOUR ASTONISHMENT YOU SEE A MOUSE IN THE FOOD CUPBOARD.

REALISING THE CONSIDERABLE HEALTH HAZARD WHICH EXISTS YOU DECIDE TO RID YOURSELF OF THE MOUSE.

HOW DO YOU DO THIS?

DO YOU CONSIDER THERE TO BE ANY LIMITATIONS WITH THE METHOD WHICH YOU DESCRIBE?

HOW COULD THIS DIFFICULTY BE OVERCOME?
You have been introduced to the meaning and influence of four different types of response which can be used to manipulate our choice of product. These are the AESTHETIC, ECONOMIC, MORAL and TECHNICAL values with which we assess the quality of products. COMPLETE THE FOLLOWING NOTES by inserting the correct type of response which is being described.

............. VALUES:
**************************************************
Concerned with an appreciation of efficiency and fitness for purpose.

............. VALUES:
**************************************************
Concerned with an awareness of multitude of issues raised in the phrase 'value for money'.

............. VALUES:
**************************************************
Concerned with the appreciation and awareness of beauty in all aspects of the natural and man-made world.

............. VALUES:
**************************************************
Concerned with human relationships (eg. social or religious) and their impact on the world.

THESE POINTS OF REFERENCE DESCRIBE THE VALUES WHICH CAN BE USED TO INFLUENCE OUR CHOICE OF PRODUCT.

THEY ARE NOT STATED IN ANY PRIORITY ORDER BUT ARE EASILY REMEMBERED BY USING THE ACRONYM OF T.E.A.M.

T .................
E ..................
A ..................
M ..................
<table>
<thead>
<tr>
<th>Products</th>
<th>Mechanisms</th>
<th>Functions</th>
<th>Principles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curtain Track</td>
<td>Pulley</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vacuum Cleaner</td>
<td>Wheel &amp; Axle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Egg Whisk</td>
<td>Windlass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bicycle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fishing Reel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crane Winch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cork Screw</td>
<td>Screw</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bench Vice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cricket Stumps</td>
<td>Self-Locking Tape</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taper Shank Drill</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kitchen Knife</td>
<td>Cutting Tool</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hack Saw Blade</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**PRODUCT DESIGN 2.1**

**DESIGN TASK NO. 14 (Model)**

**NAME**

---

<table>
<thead>
<tr>
<th>PRODUCTS</th>
<th>MECHANISME</th>
<th>FUNCTIONS</th>
<th>PRINCIPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curtain Track</td>
<td>Pulley*</td>
<td>Lever *</td>
<td>Turning Moment</td>
</tr>
<tr>
<td>Vacuum Cleaner</td>
<td>Wheel &amp; Axle</td>
<td>Action</td>
<td></td>
</tr>
<tr>
<td>Egg Whisk</td>
<td>Windlass*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bicycle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fishing Reel</td>
<td></td>
<td></td>
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<td>Screw</td>
<td>Wedge *</td>
<td>Inclined Plane</td>
</tr>
<tr>
<td>Bench Vice</td>
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<td>Cricket Stumps</td>
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</tr>
<tr>
<td>Kitchen Knife</td>
<td>Cutting Tool</td>
<td></td>
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</tr>
<tr>
<td>Hacksaw Blade</td>
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</tr>
</tbody>
</table>

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Ref: destask

( DRH 140987 )

-119-
PRODUCT DESIGN 2.1

NAME

(a) Socket Screw Wrench

(b) Screwdriver

(c) Childrens Slide

(d) Drill Drift

(e) Taper Gib Head Key

(f) Taper Pin

(g) Bicycle

(h) Childrens Slide

Ref: destask (DRH 300388)
PRODUCT DESIGN 2.1

NAME

INSERT THE DIRECTION OF THE 'NORMAL' FORCES APPLIED TO THE DOOR HANDLE IN ORDER TO OPEN IT:

(a) On the PLAN VIEW
(b) On the ELEVATION
and (c) On the PICTORIAL VIEW

(a) PLAN VIEW

(b) ELEVATION

(c) PICTORIAL VIEW
PRODUCT DESIGN 2.2

NAME

(9) Vee-belt Profile

(10) Self-holding Taper

(11) Lathe Spindle Nose

(12) Hacksaw & Blade

(13) Tin Opener

(14) Corkscrew

(15) Toggle Clamp

(16) Slotted C'sk Hd. Woodscrew

Ref: destask (DRH 300388)
PERFORMANCE OF LEVERS
PRODUCT DESIGN 2.3

AIMS

(a) Review of formula for calculating the Turning Moment of a Force.
(b) Review the similarity which exists between all Turning Moments when equilibrium prevails.
(c) Establish the power to predict the unknown forces/ distances given the remaining relevant data.
(d) Predict the forces required to open the model door given various door closer designs.

INTRODUCTION (15 mins)

Q & A of previous lessons content.

(e) Name four distinct aspects of design which can be examined when evaluating products:

TECHNICAL
ECONOMIC
AESTHETIC
MORAL

(f) Describe a simple method of remembering these four aspects of evaluation.

T.E.A.M. acronym

(g) "Functional Performance" is a topic which is closely associated with which of the four aspects of evaluation:

TECHNICAL

(h) Many mechanisms are developments of two basic functions:

LEVERAGE AND
WEDGE ACTION

(i) The functions of Leverage and Wedge Action involve the use of which two basic mechanical principles:

Turning Moments and the Inclined Plane.

(j) Many products are machines which can be argued to involve the use of which principles for their successful functioning:

The Principle of Moments and the Inclined Plane
DEVELOPMENT (40 mins)

Q & A Session (contd)

(1) Which principles can you see within the following products?
   Model Door
   "Many examples"

(2) Door Wedge

(3) Door Hinge

(4) Hinge Screws

(5) Classroom Door

(6) Door Closer*

TURNING MOMENT? INCLINED PLANE?
HOW BIG IS THE TURNING MOMENT?
CAN IT BE MEASURED?
CAN IT BE CALCULATED?

