DIFFERENTIAL PERCEPTION OF INNOVATION WITH PARTICULAR REFERENCE TO THE ORGANISATIONAL CONTEXT

by

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THE UNIVERSITY OF ASTON IN BIRMINGHAM

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SUMMARY

Differential perception of innovation is a research area which has been advocated as a suitable topic for study in recent years. It developed from the problems encountered within earlier perception of innovation studies which sought to establish what characteristics of an innovation affected the ease of its adoption. While some success was achieved in relating perception of innovation to adoption behaviour, variability encountered within groups expected to perceive innovation similarly suggested that the needs and experiences of the potential adopter were significantly affecting the research findings. Such analysis being supported by both sociological and psychological perceptual research.

The present study sought to identify the presence of differential perception of innovation and explore the nature of the process. It was decided to base the research in an organisational context and to concentrate upon manufacturing innovation. It has been recognised that such adoption of technological innovation is commonly the product of a collective decision-making process, involving individuals from a variety of occupational backgrounds, both in terms of occupational speciality and level within the hierarchy. Such roles appeared likely to significantly influence perception of technological innovation, as gathered through an appropriate measure and were readily identifiable.

Data was collected by means of a face-to-face card presentation technique, a questionnaire and through case study material. Differential perception of innovation effects were apparent in the results, many similarities and differences of perception being related to the needs and experiences of the individuals studied. Phenomenological analysis, which recognises the total nature of experience in influencing behaviour, offered the best means of explaining the findings. It was also clear that the bureaucratic model of role definition was not applicable to the area studied, it seeming likely that such definitions are weaker under conditions of uncertainty, such as encountered in innovative decision-making.

Key Words

Differential Perception   Technological Innovation   Organisation

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PART ONE

OVERVIEW

CHAPTER ONE

INTRODUCTION

The field of Diffusion of Innovation is now around eighty years old. During that time many different approaches have been applied to the central issues of diffusion of innovation and its attendant adoption behaviour. Within the core of this work, as documented by Rogers (1962) and Rogers and Shoemaker (1971), a conceptual development can be perceived; the experience of earlier approaches generating new research paradigms. A comparitively recent development has been that of "Differential Perception of Innovation", which emphasises the importance of subjective experience of innovation as a determinant of adoption behaviour. Such an approach stems directly from the perception of innovation work of, for example, Fliegel (1956), which sought to relate rate of adoption and individual adoption behaviour to the perceptions of members of the "potential adoption population".[1] Variability in adoption behaviour could, it was argued, arise from the needs and experience of the potential adopter influencing how he perceived an innovation, with direct consequences for how he responded to it. Obviously, many needs and experiences are common to individuals who are grouped in a meaningful way and so this analysis can be extended to allow for social relationships:

> "We need research on how perceptions of innovations differ for various groups, such as adopter categories, scientists, change agents and the like. The differences in these perceptions could help to predict likely communication 'hang-ups' that diffusion campaigns encounter."
>
> (Rogers and Shoemaker, 1971)

1. The term "potential adoption population" has been used to describe the population eligible to adopt some particular innovation. Usually it will refer to a population where some diffusion of the innovation has occurred.

The research documented here examines the perceptions of groups and individuals who operate within an organisational framework and who took part in the collective adoption of a particular form of technological innovation - Manufacturing Innovation[2] (Braun, Moseley and Wilkinson, 1981).

For an innovation to diffuse through a population, it is necessary for the units who constitute that population to adopt it. From Tarde (1903) onwards there has been a recognition that adoption behaviour is the key to the diffusion process. Over time a number of factors have been explored in a search for variables which can be established as causal in determining the adoption of innovation by one person and not by another. The characteristics of the innovation as perceived by those considering adopting it have been much studied, the present research being a development from such work. In essence it was reasoned that a significant factor in the evaluation of any innovation, particularly technological innovation, would be the nature of the innovation itself. However:

> "Unfortunately, the theoretical value of the research that has been done is problematic, perhaps the most alarming characteristic of the body of empirical study of innovation is the extreme variance among its findings, what we call instability. Factors found to be important for innovation in one study are found to be considerably less important, not important at all, or even inversely important in another study. This phenomenon occurs with relentless regularity. One should certainly expect some variation in the results in social science research, but the record in the field of innovation is beyond interpretation. In spite of the large amount of energy expended, the results have not been cumulative."
>
> (Downs and Mohr, 1976)

A basic quality of most scientific method concerns the restriction of variability to a single source, so that the effects of this variable can

2. In this document, "Technological Innovation has commonly been used, except when specifically referring to manufacturing equipment, such as that studied within this research.

be accurately measured. There are, however, assumptions inherent in such analysis, which may or may not be well founded:

> "There are two quite different kinds of scientific investigation in the natural and social sciences: those I shall call parametric and those I shall term structural. In a parametric study it is assumed that the properties referred to by the variables which describe the system are not internally related, that is, that they can be varied separately while retaining their identity ..... On the other hand, an element of an internally related structure ceases to be an element of that kind if detached from that structure. In a structured entity each component part derives its meaning from the other parts to which it is internally related."
>
> (Harre, 1979)

The experimental paradigms of those who choose to study the adoption of innovation generally assume that all the individuals under consideration were the same in all matters, except adoption behaviour and causal variables; that is, within the limits of experimental error. If one seeks to clarify the nature of such behaviour through "parametric" methods, it would be expected that the main sources of variability would exist between the adoption and non-adoption groups. Such does not prove to be the case in the majority of research studies. In the face of high perceptual variability within groups and assisted by obvious differences between, for example, change agents and members of the potential adoption population (Rogers and Shoemaker, 1971), the notion of "Differential Perception of Innovation" was proposed and utilised by Kivlin and Fliegel (1967).

In contrast to the view that an innovation had objective characteristics which would be evaluated in the same way by everybody, it was proposed that the different needs and experiences of those in particular situations would produce distinctive perceptions of an innovation. This notion, particularly when applied to manufacturing innovation, might be considered somewhat dubious. However, the findings of studies of perception of innovation are clear in one respect - little commonality of perception of innovation exists. It must be concluded that perception of innovation is a subjective process dependent upon the internal value system of the individual, as is suggested by the analysis of perception generally (e.g. Bruner, 1951) and by phenomenological psychology (e.g. Kelly, 1955; Rogers, 1959). The potential adoption population, be it an industrial sector or the farming community, was seen as being segmented, rather than a collective of homogeneous units, be they individuals or companies. Obviously an industrial sector, for example, will contain different sized companies and those operating in different areas of the market place. Such differentiation is likely to generate differing requirements, which would, in turn, be reflected in their perception of innovation. Such a paradigm was applied by Kivlin and Fliegel (1967), who compared the perception of farming innovations by individuals with different sizes of operation (small-scale and middle-scale dairy farmers) and demonstrated that differences existed between the groups.