(7) STUDENT ACTIVITY

Fit extended closer arm (with hooks)

(8) Find position of smallest force to hold arm at 90° to door frame in both planes.

(9) Explain 'Normal' Force.

(10) Establish 'smallest' Force necessary.

(11) Initiate Destask 16A to establish a vector diagram from space diagram.

(12) Request size of 'Turning Moment' .......... Destask (16a)

(13) TURNING MOMENT = FORCE & PERP DISTANCE

(14) Establish that all turning moments are the same whatever position spring balance has taken.

(15) RECAPITULATION (5 mins)

Identified the specific mechanism within the total product eg. Door closer.

Establish the relevant principle and from that derived the forces, fulcrum and perpendicular distances.

Calculated the Turning Moment
(16) CONSOLIDATION (15 mins)
What possible use is this to us - the designers POWER TO PREDICT!!

(17) Preduction of the forces acting at any point along the door closer arm given that the Turning Moment is the constant.

(18) Initiate Destask No. 17.
(19) Initiate Destask No. 18.
(20) Predict force required to open door.
(21) Initiate Destask No. 19.
PRODUCT DESIGN 2.3

DESIGN TASK NO. 15a

NAME

PRODUCT: Door Closer

SPACE DIAGRAM

VECTOR DIAGRAM

[Position 2]

Ref: des-task

(DRH 140987)
PRODUCT DESIGN 2.3

DESIGN TASK NO. 18.

NAME

Space Diagram

Vector Diagram

ef: destask 18

(DRH 060488)
NOISY LEVERS (70 mins)

PRODUCT DESIGN 2.4

AIMS

(a) Establish the existence of Turning Moments.

(b) Relate Input/Output criteria to simple products using leverage.

(c) Establish quantitative appraisals of a selection of Crown-Top Lifters.

INTRODUCTION (15 mins)

(d) Q & A to review 2.3 OHP.

(e) TITLE: NOISY LEVERS (Request explanation)

(f) Give examples of Noisy Lever

(g) What use to designer?

(h) POWER TO PREDICT PERFORMANCE!

(i) Predict the force acting upon the original door closer

Review Destask No.18

(j) Predict the force required to open the door

Review Destask No.19

(k) Examine proportions of forces and distances.

FORCES

eg

<table>
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<th>Effort</th>
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<th>Distance</th>
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DISTANCES

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<td>2</td>
<td>100/250 = 10/25</td>
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= 2.5:1

= 1:2.5

i.e. "INVERSELY PROPORTIONAL QUANTITIES"
DEVELOPMENT (35 mins)

(1) Distribute Probus Can Openers.

(2) Establish Principles - How Many?

(3) Focus upon Crown Top Lifter.

(4) Which Principle/s?

(5) Review its function

(6) Review its functional criteria

(7) Establish the functional surfaces

(8) Establish the functional dimensions

(9) Establish proportions
   (a) Dimension (Output/Input)
   (b) Force (Output/Input)

RECAPITULATION (5 mins)

(10) Established the existence of numerous cases of the use of the principle in one product.

(11) Examined the FUNCTION, FUNCTIONAL CRITERIA and DIMENSIONS
     Estimated the force amplification in terms of THEORETICAL MECHANICAL ADVANTAGE
CONSOLIDATION (15 mins)

(12) Establish the highest value of the M.A. for a given selection of Crown Top Lifters .................. Destask No. 20/21/22/23.

(13) Modify the 'Probus' example to give an M.A. of 8. (Destask 24)
Objective: To establish the force amplification of the crown top lifter design of the given Probus Can Opener.

Product Analysis

(1) Establish functional criteria
(2) Identify relevant functional surfaces
(3) Establish relevant measurements
(4) Construct vector diagram
(5) Calculate Movement/Velocity Ratio
(6) Propose maximum Force Ratio/Mechanical Advantage
(1) Establish the Force Ratio/Mechanical Advantage generated by the given hexagonal wrench and socket.

(2) Determine any changes which may result from using other sockets within the same set.

(3) Establish the Force Ratio's resulting from using the given hexagonal socket wrench with the standard cap-headed screw and grub-screw.
Objective (1): To establish the range of Force Ratio inherent in the design of a given adjustable spanner.

Objective (2): To establish the range of Force Ratio by separate items of a given Socket Wrench Set.
Objective (1): To establish the Force Ratio allowed in the design of the Probus Can Opener for initially piercing the can lid.

Objective (2): To establish the Force Ratio used to drive the serrated wheel around the edge of the can.
Objective (1): To re-design the Probus Crown Top Lifter in order to arrange for a Force ratio of 8.

Objective (2): To discuss the effects of this design change on other aspects of the product.

Objective (2): To decide whether or not to action this proposed design change.
PRODUCT DESIGN 2.4

DESIGN TASK NO. 24. (MODEL)

NAME

Objective (1): To re-design the Probus Crown Top Lifter in order to arrange for a Force ratio of 3.

Objective (2): To discuss the the effects of this design change on other aspects of the product.

Objective (3): To decide whether or not to action this proposed design change.

1st Proposal to give an MA, of 3.

2nd Proposal to give an MA of 3.
PERFORMANCE OF THE WEDGE (75 mins)

PRODUCT DESIGN 2.5

AIMS

(a) Relate the linear proportions of various wedge designs with the corresponding vertical and horizontal force components.

(b) Predict theoretical force components for a selection of given wedges.

(c) Compare the values of M.A. of the domestic door wedge and fox wedges used for lifting machine tools.

INTRODUCTION (15 mins)

Q & A to review 2.2, 2.3 and 2.4.

Return Destask 24 with Model Answer.

DEVELOPMENT (40 mins)

(1) Initiate Design Task No. 25.

(2) Group to choose between 3 door wedge sets (blue, yellow and red) for best design.

(3) Establish primary function of a Door Wedge.

(4) Demonstration of 1, 2 and 4:1 wedges on a Model Door to examine horizontal and vertical force components.


RECAPITULATION (5 mins)

(6) Theoretical Force amplifications of both horizontal/vertical components (using the inclined plane) are proportional to the adjacent sides of the right angled triangle which forms the incline.

(7) Performance indicators can result from this realisation.

(8) How?

CONSOLIDATION (15 mins)

(9) Distribute Wedge Boards to predict expected performance of each.

(10) Examination of Fox Wedges to establish the difference in relevant proportion.

(11) Discuss possible errors/inaccuracies "FRICITION".

(12) Initiate Destask No. 27 and collect in for marking.
PRODUCT DESIGN 2.5

DESIGN TASK NO. 25.

NAME

The design of a standard door wedge basically takes on the geometric form of a triangular prism.

You are to produce a diagram of your wedge and include three of the most important dimensions.
Draw in the proportions of the horizontal and vertical component forces which are likely results if using the following wedges.
NOISY WEDGES (70 mins)

PRODUCT DESIGN 2.6

AIMS

(a) Relate the geometric form of the helix with the Wedge.

(b) Practice the calculations of M.A.'s gained through a given assortment of screw threads.

INTRODUCTION (15 mins)

(c) Q & A to Review 2.5.

(d) Return Destask No. 27. and review
   (i) Wedge proportions
   (ii) Force proportions
   (iii) Values of vertical and horizontal component forces.

(e) Distribute Drill Drifts.

(f) Establish proportional criteria.

(g) Suggest the theoretical MA.

(h) Examine all the inclined plaines on the w/shop drilling m/c quill.

DEVELOPMENT (30 mins)

(1) Investigate the geometric form of the screw thread and promote discussion regarding the possible source function.
   Use of Cardboard Tubes!
   "WEDGE"

(2) Lever or Wedge?

(3) What size of Inc. Plane?

(5) How do we establish the size of an inclined plane?
   "RIGHT ANGLED TRIANGLE"

(6) Demonstration No. 1

(7) OHP No. 1
   Distribution of Handout

(8) Initiate Destask No. 28 "ENTER ONLY CIRCUMFERENCE (ΠD) and PITCH"
   (Disregard the added complication of Lead for multi-start threads)
(9) Distribute tubes "Yellow and Mauve"

Establish functional dimensions

<table>
<thead>
<tr>
<th>Enter</th>
<th>DIA</th>
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<th>Ratio</th>
<th>M.A.</th>
<th>Axial Force</th>
<th>Rotary Force</th>
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</table>

"WHAT DOES THIS MEAN??"

(10) Establish best M.A. of all different tubes

(11) RECAPITULATION (5 mins)

Noisy Wedges - eg
Helix
Cutting Tools
Tapers

Screw Threads are Noisy Wedges

Proportions of Wedge give key to forces generated by helical path.

Formation of Right Angled Triangle is based upon two adjacent perpendicular sides representing axial and rotary forces (ie. horizontal and vertical components of the basic wedge).

(12) CONSOLIDATION (15 mins)

Establish M.A. of a given sample screw thread (Ø 19 x 2.5)
The use of a Drill Drift to Demonstrate the conversion of Force Direction by a simple wedge action.
Ref: destask

<DRH 140987>
PRODUCT EVALUATION

(75 mins)

PRODUCT DESIGN 2.7

AIMS

(a) Establish an objective technical appraisal of a selection of given products.

INTRODUCTION (15 mins)

Q & A Session

(b) Return Destask 28 and recap.

Helix? (Geometric Form of Thread Path)
Wedge? (Embedded within Noisy Product)
Proportions? (Pitch & Circumference)
Pitch ø M8 x 2 Thread? (2mm)
Circumference (TTD)

What does an M.A. of 5 tell me?
What does an M.A. of 0.5 tell me?

What would be the result on M.A. from an increase in diameter?
What would be the result on M.A. from an increase in pitch?

(c) Review 2.2 Actions and Principles
          2.3 Turning Moments
          2.4 Noisy Levers
          2.5 Inc. Plane
          2.6 Noisy Wedges

TODAY 2.7 PRODUCT EVALUATION

DEVELOPMENT (50 mins)

(1) Initiate Destasks 29, 30, 31, 32, 33 and 34.

(2) RECAP & CONSOLIDATION (10 mins)

Review main points!

T.E.A.M.
INPUT/EFFORT
OUTPUT/LOAD
DISTANCES
INVERSE PROPORTIONS

-147-
Variation of MA found in similar Tools
Examples of 'Noisy' Wedges and Levers in combination
(1) The 8 mm hexagonal socket wrench/key can be operated by using either of its two ends. Determine the Mechanical Advantage in each case.

(2) This particular wrench is suitable for use on either an M 10 cap headed screw or an M 16 grub screw. Using the wrench to its best advantage, what resulting values for M.A. are likely when tightening down these two different screws?
(1) You have been given two samples of G-Clamp to examine. Select the example which, in your opinion, is less likely to clamp well.