The industrial/organisational context was chosen for this study as it is generally recognised that the adoption of innovation in this situation is commonly the product of a group decision-making process. Moreover the individuals involved are usually occupationally distinct in terms of professional speciality (e.g. engineer, accountant) and hierarchical level within the organisation. It was, therefore, possible to categorise individuals in terms of a number of variables, with the expectation that individuals who were similar in these terms would demonstrate commonality in perceptions; such a view being suggested by Lawrence and Lorsh (1967), when they stated that industrial practitioners would maintain interests consonant with their role. The combination of techniques designed to elicit perceptions of innovation and information by which they could be classified, generated a practicable experimental paradigm for the exploration of differential perception of innovation. The industrial/organisational context has the added appeal of being a relatively under-researched area.

Differential perception of innovation, as discussed by Rogers and Shoemaker (1971), is a relatively crude concept, somewhat akin to market segmentation. The inadequacy of such a concept to provide a framework for the study of differential perception of innovation became painfully clear in the course of the research. Consequently the theoretical basis of the study was reviewed and literature outside that normally considered within the diffusion of innovation area was examined to provide insights as to the nature of the process involved. The product of this analysis was a re-think of the research problem. In essence the basic assumption inherent in differential perception of innovation, that perceptions of innovations were attributable to sub-groups within the potential adoption population was strongly questioned. Instead a more phenomenological analysis was attempted, in which it was proposed that perception of innovation was the product of individual, rather than group factors; this undoubtedly being a "paradigm switch" (Kuhn, 1970) within this project and possibly in the field generally. Therefore the life situation and experiences of the individual became the primary determinants of perception of innovation, with social processes and current occupational needs and experiences generating only a proportion of a person's perceptual construction.

Differential perception of innovation, while seemingly a departure from the conceptual framework which preceeded it, is in fact an exercise in "normal science" (Kuhn, 1970). The researcher or practitioner, when considering the introduction of innovation, of necessity and generally with good reason, constructs a boundary around those he considers eligible to adopt that innovation - the potential adoption population. Few, if any, innovations would be considered as useful to all of humanity and thus, although he may not realise it, the researcher or practitioner has already accepted the operation of a differential perception process. The actual recognition of its operation by Kivlin and Fliegel (1967) and Rogers and Shoemaker (1971) is therefore only a slight modification of approach, proposing a 'little population' (sub-group), within a 'bigger population' (the potential adoption population), which is itself part of a society and so on.

If one seeks to account for variation within a population by proposing that it is constituted of sub-groups, which can, in turn, be considered 'populations' and subjected to the same analysis, the ultimate destination is at the individual level. Indeed, the idea of a "population" or of a "sub-group" is itself a construction of whosoever finds it convenient to think of collections of individuals in this way. When a researcher applies such a notion it should be with some recognition of the assumptions that are being made about the properties of the individuals involved and what aspect of their behaviour is being studied. If one categorises an individual in some way, it is in the interest of convenience and with the expectation that it will aid the making of useful predictions. However, the probability of success associated with those predictions would be directly related to the relevance of the category to the behaviour being considered.

Within the organisational context the successful selection of variables which can be used to categorise individuals is dependent upon the extent to which the conception of the organisation itself is appropriate.

Expectations of differential perception of innovation occuring within this context relies on assumptions of role specialisation, derived from a broadly bureaucratic model of organisational function. That such "stereotypes" of organisations apply can undoubtedly be questioned:

> "These stereotypes have been formulated for analytic convenience, and that is quite reasonable. However, they are derived from a limited span of empirical research. They rely upon an assumption which remains open to further investigation, namely that the structural components of the stereotype will in practice vary together proportionately."
>
> (Child, 1970)

If organisations do not function as predicted within such models, then hypotheses derived from them are unlikely to be suported. It may also be found that the 'general rules' do not apply under certain conditions, one of which could be innovative decision-making. Certainly organisations face difficulties in coming to terms with innovation, if their structure is too rigid:

> "Another dysfunctional consequence within the organisation itself is the lack of innovative and spontaneous behaviour necessary for effective organisational functioning. It is impossible to prescribe role requirements precisely and completely or lay down rules with sufficient specificity to cover all contingencies arising in a single week of a complex organization. An enterprise must rely both on stable role patterns and the spontaneous actions of people directed towards the accomplishment of organisational goals. An almost exclusive emphasis upon rule enforcement, with its resulting rigidity, can destroy this innovative aspect of organizational functioning."
>
> (Katz and Kahn, 1978)

It must be recognized, therefore, that the effects of role in determining cognitive functioning may be confounded when innovative decision-making is involved, to allow the individuals the degree of "spontaneity" necessary.

The organisational and phenomenological qualities of the research problem, as documented earlier, generated a number of difficulties, some of which have proved beyond resolution. The diffusion and adoption of innovation are undoubtedly complex phenomena and this work cannot claim to have provided fundemental solutions to the issues involved. The description of the research process, as presented here, is also in one sense inaccurate. Much of the incremental nature of the research has been lost in the interest of clarity. The document itself has been organised into three parts: the first providing a general overview of the research, the second seeking to create a conceptual framework and the third detailing the methodology and findings.

CHAPTER TWO

SPECIAL FEATURES / AIMS and OBJECTIVES / CONSTRAINTS

Special Features

The research as a whole, in terms of the area chosen for study, is probably unique at the present time. Differential perception of innovation has, as yet, been rarely researched and the same applies to the adoption of innovation within an organisational context. The combination of these areas, leading as it does, to the study of true collective decision-making involved in the adoption of technological innovation in an organisational context, resulted in a rewarding, though at times difficult, research project. The research, being of an exploratory nature, attempted to tackle basic concepts, particularly differential perception of innovation itself. To achieve this a widespread search of literature was conducted and multiple research methods utilised. A high level of cooperation was achieved between the researcher and members of the companies collaborating in the study; there having been three large manufacturing companies and two small ones involved in the overall design[1]. Respondents and contacts within the companies influenced the research in a number of ways, not only in relation to methodological issues, such as identification of suitable innovations to act as a focus for study, but also in discussions of the wider implications of an analysis of the adoption of manufacturing innovation.

Aims and Objectives

The primary aim of the study was to advance understanding of the adoption of technological innovation, specifically by clarifying the nature and dynamics of differential perception of innovation. To achieve this

1. Data collected from the small companies have not been included in the material presented here.

there were three main objectives:

1) To establish the operation of differential perception of innovation effects within the organisational context.

2) To gain insights into the nature of the group decision-making processes generally involved in the adoption of innovation in the organisational context.