(2) Suggest some modifications which might be made to increase its clamping performance beyond that of the other.
You have been given three different types of Cork Extractor to examine. Establish which of the utensils will require less effort to extract a given cork.
Establish the M.A. of the given Wedge Jack.
POST - TEST

PRODUCT DESIGN 2.8

AIMS

(a) Establish another measure of the prominence of Mechanical Acumen

INTRODUCTION (10 mins)

Final Lesson - Conclusion of the planned input for you over past 4 weeks.
Review Aim - To increase your design awareness
1st Lesson - Tested performance
8th Lesson - Test performance - same test

DEVELOPMENT (50 mins)

(See Guidance Notes and Test in Appendix V)

RECAP & CONSOLIDATION (10 mins)

Record Appreciation and Thanks
Distribute 'Goodies'
Answer Queries
APPENDIX V

TEST OF MECHANICAL ACUMEN
DESIGN AWARENESS
TEST CHECKLIST

GENERAL REQUIREMENTS

1. Stopwatch
2. 12" (300 mm) Rules
3. Question Booklets
4. Model 130B Yankee Screwdrivers
5. Model 131B Yankee Screwdrivers
6. Support Blocks
7. Wedge Type Ball-Joint Separators
8. Direct Type Ball-Joint Separators
9. Lever Type Ball-Joint Separators
10. Twist-off Bottle Openers
11. Mini-hub demo rig
12. Screwtopped Bottle
13. Spare Paper

SPECIFIC REQUIREMENTS

14. Pre-test 5.5 Slotted blades to be fitted to Medium 130B Yankee Screwdrivers
    7.5 Slotted blades to be fitted to Large 131B Yankee Screwdrivers.
15. Post-test Both 130B and 131B to be fitted with 7.5 slotted Screwdriver blades
MECHANICAL ACUMEN

TEST

GUIDANCE NOTES

1. This is a test in Design Awareness.

2. Do NOT touch any of the equipment until you are told.

3. The instructions from this point will be given "verbatim" to preserve a standard input for all groups tested.

4. The test is divided into 3 sections (Pause).
   These are identified by letter and colour.

5. Section A is printed on Yellow paper
   Section B is printed on Pink paper
   Section C is printed on Green paper

6. Each section is introduced by a demonstration of the products associated with it.

7. Having first completed the white information sheet on the front page you will be given a timed period to complete each section.

8. Does anyone have any questions?
   (Answer all questions at this point)

9. DISTRIBUTE TEST (FACE DOWN) ........

 ....... Saying "Do NOT touch your test papers until you are told".

10. Full instructions are given at the top and foot of each page.

11. Turn over your booklets and look for the instructions.

12. Fill in as much detail of the following profile as you can.

13. Walk around to make sure all candidates are:
   (a) Completing the Profile
(b) Stopping when completed

14. When all candidates have finished say:
   "You will find that the test contains instructions at the foot of each page. In this case:
   "STOP. DO NOT PROCEED FURTHER. WAIT"
   You are NOT to proceed until told.

15. Any questions you may have should be asked now (Pause)

16. There must be no talking from this point onwards...(Pause)....

17. It is now time for the demonstration for Section 'A' and involves two examples of "Yankee" screwdriver.

18. Do NOT touch the tools at this stage as they can be VERY DANGEROUS.

19. The first 'Yankee' spital ratchet screwdriver was produced way back in 1898.

20. Used correctly it is the QUICKEST way of inserting a large number of screws by hand.

PARTS LIST

21. There are 8 main parts: Bit, chuck, spindle, locking ring, shifter, shell, handle tube and handle.

22. It is always stored in its extended position to avoid:
   (a) straining the return spring
   (b) the possibility of accidental release.

23. SAFETY CHECK
   (a) Never point the screwdriver at anyone
   (b) Never look down the end of the spindle
   (c) Never store in loaded mode.

24. PERIOD OF FAMILIARIZATION ...... SAFELY STORE YOUR SCREWDRIVER
25. **BENEFITS**

The 'Yankee' will work at least **TWICE AS FAST** as an ordinary screwdriver and can be used to:

(a) Drive in screws - locate shifter at the end of the slot nearest the chuck.

(b) Withdraw screws - locate shifter at the end of the slot nearest the handle.

(c) Rigid Mode - locate shifter in the central position.

26. **PERIOD OF FAMILIARIZATION**

27. Safely store your screwdrivers.

28. Your samples are fitted with conventional slotted screwdriver blades.

29. Other accessories include: Phillips, Pozidrive/Superdrive, Drill point and countersunk bits for drilling holes.

30. To change the bit: (Candidates to follow sequence)

(a) Extend the spiral spindle

(b) Place shifter in central position

(c) Pull chuck sleeve down

31. **PERIOD OF FAMILIARIZATION**

32. Safely store your screwdrivers.

33. The main points of this demonstration are reviewed by two information sheets given in the test booklet.

34. Any Questions?

35. There will be no talking from this point onwards.

36. You have 10 minutes to complete Section 'A' starting **NOW**

Start Stopwatch

37. After 10 minutes ...... Stop working now

Put your pens/pencils down and look this way.

38. It is now time for the demonstration for Section 'B' and involves
the three examples of Ball Joint Separator.

39. Gather around the front bench.

40. **Ball Joint** These joints replace king pins for the steering swivels of many modern automobiles, to cope with the suspension and steering movements.

41. They are held in position by a lock-nut and spring washer but invariably get stuck on their locating taper and need a Ball-Joint separating tool to split the assembly.

42. We have examples of three different types.

43. First is a **wedge** type remover.
   
   The tapered fork is inserted between the ball cup and the steering arm.
   
   A few taps with the hammer on the end of the handle releases the taper from the steering arm.

44. Second is an **offset-lever** type remover.
   
   The jaws are inserted between the ball cup and the steering arm.
   
   Tightening of the screw will release the taper from the steering arm.

45. Third is a **direct-action** type remover.
   
   The jaws are inserted between the ball cup and the steering arm.

46. Any Questions?

47. Return to your seats.

48. There must be no talking from this point onwards.

49. You have 15 minutes to complete Section 'B'
   
   Starting from N O W ....... Start Stopwatch.

50. After 15 minutes ....... Stop working now
   
   Put your pens/pencils down and look this way.
51. It is now time for the demonstration for Section 'C' and involves the round plastic device to assist in the opening of screw topped bottles. (Candidates to remain seated. Demo from front).