3) To discover groupings of perception of innovation attributable to classifications incorporated into the research design, such as Occupational Role and Management Level.

The objectives were seen as steps in the search for understanding of the differential perception of innovation process, rather than an end in themselves. It was the overall aim, albeit an ambitious one, which was seen as important.

Constraints

The major constraint upon the research was one of time, both the researcher's and what could realistically be expected of the respondents. A number of issues raised during the research appeared worthy of lengthy and intensive study; however time was not available to give them the attention necessary. A related conceptual and methodological constraint concerned the setting of boundaries in the research process. Obviously any researcher would like to take as wide as possible a view of the topic under consideration. Certain factors which suggested themselves as possibly operative in the differential perception of innovation process, for example the personality of the individual, were excluded from the design.

CHAPTER THREE

SUMMARY OF FINDINGS

Data for the study was collected by multiple methods, specifically a major case study and two surveys. The case study examined the development of a Computer Aided Design (CAD) system by one company, Automotive Systems Ltd. (ASL), for its own use and was used to explore the nature of differential perception of innovation as it relates to other facets of the organisational context. The two surveys were used to provide a more precise, quantitative approach to the analysis of differential perception of innovation. Survey I was conducted mainly within two manufacturing companies, known as Company X and Company Y for the purposes of this study, using a face-to-face characteristic of innovation method developed for this research. Survey II used a self-completion questionaire, developed from the method used in Survey I, on a sample of practising managers engaged in part-time management education, principally the DMS. Survey I presented the individual with a list of innovation characteristics (eg Initial Cost) and asked him to select those he would use to evaluate technological innovation (Characteristic Choice); the rank order of those characteristics, (Characteristic Importance) and innovation ratings (Characteristic Ratings)[1]; Survey II utilised 'Characteristic Choice' alone. Survey II, although not generating as much detailed information as Survey I, was engaged in to provide a larger sample than had previously been possible with the time-consuming face-to-face method. To clarify the aims of the study a number of operational hypotheses were developed utilising the variables (known as the 'Classifying Variables') which were used to categorise the individuals who assisted in the study - these being organisationally relevant factors such as the individual's level in the hierarchy (Management

1. These Characteristic Ratings, however, have not been drawn upon within this account of the research.

Level) and professional speciality (Occupational Role). The final hypothesis, suggested that perceptions of innovation were the product of a number of variables, this being termed the "Multidimensional Hypothesis".

The Computer Aided Design case study provided a number of indicators as to the nature of differential perception of innovation, the effect of experience in establishing perceptual outlooks and its importance within political processes. The case describes the development of a CAD system by the Body Design area of Automotive Systems Ltd. The company were of the opinion that CAD systems then available were unsuitable for their needs and, although they had no experience of such development, decided to build their own. The project encountered a number of problems, the first attempt at developing a system reaching an impasse. There were a number of individuals involved in the early stages of the development, operating under different occupational paradigms and many of the difficulties could be directly related to the consequences of this for their perceptions of the innovation. The implementation team consisted of engineers from Body Design itself, computer professionals supplied by the Computer Services Department and a computer consultant who specialised in graphical software. Unfortunately they failed to reach a consensus as to the aims of the development and thereby achieve a successful completion.

After two years' development work, the team had produced nothing which worked. This became starkly clear when two of the Body Design engineers produced pictures on a screen for the first time, for their own purposes. At the request of the Head of Body Design, this was developed into a small scale, though usable CAD system. The Computer Services Department and the computer consultant ceased to be involved and the engineers gradually improved the system. This stage of the case, which lasted around eighteen months, was a much more productive and painless process than the previous development, emphasing the reduction in conflict and differing perceptions when those involved operate within the same occupational paradigm. However, this was not to last as top management, who had previously taken a somewhat laissez-faire approach to CAD, decided to review all computer developments. CAD was re-examined by different occupational and departmental groups within the company, including Computer Services and it was decided to abandon the internal development in favour of an externally purchased system, which would satisfy the requirements of areas other than Body Design. Again, perceptual differences could be seen - the Body Design engineers emphasis upon "Ease of Use" was discounted in favour of the Computer Services Department's desire for "Transportability" (the ability to run on any machine). This, moreover, demonstrates the importance of perceptual differences within political processes.

For the quantitative analysis, most attention was paid to the Survey I data; the Survey II results being generally supportive. A number of differences in perception of innovation were established within the framework of the "Basic Measures" analysis that examined which innovation characteristics were chosen frequently or thought important by the respondents, such that differential perception of innovation effects cannot be denied. If one examined the Characteristic Choice or Characteristic Importance data, it was clear that while some commonality did exist in relation to such characteristics as "Reliability" and "Re-sale Values", there were wide differences in the perceptions of the members of different groups, as defined by the Classifying Variables. Taking Occupational Role, as was done in Chapter 12, indicated, for example, that Production role holders chose "Initial Cost" far less often than other groups. When specific roles were compared, some of the differences were difficult to explain, such as that Production Engineers chose "Relative Advantage" frequently, when Engineers (those involved primarily in R & D) did not. There was also a suggestion that the Management Level variable might not be linear - while "Top Management" and "Lower Middle Management" chose "Variations in End Product" frequently, "Middle Management" chose it infrequently. The Characteristic Importance data also supported the Differential Perception Hypothesis. For example, Production personnel saw "Raw Material Costs" as highly important and Accountants saw it as unimportant. Again, there was evidence of commonality of perceptions, with the majority of groups perceiving "Time Saving", "Operator Comfort" and "Effects on Noise" in a similar way.

The predictions made under the Occupational Role Hypothesis received some support from the findings, such as Production Engineers choosing "Relative Advantage" frequently and Production personnel thinking "Effects on Labour Requirement" important. Although there was a quantity of information confirming the expectations generated, it was insufficient to truly validate them, highlighting the lack of parameters for making such predictions and reinforcing the need for research such as the present project. However, it was also clear that the measures of characteristic 'value' were not always eliciting comparable perceptions of innovation. Whilst it could be argued that the same characteristics would be both chosen frequently and thought important, this proved not to be the case. Taking "Perceived Risk of Adoption" as an example, it was clear that while this characteristic was not frequently chosen, it was considered important by those who did choose it. This phenomenon alone was a demonstration of differential perception of innovation.

The second approach to the data analysis, through Hierarchical Cluster Analysis, which grouped individuals according to their perceptions of innovation (as suggested by Lin and Zaltman, 1973), was adopted to clarify the nature of the differential perception process. The attempts at explaining the causation of perceptual similarity, often indicated localised effects, such as current or past work experience and the membership of particular adoption teams. However there was also evidence of more general trends and the relative importance of the different Classifying Variables. It was found that Occupational Role, Management Level and Organisational factors, were more important than the other variables, as might be expected. Organisational structure proved particularly strong, the majority of perceptual links occurring within the companies and many being demonstrated at a departmental level.