52. It is a simple device which is pressed into position and turned

53. Any Questions?

54. There must be no talking from this point onwards.

55. You have 10 minutes to complete Section 'C' starting from NOW Start Stopwatch.

56. Times up. The test is now over.

57. Close your test booklets and sit quietly.
INSTRUCTIONS TO ALL CANDIDATES

Complete the following profile

---

DESIGN AWARENESS

CANDIDATE PROFILE

Name: __________________________  Gender: Male/Female

Date: __________________________  Date of Birth: __________________________

From: 1st/2nd/3rd/4th/5th/6th

---

Examinations:

Enter Subjects and tick (/) appropriate box

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<td></td>
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<td>Sitting</td>
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STOP - DO NOT PROCEED FURTHER - WAIT
WHAT DOES IT DO?
The first Yankee spiral ratchet screwdrivers were produced way back in 1898. 'Yankee' is the original spiral ratchet screwdriver. Used correctly it is the QUICKEST way of inserting a large number of screws by hand. It will work at least TWICE AS FAST as an ordinary screwdriver and can do the following.

1. Drive in
2. Take out
3. Drill holes
4. Countersink

With its accessories it is the complete tool for inserting and removing wood screws.

WHICH PATTERN TO CHOOSE
Frequency, quantity and size of screw all play a part in the choice of the right pattern for you. You may choose from:

- 130B Light duty pattern, ideal for use with screw gauges 3 to 10
- 131B Medium pattern, most popular length ideal for use with screw gauges 3 to 14

ACCESSORIES

- Slotted
- Phillips
- Pozidriv/Supadriv
- Drillpoint
- Countersink
- Chuck adaptor

A full range of accessories is available for your Yankee screwdriver. See packaging for precise details. Pozidriv and Supadriv are Regd Trade Marks of GKN Fasteners.
How to get the best from your Yankee Screwdriver

**PARTS:**

- bit
- chuck
- spindle
- shell
- handle tube
- handle
- locking ring
- shifter

**HOW IT WORKS:**

**To drive screws:**
Locate shifter at the end of the slot nearest the chuck.

**To use as a rigid screwdriver:**
Locate the shifter in the central position.

**To withdraw screws:**
Locate the shifter at the end of the slot nearest the handle.

**NOTE:** With patterns 131B, 130B and 135B it is recommended that to prevent accidental damage to the spindle when using it as a rigid screwdriver that the spindle is locked into the handle tube. This is achieved by fully retracting the spindle and turning the locking ring. In this mode the tool may be used as an ordinary ratchet screwdriver, simply by moving the shifter as described above. This feature does not apply to the Handyman patterns Nos. 133B and 233B.

**HOW TO CHANGE A BIT**

- Extend the spiral spindle, place the ratchet shifter in the central position, pull the chuck sleeve down.
- Insert the bit in the chuck and turn it until you feel it has seated. To remove the bit, pull the sleeve down and pull the bit out.

**USEFUL HINTS:**

1. Store in the open position to avoid straining the return spring, and the possibility of accidental release of the spindle.
2. If using near double glazing units, remove the return spring to avoid accidental spindle release.
3. Ensure all bits are held securely in the chuck.
4. Lubricate with light machine oil or flake graphite - never use grease.
5. Soap or candle grease on the screw thread will allow the screw to be turned easily.
6. Never attempt to drive a large screw with a small Yankee.
7. Never drive a small screw with a large Yankee. There is too much power and screw damage will result.
8. If the tool becomes difficult or 'sticky' in use, clean the ratchet mechanism and spindle with paraffin.
9. Fitting a jubilee clip to the shell will help prevent the tool rolling off the work surface.

A complete repair service is available for your Yankee. Ask your local stockist for details or write to:
Service and Repair Section, Stanley Tools, Woodside, Sheffield S3 9PD.
Please read carefully

SECTION 'A' (10 minutes)

A FULL EXPLANATION/DEMONSTRATION

OF THE 'YANKEE' SCREWDRIVER

IS NECESSARY BEFORE ATTEMPTING

THIS SECTION

ALL WORK MUST BE SHOWN IN THIS

BOOKLET. ADDITIONAL PAPER

IS AVAILABLE ON REQUEST

DO NOT START UNTIL YOU ARE TOLD
SECTION 'A'

A1 You have been given two samples of 'Yankee' screwdriver to evaluate.

You are to make a selection between them and justify your preference by describing the reasons for your choice.
A2 Select the example which, in your opinion is less likely to perform well and suggest some modifications which might be made to increase its performance.
THE FRONT SUSPENSION

GENERAL DESCRIPTION

The independent front suspension comprises upper and lower suspension arms located in the side-members of the front sub-frame with their outer ends attached by ball joints to the swivel hubs. Rubber cone spring units are mounted in the front sub-frame towers with tubular struts interposed between the springs and the suspension upper support arms. Telescopic dampers are mounted on the upper support arms, with their top spigots anchored on the wing valance.

A section through the front suspension assembly
SECTION 'B' (15 minutes)

A FULL EXPLANATION/DEMONSTRATION
OF THREE TYPES OF BALL JOINT
SEPARATOR IS NECESSARY BEFORE
ATTEMPTING THIS SECTION

ALL WORK MUST BE SHOWN IN THIS BOOKLET

ADDITIONAL PAPER IS AVAILABLE ON REQUEST
B1 Describe how the mechanical performance of the two following examples might differ.

(a)  

(b)
Which of the three tools described is likely to produce a force amplification of approx 30:1
If a hammer blow produces a horizontal force of 100N as shown, what is the likely vertical force generated by the separating tool.
STOP  This is the end of Section 'B'. Check through your work  WAIT
SECTION 'C' (10 minutes)

A FULL EXPLANATION/Demonstration of a Twist-Off Bottle Opener is Necessary Before Attempting This Section

All work must be shown in this booklet. Additional paper is available on request.