Analysis in terms of Occupational Role demonstrated that Computing and Finance personnel tended to form tighter perceptual groups than did the members of the other roles. A recurrent theme in the explanation of perceptual links proved to be in terms of a 'Production/Production-Engineering Orientation', used when groups were found containing Production, Production Engineering and Engineering personnel. These roles were not distinct in perceptual terms, apparently as the product of similar experience; there are a number of suggestions (e.g. Griffiths, 1979) that the career paths of such individuals are not distinct, there being many transfers between production and engineering functions. By way of contrast Computing and Finance roles, particularly the latter, are functionally distinct and therefore generate more identifiable perceptions of innovation.

The effect of work experience as a determinant of perception of innovation was further reinforced by the presence of individuals who were perceptually grouped with members of other role groups. In these cases current or past experience could be demonstrated as causal. For example, there was the Technical Director who was perceptually similar to computer personnel, who was the head of a Computer Aided Design department and the

Works Manager, who, though classified as occupying a production role, was perceptually grouped with engineers - his previous means of employment. Specifically phenomenological explanations were also made, where individuals were grouped with significantly higher or lower Management Level groups, than they occupied. Such individuals were termed 'upward looking' and 'downward looking' respectively, in the belief that they identified strongly with the groups with whom they were perceptually associated. However, it was recognised that this form of explanation makes analysis of differential perception of innovation difficult, this state being aggravated by the presence of 'stepwise linkage' - the grouping of individuals in which different causes of perceptual similarity were seen to exist for each of the links.

The overall complexity of the pattern generated by the findings, suggested that while predicting perceptions of innovation using some classificatory system may have probabilistic value, it will not necessarily be validated by individual cases. Consequently it must be concluded that it is the life experience which is important, with occupational function only controlling part of the process. Moreover, the extent to which an organisation seeks to define an individual's role in strictly functional terms may vary for individuals and most certainly for organisations.[3] The realities of organisational life are that individuals are given tasks in line with their abilities and experience, often irrespective of supposed function. It would also seem likely that role definition breaks down under conditions of uncertainty, such as that involved in innovative decision-making. In the final analysis perceptions of innovation can only be typified at the individual level, though with recognition of commonality between individuals.

3. Whether the organisation is "mechanistic" or "organic" (Burns and Stalker, 1961), for example.

PART TWO

BACKGROUND TO THE RESEARCH

CHAPTER FOUR

INTRODUCTION

If one wishes to study Differential Perception of Innovation it is neccessary to develop some understanding of the term, preferably an analysis which has the possibility of generating worthwhile research hypotheses. Examination of the literature makes it clear that there are no theories of differential perception of innovation, nor models of how such a process would operate. This is not to say that ideas about differential perception do not exist. In very simple terms a theory of such perception can be proposed, in which differential perception of innovation is just that individuals perceive innovation differently. In many ways it can be viewed as a market segmentation concept, in which individuals as a result of their needs, experience, current environment and so forth perceive and react differently to innovation, thus producing rule-of-thumb expectations of behaviour: "Snow blowers sell better in Toronto than they do in Texas" (Faris, 1967). This is similar in conception to consumer research, where "representative samples" are sought, using sampling frames, stratified sampling and so on to ensure that an "even mix" of all viewpoints in the population are obtained; causing Belson (1959), for example, to propose a classificatory system based upon the "principle of Biological Classification", in which respondents could be analysed in terms of a tree structure. The nodes being based upon criteria such as sex, age and so on.

We therefore have an expectation that an individual's adoption behaviour will in some way be related to his perception of innovation, which in turn is the product of some form of personal characteristic. At the outset of the present research such analysis appeared to offer a viable framework for empirical study. If measures were made of both perceptions of innovations and individual characteristics of a relevant nature, it would be possible to correlate the differences between both measures and thereby establish the presence of a differential perception process. Certainly the work of Kivlin and Fliegel (1967) and their comparison of the perception of farmers who worked different quantities of land, suggested that such a goal should be attainable. In practice the exploration of differential perception effects proved more complicated, which led to an attempt to provide a more meaningful analysis of the concept. This part is the product of that search for meaning.

The wide range of endeavours studied within the diffusion of innovation framework has made it difficult to provide a satisfactory definition of a central concept - that of "innovation" itself. A particular confusion concerns the distinction between innovation and invention. While the latter may be highly novel it may not be used in practice and therefore can be distinguished from innovation in this respect, for example:

> "An innovation in the economic sense is accomplished only with the first commercial transaction involving the new product, process, system or device, although the word is also used to describe the whole process."
>
> (Freeman, 1974)

While "innovation" can be restricted to only that which is significantly novel, in terms of a particular culture, this would exclude many studies, including the present one, from consideration as part of this body of knowledge. For the purposes of this study, therefore, a general definition has been taken thus:

> "An innovation is an idea, practice, or object perceived as new by an individual. It matters little, so far as human behaviour is concerned, whether or not an idea is 'objectively' new as measured by the lapse of time since its first use or discovery. It is the perceived or subjective newness of the idea for the individual that determines his reaction to it. If the idea seems new to the individual, it is an innovation.
>
> (Rogers and Shoemaker, 1971)

As will become clear in later chapters, the innovations chosen as the basis of this study were of varying degrees of novelty, in terms of the industries in which the companies contributing to the study were concerned, however, all were 'new to the firm'.

Historically the field of Diffusion of Innovation can be seen as a progression from the work of Tarde (1903). After an initial focus on the essentially statistical analysis of the diffusion process - the spread of a new idea, product or practice - attention moved to discovering reasons why diffusion occurred in the way it did. Examination of diffusion curves clearly demonstrated that the rate of adoption, time for a particular adoption level to be attained and so on varied across innovations, such that statistical modelling (e.g. Mansfield, 1973) met with little success. Given that people adopt innovation and that some people adopt earlier than others, the obvious starting place for the search for factors involved in diffusion was with the individual. Thus a number of studies, including the classic Ryan and Gross (1943) work, concentrated upon the characteristics of the individual: age, social status and so forth. Undoubtedly these researches were productive in adding to the understanding of the diffusion process, but were unable to satisfy the requirements of truly explanatory concepts.