Do not start until you are told.
SECTION 'C'

C1 Identify three mechanical principles which will most likely affect the product's functional performance.

(1) (2) (3)

C2 Describe, with the aid of sketches, the individual factors which will affect these three principles.
C3 Explain how the performance of this product could be increased.

This is the end of the test. Check through your work and wait for further instructions.
### SECTION A

**A1:** Notion of technical performance criteria

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<td>Effort</td>
<td>Mech. Adv.</td>
<td>(a) Blade/handle and</td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td></td>
<td></td>
<td>(b) Ditch/Dia</td>
<td></td>
</tr>
<tr>
<td>Accuracy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strength</td>
<td>Friction</td>
<td>(opt.calcs)</td>
<td>(with calcs)</td>
<td></td>
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</tbody>
</table>

**A2:** Idea on where to change design for increased performance (functional criteria)

<table>
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<tr>
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<th>High</th>
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<tbody>
<tr>
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<td>Subjective/ Objective</td>
<td>Objective/ Subjective</td>
<td>Objective [Tech.Perf.]</td>
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<tr>
<td>Aesthetic</td>
<td>Address: Pitch/ Diameter</td>
<td>Eff: Helix</td>
<td>Mech. Adv. and</td>
<td></td>
</tr>
<tr>
<td>Moral Elements</td>
<td>[common features of both tools]</td>
<td>Weight/ Blade</td>
<td>Efficiency</td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>Force</td>
<td>Size</td>
<td>Distance</td>
<td>Strength</td>
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<td>Strength</td>
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<td>Size</td>
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<tr>
<td>Distance</td>
<td></td>
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<tr>
<td>Strength</td>
<td>Friction</td>
<td>(opt.calcs)</td>
<td>(with calcs)</td>
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### B1

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<td>2</td>
<td>3</td>
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</tbody>
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<table>
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<tr>
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<th>Subjective Understanding</th>
<th>Objective Judgement</th>
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<tr>
<td>Leverage</td>
<td>Pivot/Dist</td>
<td></td>
<td>Mech. Adv</td>
</tr>
<tr>
<td>Screw</td>
<td>+</td>
<td></td>
<td>with</td>
</tr>
<tr>
<td>Spanner</td>
<td>Screw Pitch/</td>
<td></td>
<td>Calculation</td>
</tr>
<tr>
<td>length</td>
<td>and Dia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mech. Adv</td>
<td></td>
<td></td>
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### B2

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<td>2</td>
<td>3</td>
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</tbody>
</table>

| Subjective Guess | Some Evidence of Calls or Diagram | Considerable Calculations But Incomplete [possible incorrect answer] | Most Calculations in Evidence |

### B3

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<th>Med</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

| Less than 100 N Evidence of drawings and/or calculations but incorrect | Incomplete -- Complete Ratio + | Any Ratio -- drawings and Close Answer -- Correct |

### C1

<table>
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<tr>
<th>None</th>
<th>Low</th>
<th>Med</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

| No/Incorrect response Friction | One from three | Two from three | All three |
| Moments Inc. Plane | any one (1) | any two (2) | All (3) |
### C2

<table>
<thead>
<tr>
<th>None</th>
<th>Low</th>
<th>Med</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

**No/Incorrect response**
- Features/elements with each of the three principles
  - One feature from one principle
  - One feature from two principles
  - One feature from three principles

### C3

<table>
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<tr>
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<th>Low</th>
<th>Med</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

**Subjective/Aesthetic**
- One practical change
- Two changes
- Three changes
APPENDIX VI

ANALYSIS OF RESULTS
RESULTS OF A H 4 GROUP TEST OF INTELLIGENCE
(Mean score = 89) (Standard Deviation 14.74)

<table>
<thead>
<tr>
<th>Name</th>
<th>Raw Score</th>
<th>(A)</th>
<th>(A-A)</th>
<th>(A-\bar{A})^2</th>
<th>(Z_A)</th>
<th>%ile</th>
<th>SM %ile</th>
<th>GS %ile</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Sarah</td>
<td>107</td>
<td>18</td>
<td>324</td>
<td>1.22</td>
<td>87</td>
<td>99</td>
<td>97</td>
<td></td>
</tr>
<tr>
<td>2. Richard</td>
<td>105</td>
<td>16</td>
<td>256</td>
<td>1.09</td>
<td>85</td>
<td>98</td>
<td>94</td>
<td></td>
</tr>
<tr>
<td>3. Bridget</td>
<td>105</td>
<td>16</td>
<td>256</td>
<td>1.09</td>
<td>85</td>
<td>98</td>
<td>94</td>
<td></td>
</tr>
<tr>
<td>4. Martin</td>
<td>102</td>
<td>13</td>
<td>169</td>
<td>0.88</td>
<td>80</td>
<td>98</td>
<td>91</td>
<td></td>
</tr>
<tr>
<td>5. Neil</td>
<td>98</td>
<td>9</td>
<td>81</td>
<td>0.61</td>
<td>71</td>
<td>97</td>
<td>86</td>
<td></td>
</tr>
<tr>
<td>6. Simon</td>
<td>97</td>
<td>8</td>
<td>64</td>
<td>0.54</td>
<td>68</td>
<td>97</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>7. James</td>
<td>88</td>
<td>-1</td>
<td>1</td>
<td>-0.07</td>
<td>48</td>
<td>90</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>8. Rachel</td>
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<tr>
<td>9. David</td>
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<td>16</td>
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<td>41</td>
<td>88</td>
<td>49</td>
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</tr>
<tr>
<td>10. Charles</td>
<td>79</td>
<td>-10</td>
<td>100</td>
<td>-0.68</td>
<td>27</td>
<td>84</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>11. Brian</td>
<td>75</td>
<td>-14</td>
<td>196</td>
<td>-0.95</td>
<td>18</td>
<td>77</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>12. Anthony</td>
<td>75</td>
<td>-14</td>
<td>196</td>
<td>-0.95</td>
<td>18</td>
<td>77</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>13. Daniel</td>
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<td>-34</td>
<td>1156</td>
<td>-2.31</td>
<td>2</td>
<td>42</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>14. Kliener</td>
<td>Absent</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

\[ \bar{A} = \frac{\Sigma A}{N} = \frac{1157}{13} \approx 89 \]

\[ \sigma_A = \sqrt{\frac{\Sigma (A-\bar{A})^2}{N}} = \sqrt{\frac{2824}{13}} \approx 14.74 \]

\[ Z_A = \frac{(A-\bar{A})}{\sigma_A} \]
RESULTS OF A C E R MECHANICAL REASONING TEST
(Mean score = 13) (Standard Deviation 4.04)

<table>
<thead>
<tr>
<th>Name</th>
<th>Raw Score</th>
<th>(B)</th>
<th>(B-B)</th>
<th>(B-B)^2</th>
<th>(Zb)</th>
<th>%ile</th>
<th>Group(1)</th>
<th>Group(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. David</td>
<td>22</td>
<td>9</td>
<td>81</td>
<td>2.23</td>
<td>98</td>
<td>99</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>2. Sarah</td>
<td>17</td>
<td>4</td>
<td>16</td>
<td>0.99</td>
<td>84</td>
<td>88</td>
<td>79</td>
<td>79</td>
</tr>
<tr>
<td>3. Bridget</td>
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<td>3</td>
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<td>0.74</td>
<td>75</td>
<td>78</td>
<td>72</td>
<td>72</td>
</tr>
<tr>
<td>4. Simon</td>
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<td>69</td>
<td>64</td>
<td>64</td>
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<td>60</td>
<td>56</td>
<td>56</td>
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<tr>
<td>6. Neil</td>
<td>14</td>
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<td>1</td>
<td>0.25</td>
<td>58</td>
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<td>56</td>
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<tr>
<td>7. Daniel</td>
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<td>8. Anthony</td>
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<td>1</td>
<td>-0.25</td>
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<tr>
<td>9. Brian</td>
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<td>-1</td>
<td>1</td>
<td>-0.25</td>
<td>42</td>
<td>41</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>10. Charles</td>
<td>12</td>
<td>-1</td>
<td>1</td>
<td>-0.25</td>
<td>42</td>
<td>41</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>12. James</td>
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<td>-6</td>
<td>36</td>
<td>-1.49</td>
<td>9</td>
<td>7</td>
<td>6</td>
<td>6</td>
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<tr>
<td>13. Rachel</td>
<td>7</td>
<td>-6</td>
<td>36</td>
<td>-1.49</td>
<td>9</td>
<td>7</td>
<td>6</td>
<td>6</td>
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<tr>
<td>14. Kliener</td>
<td>Absent</td>
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<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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</table>

ΣB = 169

\[ \bar{B} = \frac{\sum B}{N} = \frac{169}{13} = 13 \]

\[ \sigma_B = \sqrt{\frac{\sum (B - \bar{B})^2}{N}} = \sqrt{\frac{212}{13}} = \sqrt{16.31} = 4.04 \]

\[ Z_B = \frac{(B - \bar{B})}{\sigma_B} \]
INITIAL ASSESSMENT OF MECHANICAL ACUMEN
(Mean Score = 5.07)  (Standard Deviation = 2.33)

<table>
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<tr>
<th>Name</th>
<th>Raw Score</th>
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<th>(x-\bar{x})^2</th>
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<th>%ile</th>
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<tr>
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<td>78</td>
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<tr>
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<td>0.86</td>
<td>0.40</td>
<td>64</td>
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<tr>
<td>Richard</td>
<td>6</td>
<td>0.93</td>
<td>0.86</td>
<td>0.40</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>Sarah</td>
<td>6</td>
<td>0.93</td>
<td>0.86</td>
<td>0.40</td>
<td>64</td>
<td></td>
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<tr>
<td>Daniel</td>
<td>5</td>
<td>-0.07</td>
<td>0.004</td>
<td>-0.03</td>
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<tr>
<td>Neil</td>
<td>5</td>
<td>-0.07</td>
<td>0.004</td>
<td>-0.03</td>
<td>49</td>
<td></td>
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<tr>
<td>Rachel</td>
<td>5</td>
<td>-0.07</td>
<td>0.004</td>
<td>-0.03</td>
<td>49</td>
<td></td>
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<tr>
<td>Brian</td>
<td>4</td>
<td>-1.07</td>
<td>1.14</td>
<td>-0.46</td>
<td>34</td>
<td></td>
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<tr>
<td>Bridget</td>
<td>4</td>
<td>-1.07</td>
<td>1.14</td>
<td>-0.46</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>Charles</td>
<td>4</td>
<td>-1.07</td>
<td>1.14</td>
<td>-0.46</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>James</td>
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<td>9.42</td>
<td>-1.32</td>
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<tr>
<td>Martin</td>
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<td>16.56</td>
<td>-1.74</td>
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</tr>
<tr>
<td>Simon</td>
<td>Absent</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>NIA</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Σ x = 66

70.87 = Σ (x-\bar{x})^2

\[ \bar{x} = \frac{\Sigma x}{N} \]
\[ \bar{x} = \frac{66}{13} \]
\[ \bar{x} = 5.07 \]

\[ \sigma_x = \sqrt{\frac{\Sigma (x-\bar{x})^2}{N}} \]
\[ \sigma_x = \sqrt{\frac{70.87}{13}} \]
\[ \sigma_x = 2.33 \]

\[ Z_x = \frac{(x-\bar{x})}{\sigma_x} \]
FINAL ASSESSMENT OF MECHANICAL ACUMEN
(Mean Score = 10.38) (Standard Deviation = 3.14)
### CORRELATION OF MECHANICAL ACUMEN WITH STANDARD MEASURES