The failure of one approach generated another, that of Characteristics of innovation. If the nature of the persons involved was not a prime cause of differences found in adoption behaviour, then possibly the nature of the innovation itself was a significant factor in the process. Thus studies such as Fliegel and Kivlin (1962 (a)) and Kivlin and Fliegel (1967) were conducted. In these researches the primary focus was the perceived characteristics of the innovations themselves, as viewed by the individuals who would be interested in adopting them. This area of innovation research became conceptually and methodologically sophisticated. Primary innovation characteristics were identified by Rogers (1962), which were believed to be applicable to the majority of innovations. However it was also recognised that some specific characteristics might be more applicable to particular innovations or types of innovation. Zaltman (1973), for example, wrote that "all attributes do not pertain to all possible innovations." Thus there was some uncertainty as to the evaluation of innovation attributes, in the absence of 'objective' criteria as to the nature of the innovation; unfortunately it is difficult to predict which attributes of an innovation will be perceived as important by the adoption group on an a priori basis.

To further aggravate this problem it would appear that different individuals within an adoption group also select different innovation characteristics for their evaluation of technological innovation, such that some attributes prove more important than others. This was reflected in the results of characteristic studies as an apparently random variation. Thus it may have been found that the adopter of some innovation perceives some characteristics in a highly unfavourable light. From this it could be concluded that he considered these characteristics as relatively unimportant, outweighed by other features that were perceived positively. This was certainly confirmed by the experiences of the researcher, when involved in a study of characteristics of innovation (Hayward and Masterson, 1977). It is also very much the picture that develops when characteristics of innovation literature is reviewed. Like the individual attribute studies, characteristics of innovation research has elucidated some of the concepts, but failed to truly account for the variation in the diffusion process.

We thus have research findings which demonstrate high variability within groups where similarity was expected, such that it was difficult to distinguish between groups such as adopters and non-adopters. In the past, diffusion research has developed in response to such 'failures' of the then current theoretical and methodological structures, in the same way as have other scientific endeavours. We therefore have a process from the statistical orientation, through the individual attribute models to the characteristics of innovation approach. The latter, too, has been found wanting and a "new paradigm" must be developed. However the research does not operate in a vaccuum, nor can reference be made to an "objective reality" which might illuminate the new direction to be taken:

> "Even though Lakatos and Popper wrote of a 'third world' (the world of truth and objective knowledge) the world revealed (or constructed) by scientific theories cannot exist apart from the human mind. To assert, as these writers do, that anything exists apart from thought is meaningless. Thus there can be no scientific knowledge free of presuppositions, and it is therefore impossible to get to the bottom in any verification process. When we speak about the 'facts' we are speaking about what people in a given social milieu at a given time accept as facts. If this milieu happens to be considered a scientific community, then we can speak of 'scientific facts'."
>
> (Phillips, 1973)

If we accept that knowledge is the product of the conceptual framework, and it can undoubtedly be argued that such a viewpoint is inherent in a differential perception theory, then analysis of the nature and development of differential perception of innovation must be attempted. If the idea of differential perception of innovation is a reaction to difficulties with earlier concepts, why was this form of explanation accepted? Admittedly this 'theoretical innovation' has not been widely adopted as yet, within an empirical framework. However, the concept is highly acceptable to the innovation theorist; it is suggested as a product of a surrounding 'Cultural Climate', which pinpoints the importance of subjective analysis in understanding human affairs. Certainly Kivlin and Fliegel (1967) wrote:

> "The importance of perception as a key dimension in behaviour is quite generally accepted in sociological research and is seen as crucial to the understanding of the diffusion process."

and

> "An integral part of social - psychological theory and research, the concern for perception as the behavioural meaning, given to objects of ideas has a very wide range of expression and interest."

If we wish to argue that a particular notion arises from a Cultural Climate, as has been done for the acceptance of innovation (Rogers and Shoemaker, 1971), then some measure of that climate must be attempted. When one examines differential perception in depth, there comes an increasing awareness of the similarity of this concept to other scientific, particularly social science, ideas. Obviously this is in part a direct result of the use of theoretical notions from other disciplines. For example, Chatterlee and Gangully (1977) in their study of "Differential Perception of Certain Industry-related Concepts", utilise the work of Newcomb (1958) as follows:

> "Newcomb (1958) suggests that cognitive similarity between two persons leads to identical orientation in them towards a specific object. This implies that cognitive structure develops a frame of reference against which attitudinal reactions are to be evaluated.
>
> "In industrial situation man's relation to job determines to a certain extent his cognitive structure. The degree of job involvement may be considered a contextual frame of reference for cognitive similarity".(sic)

The work of Bruner and Goodman (1947) concerning the relationship between class and perceptual behaviour, has been used by many researchers as a demonstration of the effect of culture on perception. They demonstrated that class acts as a determinant of perceptual behaviour, producing the "cognitive similarity" referred to by Chatterlee and Ganguly (1977).

The way that individuals and groups define reality can be analysed in terms of "paradigm" (Kuhn, 1962, 1970). Such a paradigm acts as a filter applied by the person, to simplify his dealings with the world and is so much inherent in this process that he is unaware of it:

> "As Kuhn and others have shown, we normally become explicitly aware of paradigms only when they are contradicted. Likewise, the boundaries or rules of situated interactions tend to become apparent only when they are contested. Stated conversely, paradigms constitute not only a structure of selective attention, but also one of inattention by which we screen out aspects of our environment that 'don't count'."
>
> (Brown, 1978)

Thus we have a further indication of the importance of subjectivity in the Kuhnian conception of science, which has implications for sociological theory:

> "The sociology of knowledge, therefore, must concern itself with the social construction of reality. The analysis of the theoretical articulation of this reality will certainly continue to be a part of this concern, but not the most important part. It will be clear that, despite the exclusion of the epistemological/methodological problem, what we are suggesting here is a far-reaching redefinition of the scope of the sociology of knowledge, much wider than what has hitherto been understood as this discipline."
>
> (Berger and Luckmann, 1966)

We must conclude that sociologists, particularly ethnomethodologists, are convinced of the importance of subjective experience; the belief that understanding of social phenomena are only "accessible from within - via meaning inhabiting the minds of the actors" (Bauman, 1973). Differential perception of innovation in recognition of this cultural climate must necessarily move beyond a 'market segmentation' structure. We are not simply dealing with a behavioural response which can be correlated with some personal characteristic, but rather a cognitive structuring which derives from these personal characteristics. However, to operationalise the differential perception notion it is necessary to work within some context which gives meaning to the concept. Obviously social research cannot work in a vacuum, but must identify measurable variables, such as farm size (Kivlin and Fliegel, 1967), managerial attitudes (Chatterlee and Ganguily, 1977) or adopter categories, as proposed by Rogers and Shoemaker (1971).