<table>
<thead>
<tr>
<th>Name</th>
<th>Mechanical Acumen</th>
<th>A H 4</th>
<th>ACER</th>
<th>Product Moment Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(N = 12)</td>
<td>(Zy)</td>
<td>(Zx)</td>
<td>(Za)</td>
</tr>
<tr>
<td>David</td>
<td>1.47</td>
<td>2.54</td>
<td>-0.27</td>
<td>2.23</td>
</tr>
<tr>
<td>Sarah</td>
<td>1.47</td>
<td>0.40</td>
<td>1.22</td>
<td>0.99</td>
</tr>
<tr>
<td>Neil</td>
<td>1.15</td>
<td>-0.03</td>
<td>0.61</td>
<td>0.25</td>
</tr>
<tr>
<td>Anthony</td>
<td>0.83</td>
<td>0.83</td>
<td>-0.95</td>
<td>-0.25</td>
</tr>
<tr>
<td>Bridget</td>
<td>0.83</td>
<td>-0.46</td>
<td>1.09</td>
<td>0.74</td>
</tr>
<tr>
<td>Simon</td>
<td>0.52</td>
<td>Absent</td>
<td>0.54</td>
<td>0.49</td>
</tr>
<tr>
<td>Kliener</td>
<td>-0.12</td>
<td>0.40</td>
<td>Absent</td>
<td>Absent</td>
</tr>
<tr>
<td>Richard</td>
<td>-0.12</td>
<td>0.40</td>
<td>1.09</td>
<td>-1.24</td>
</tr>
<tr>
<td>James</td>
<td>-0.44</td>
<td>-1.32</td>
<td>-0.07</td>
<td>-1.49</td>
</tr>
<tr>
<td>Daniel</td>
<td>-0.76</td>
<td>-0.03</td>
<td>-2.31</td>
<td>0.00</td>
</tr>
<tr>
<td>Charles</td>
<td>-1.39</td>
<td>-0.46</td>
<td>-0.68</td>
<td>-0.25</td>
</tr>
<tr>
<td>Brian</td>
<td>-1.71</td>
<td>-0.46</td>
<td>-0.95</td>
<td>-0.25</td>
</tr>
<tr>
<td>Martin</td>
<td>-1.71</td>
<td>-1.74</td>
<td>0.88</td>
<td>0.25</td>
</tr>
<tr>
<td>Rachel</td>
<td>Absent</td>
<td>-0.03</td>
<td>-0.20</td>
<td>-1.49</td>
</tr>
</tbody>
</table>

**Product-Moment Correlation Coefficients (r):**

(-1.68) (6.81) (5.21) (6.84)

**Statistical Significance of 'r' values**

\[
\delta r = \frac{1}{\sqrt{(N-1)}} \quad \frac{1}{\sqrt{(12-1)}} \quad 3.32 \quad 0.3
\]

\[
t = \frac{r}{\delta r} = \frac{-0.14}{0.3} \quad \frac{0.57}{0.3} \quad \frac{0.43}{0.3} \quad \frac{0.57}{0.3}
\]

\[
t = \frac{-0.467}{1.9} \quad \frac{1.9}{1.433} \quad \frac{1.9}{1.9}
\]

From the following table, it is concluded that no significant correlation exists between any of the above measures.
Values of 't' at the .05 and .01 levels of significance

<table>
<thead>
<tr>
<th>Degrees of freedom</th>
<th>Two-tailed test</th>
<th>One-tailed test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.05 level</td>
<td>.01 level</td>
</tr>
<tr>
<td>1</td>
<td>12.706</td>
<td>63.657</td>
</tr>
<tr>
<td>2</td>
<td>4.303</td>
<td>9.925</td>
</tr>
<tr>
<td>3</td>
<td>3.182</td>
<td>5.841</td>
</tr>
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## CORRELATION OF IMPROVEMENTS IN MECHANICAL ACUMEN
### WITH THE STANDARD MEASURES

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<tr>
<th>Name</th>
<th>Mechanical Acumen Gains (Z_d)</th>
<th>A H 4 (Z_a)</th>
<th>A C E R (Z_b)</th>
<th>Product Moment Correlation (ZdZa)</th>
<th>(ZdZb)</th>
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<tbody>
<tr>
<td>Bridget</td>
<td>1.43</td>
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| Product-Moment Correlation Coefficients (r) | (7.24) | (1.37) |

Statistical Significance of 'r' values

\[
\delta_r = \frac{1}{\sqrt{(N-1)}} = \frac{1}{\sqrt{10}} = \frac{1}{3.16} = 0.32
\]

\[
t = \frac{r}{\delta_r} = \frac{0.66}{0.32} = 2.06 \quad \frac{0.12}{0.32} = 0.38
\]

From the table on analysis sheet (6), it is concluded that no significant correlation exists between any of the above measures.
IMPROVEMENTS IN MECHANICAL ACUMEN

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<tr>
<th>Name</th>
<th>Raw Score (1)</th>
<th>Raw Score (2)</th>
<th>Diff.: (2)-(1)</th>
<th>D² (N = 12)</th>
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<td>9</td>
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<tr>
<td>Neil</td>
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<td>Sarah</td>
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<td>Simon</td>
<td>Absent</td>
<td>12</td>
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</tr>
</tbody>
</table>

$$\Sigma D = 62 \quad \Sigma D^2 = 406$$

Statistical significance of 'Improvements'

$$t = \frac{\Sigma D}{\sqrt{N \Sigma D^2 - (\Sigma D)^2}} = \frac{62}{\sqrt{4872 - 3844}} = \frac{62}{\sqrt{1028}} = 6.41$$

From the table on analysis sheet (6), it is concluded that the sample's improvement was significant at 1% level.