For this study, perceptions of technological innovation within manufacturing organisations were seen as offering great potential for implementing the differential perception concept. Technological innovation can be defined as follows:

> "We define as a technological innovation an entirely new or technically improved product or process which is offered for sale to potential users. This definition distinguishes carefully between an invention and an innovation, for an invention is merely an idea for or a prototype of a new product or process and does not become an innovation until it reaches the market. Most inventions never become innovations, they fall by the wayside on the long road from idea to marketable product."
>
> (Braun, 1984)

However, as the main part of the research was performed within manufacturing organisations a more precise definition is necessary:

> "Technological innovation is a term of great generality and in this paper we shall concentrate on that aspect of technological innovation which has the most direct bearing on manufacturing efficiency - manufacturing innovation. We define manufacturing innovation as a new method of producing an essentially established product by an essentially established process. Manufacturing innovation usually involves the installation of novel machinery and/or novel methods of controlling the manufacturing process. Very often the efficient use of the innovation requires a variety of organisational changes, but changes in organisation alone do not constitute manufacturing innovations. If a robot is introduced to spot-weld or to spray paint, this does not necessarily involve any change in the product or process, yet it constitutes a major technological innovation. Similarly a numerically controlled machine tool, a computer controlled automated warehouse, an automated feed to a machine; all these are examples of manufacturing innovation."
>
> (Braun, 1981)

The introduction of technological innovation in the industrial/ organisational situation, including manufacturing, commonly involves a number of individuals; Baker (1977), for example, found that two-thirds of adoption decisions involved more than one manager. Differences between individuals involved in such group decision making will have obvious consequences:

> "As a first consideration it must be recognised that group members will act according to their own cognitive world, i.e. the way in which they perceive, believe and think about events and people around them. Their views and reactions may therefore be better understood by reference to their apparent cognitions and the determinants of those cognitions such as physical and social environment, personal needs, physiological structure and past experiences. For example, group members may have different 'mental sets' which cause them to view the same event quite differently (e.g. the accountant may see increasing labour turnover as a rising problem, but the personnel director may see it as a failure in supervision). That is to say, the same objects or events may have different meanings for different perceivers. This can explain, for instance, a profound difference in approaches to the same corporate problem which may become evident in a meeting of sales, production and accounting personnel."
>
> (Parker, 1980)

Thus, differential perception effects would appear highly probable within an organisational context. Certainly the findings of Chatterlee and Ganguly (1977) support this proposition:

> "Weaver (1958) observed that managerial personnel as a distinct group had characteristic ways of evaluation of certain concepts and these were significantly different from that of labour. The present findings, however, present a different picture. Apparently the two groups [middle and bottom level managers] belonged to the same organisational category. But the differential psychological past in job situation developed discriminative cognitive structures in them. This was revealed in their attitudinal reactions to job-related symbols."

and

> "The results of the present study further support the notion that the degree of job involvement of an employee can act as a referential variable and can influence his cognitive evaluation of various job-related concepts. Job involvement after its initial formation can be considered as a stable personal characteristic and remains more or less independent of changing situational variables."

The establishment of "job-related concepts" can be seen as the product of "secondary socialisation", the "internalisation of institutional or institution based 'sub-worlds'" (Berger and Luckmann, 1966).

Given that the organisational context offered the potential for identifying differential perceptions of innovation, it was necessary to attempt to provide predictors of such effects. The final chapter of this part seeks to examine the literature available on industrial innovation, group processes, roles and organisational structure. A significant study is that of Choffray and Lillien (1978) and their comparison of personnel involved in the purchasing of industrial air conditioning, which demonstrates perceptual differences. Generally, however, such information as was available left much to be desired in applicability to this study and was referred to in an effort to extract whatever pointers were available.

Thus far the rise of differential perception of innovation as a reaction to the failure of previous diffusion approaches has been discussed. The acceptance of the concept has been described as the product of a cultural climate and this demonstrated through what are believed to products of, and contributors to, this climate. The essential nature of differential perception of innovation, however, remains unclear, although some progress has been made. Doubts about what is meant by certain concepts, the use of certain variables and so on, may be inherent to social study, as is believed by the ethnomethodologists; there may indeed be no way of "repairing the accounts" (Tilley, 1980) to provide objectivity. We may therefore strive for, but never attain the establishment of the "interval" (Russel, 1969) of relativistic physics, by which events could be compared; and, particularly within the social sciences, be left with inherent uncertainties:

"The empirical basis of objective science has thus nothing 'absolute' about it. Science does not rest upon solid bedrock. The bold structure of its theories rises, as it were, above a swamp. It is like a building erected on piles. The piles are driven down from above into the swamp, but not down to any natural or 'given' base; and if we stop driving the piles deeper, it is not because we have reached firm ground. We simply stop when we are satisfied that the piles are firm enough to carry the structure, at least for the time being."

(Popper, 1959)

CHAPTER FIVE

CRITICAL REVIEW OF DIFFUSION OF INNOVATION LITERATURE

Diffusion of innovation was defined by Katz (1963) as:

> "The acceptance, over time, of some specific item, idea or practice, by individuals, groups or other adopting units, linked to specific channels of communication, to a social structure, to a given system of values or culture."

Katz's definition covers the totality of the process in a way not yet matched by research studies. Initially, at least, the object of diffusionists was the study of diffusion over time,[1] without reference to other factors, although there was an awareness of them. As the diffusion area developed, attempts were made to identify those factors which determined the rate of adoption of innovation, the most notable group engaged in this research being Rural Sociologists. Studies were made of the personal attributes and behaviour of the adopters and non-adopters of innovation and more recently the characteristics of the innovations themselves were examined. These researches, while providing much useful information, have been sadly lacking in conclusive results. The present researcher's experiences in a previous study of technological innovation characteristics and their relationship to adoption/non-adoption and rate of diffusion, came to the following conclusion:

> "Adoption of an innovation is not seen as a simply determined process but one controlled by a great many factors. Depending upon particular circumstances some forces will be more in evidence than others, a variety of vectors producing the same results."
>
> (Masterson and Hayward, 1979)

1. Tarde, (1903)

While other approaches to the diffusion of innovation have been explored, in recent years the predominant one has been that devoted to the examination of the effects of innovation characteristics and the rate of adoption. However this is changing, as Rogers (1977) writes:

> "I feel that diffusion scholars today are in an era of healthy discontent, in which we are questioning several of the assumptions, modes and methodologies of diffusion research."

and also (Rogers, 1975):

> "... realisation of the limitations of the classical diffusion model are today leading to the development of important modifications in it to allow for particular conditions with which it did not originally deal. The most important modifications in recent years have stemmed from an extension of the diffusion model from individuals as innovation decision makers, to organisations. From Iowa farmers to English industrial firms and U.S. schools."

Interest in differential perception arose in response to difficulties that were encountered in earlier approaches to the diffusion process. Historically, a development of thought and research methodology can be perceived within the field of diffusion of innovation, such that current ideas are a product of what went before. To understand differential perception fully it is necessary to place it in this historical context and so this chapter is devoted to the development of the ideas which preceded this concept.

Rate of Adoption and Adopter Categories

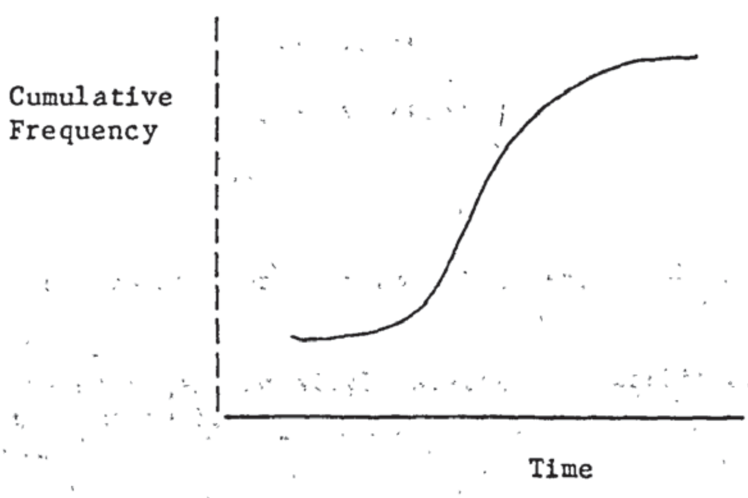
Rate of diffusion has been an important part of most innovation research and according to Katz et al (1963):

> "Time is the key to diffusion research."

If the presence or absence of a variable can be considered an index of its importance, then rate of adoption certainly qualifies as important. Leaving aside the work of the spatial diffusionists (e.g. Hagerstrand, 1967; Morill, 1968, 1970), measurement of rate of diffusion, particularly over time, is widespread. The representation of rate of adoption - the cumulative frequency of adoption curve - appears an almost essential part of any document relating to the diffusion of innovation.

It has always been recognised that the rate of adoption or even a level of diffusion per se is not an end in itself.[2] There is a need to establish diffusion rates in relation to other factors, which are proven to be causal. Even so, some study has been put into attempts to quantify and model diffusion curves (e.g. Mansfield 1961), though these have been unsuccessful. One difficulty that commonly occurs in relation to time of adoption is that of recall error - often this information is wholly dependent upon the respondent's memory. However it is generally accepted that the curves follow an approximate 'S' shape (Rogers and Shoemaker, 1971, pp 176-7).

Fig. 1 The 'S' Curve



2. Tarde was probably the first researcher to point out the need for correlates with the rate of diffusion.

If the cumulative curve is 'S'-shaped, then the frequency distribution should be of a bell shaped normal (or near-normal) configuration. Rogers (1958) tested eight distributions, from different projects, but found that half of them deviated significantly from normality. Even so, he later used the normal distribution as a statistical basis of categorisation of adopters:

1. Innovators (21.5%)
2. Early Adopters (13.5%)
3. Early Majority (34%)
4. Late Majority (34%)
5. Laggards (16%)[3]

Though these are only arbitrary categories, with sparse empirical support, Rogers and Rogers (1961) found that they were consistent with respondents self images.

<u>The Adoption Process</u>

The adoption of innovation is generally characterised in the following way:

(1) Awareness
(2) Interest
(3) Evaluation
(4) Trial
(5) Adoption

(Rogers, 1962)

While this model, or others like it,[4] have been used widely, it has

3. The percentages are simply statistical artifacts, the divisions being arrived at by limits achieved by one or more standard deviation from the mean.

4. A variety of stages have been suggested ranging from 3 (Wilkening, 1956) to 8 (Singh and Pareek, 1968).

not been without criticism. For example Hassinger (1959) questioned whether 'Awareness' is the passive process it is generally taken to be. Cambell (1966) proposed a more complex model in which adoption decisions are seen as "rational/non-rational" and in which Cognitive Dissonance (Festinger, 1957) is seen to operate in the post-decision period.5

Relationships between other variables and the adoption process have also been studied. For example Beal and Rogers (1960) found that earlier adopters have a shorter innovation decision period than later adopters, and others have suggested that early adopters have a longer trial period. However, the length of the adoption period seems to vary from innovation to innovation:

> "How can we explain these differences? Innovations with certain characteristics are generally adopted more quickly; they have a shorter innovation-decision period. For example innovations that are relatively simple in nature, divisible for trial and compatible with previous experience usually have a shorter period than innovations without these characteristics."
>
> (Rogers and Shoemaker, 1971)

Brandner and Kearl (1964) examined the effect of "congruence" on the rate of adoption. They studied the adoption of Hybrid Sorghum and found that farmers who had previously adopted Hybrid Corn,6 were more likely to adopt this new variety and more quickly, with little or no trial. The differences in rate of adoption caused Hayward, Allen and Masterson (1976) to propose the concept of "Traditionalism", innovation being classed as either traditional or non-traditional. A traditional innovation was seen as one which is compatible with previous experience and cultural norms and

5. This is an important point in relation to innovation methodology, which generally relies on recall data. Respondents may well be reporting the rationalisations of their decisions, not the components of the decision itself.

6. Ryan and Gross (1943).

it is consequently adopted more rapidly. The relationship between an innovation and the values of the potential adopter is an important one, and possibly the only viable definition of innovation is one in these terms.

Communication and Information Sources

A common feature of some early diffusion work was the collection of data about information sources, particularly reading habits. It was found that innovative individuals tended to read more relevant literature, had greater change agent contact[7] and made visits to centres where information was available.[8] Interest in media information became less prevalent when the 'Two-step-flow-of-information' approach became more prominent. Although the seeds of this theory were sown in the mid-forties (Lazarsfeld et al, 1944), it was some time before it was widely accepted. According to this model of the communication process, information provided by the media, change agents and producers of innovation impinges only upon certain individuals, known as "Opinion Leaders." Other members of the potential adoption population turn to these individuals for advice about an innovation and this personal influence seems a critical part of their decision to adopt or not. This approach to communication has formed the basis for a number of studies (e.g. Coleman et al, 1966) and has been generally found to hold true. Rogers and Beal (1957-8), for example, take the concept of opinion leadership as read:

> "The main purpose of this article is not to add further truth claims to the earlier findings on the importance of personal influence in decision making. Rather, the purpose is to determine if personal influence is more important: (1) at certain stages in the decision making process and (2) for certain individuals rather than others."

7. Many of these studies were agriculturally based, where active proponents of particular innovations such as Extension Agents were in evidence. See Hoffer (1944) and Stone (1952); also Rogers (1966).

8. Often merely visits to local towns and cities.

A parameter of the communication process which has received some attention is that of Homophilly-Heterophilly[9] (Lazarsfeld and Merton, 1964). In these terms opinion leaders are seen as individuals who are very much part of the social system, and hold high status within it (Homans, 1961). Homans also points out that the opinion leader is likely to be highly conformist in relation to norms valued by his group. The relationships occurring between group members, the membership of more than one group and their effect upon perception of innovation, particularly within an organisational context, are of importance to this study. Consequently this area will be further examined in a later chapter dealing with organisations and innovation.

The Search for Factors Affecting Rate of Adoption

Tarde (1903) set the stage for much of the development of diffusion research. He pointed out that it was the reasons for one innovation being adopted and another not, that was important. He also suggested that diffusion followed an 'S' curve and that early adopters were more likely to be cosmopolite, and he identified the operation of opinion leadership. Much of the diffusion work in the 30's and 40's (particularly the latter) was concerned with the individual attributes of those eligible to adopt innovation, their behaviour and sources of information. The late 40's and 50's saw the onset of research in which the characteristics of the innovations themselves were seen as important variables to study. This has continued through to today, although it was at its height in Britain at least in the late 60's and early 70's as demonstrated by project SAPPHO (Achilladeles et al, 1971).

Probably the most influential study which examined individual attributes was that of Ryan and Gross (1943), concerned with the diffusion

9. The extent of similarity of individuals, with the assumption that more similar individuals interact more readily.

of Hybrid Corn. Using four adopter categories, these workers correlated the time of adoption with a number of variables such as age, social status and cosmopoliteness. The study appears to have acted as a model for later research in this area, however it has been said that:

> "a great number of rural sociological studies have followed on unimaginative 'variables-related-to-innovativeness' approach."
>
> (Rogers and Shoemaker, 1971)

Developments in studies of adopter attributes included Coleman, Katz and Menzel (1957) and their study of the adoption of the drug "Gammanym" by physicians. While personal characteristics such as professional versus patient orientated, standing in the community, etc were examined, they also included sociometric measures. These proved extremely useful in mapping the pattern of diffusion - early adopters being part of an integrated professional and friendship network. In a concluding note they criticised other diffusionist work as follows:

> "... most empirical studies have either treated and described a community, a factory, a hospital ward, or any other large grouping of people as a single unit, or else they have statistically analysed data collected on hundreds or thousands of single individuals as in a typical 'survey' study. What has been missing until recently is study designs which would explicitly take into account the structuring of single persons into larger units and yet allow sophisticated quantitative treatment."
>
> (Coleman et al, 1957)

Fliegel (1956) compared six variables in relation to adoption of farm practices. It is interesting to note that in addition to individual attributes this study also includes a variable relating to 'attitudes toward farm practices'. This appears to have led to a series of papers, in which the relationship between innovation attributes and rate of diffusion was examined.[10] Characteristics of innovation such as Initial Cost, Divisibility for Trial (trial on a small scale), Compatibility and Saving of Time were correlated with rate of adoption.

Ostlund (1974) attempted to predict innovativeness in relation to consumer purchases. Variables used in the predictor included both personal and innovation attributes. Six products not yet introduced to the market were subjected to this inquiry and one of them which was subsequently retailed was used for a follow-up. The latter consisted of telephone calls to the respondents to ask if they had purchased the product. The behaviour of the respondents was compared with both the individual and innovation attributes, and the results caused Ostlund to conclude:

> "The evidence from two studies of new consumer packaged goods suggests that the perceptions of innovations by potential adopters can be very effective predictors of innovativeness, more so than personal characteristic variables."
>
> (Ostlund,1974)

Although these studies (and most other similar ones) used approximately 12 characteristics, Rogers (1962) proposed five main ones:

1. Relative Advantage
2. Compatibility
3. Complexity
4. Trialability
5. Observability

These tend to be accepted as the central characteristics even though empirical evidence of their applicability is patchy. However this may

10. e.g. Fliegel and Kivlin 1962(a), 1962(b), 1966, 1968; Kivlin and Fliegel 1967, 1968: Fligel, Kivlin and Sekhon 1968.

be because:

> "... all attributes do not pertain to all possible innovations. Some characteristics are uniquely associated with particular innovations, whereas other characteristics are irrelevant. Indeed... an important task for future researchers is to determine under what kinds of situations particular innovation attributes are likely to become salient."
>
> (Zaltman, 1973)

Zaltman later lists a number of characteristics that have been used in innovation research. While Rogers' five characteristics are seen as the basic ones, most studies use 12 or more, either presented with a five point agree/not agree with statement or a Semantic Differential.[11] Rogers and Shoemaker (1971) in reference to this kind of method wrote that "other measurement techniques should be explored." They also refer to eight studies of the relationship between perceived attributes and rate of adoption and examine the percentage variance in rate of adoption explained. The values range from 49-87% with a mean of 66.25%, suggesting that significant improvements could be made.

Thus perceptions of innovation, while providing indicators of adoption behaviour on the whole fail to account for much of the variability observed. The student of adoption behaviour is left with a need to explain the failure of perception of innovation measures, to clarify the causes of the apparently random error. The researcher's experience of characteristics of technological innovation work, suggested that potential adoption populations were not homogeneous and therefore could not be expected to perceive innovation similarly. The literature supports this proposition, taking as a starting point the differences between producers and users

11. Osgood (1952)

of innovation:

> "The salient characteristics of an innovation as seen by its originator need not coincide with those perceived by an adopter or potential adopter. Furthermore the characteristics of an innovation which are considered important before adoption may yield in perceived importance to other factors once the adoption is made and some time has passed."

and:

> "Thus the salient characteristics of innovation may vary over time within the viewpoint of any particular observer. Moreover, beyond the adopter-non-adopter category dichotomy, the innovation may be viewed differently by different ideal-type categories, suggesting that it might be equally profitable to categorise individuals or multimember units of adoption on the basis of their perceptions of innovations as opposed to or as well as the time they require before adopting. Certainly in terms of planning social change it would be more fruitful to group individuals according to their perceptions of the innovations in question."
>
> (Lin and Zaltman,1973)

Referring to the need for more research of this type, Rogers and Shoemaker (1971) wrote:

> "... there is only a limited number of diffusion investigations dealing with perceived attributes of innovations. In this closing section we suggest five types of needed research:
>
> 1. Measuring perceived attributes at the time of decision,
> 2. Differential perception by different groups,
> 3. Improved measurement of perceived attributes,
> 4. Factor analysis of perceived attributes, and
> 5. Studying innovation bundles." 12

12. Groups of similar innovations, such that the adoption of one facilitates or necessitates the adoption of others.

Of these (2) is probably the most applicable to the present research. Such evidence as there is indicates that different groups perceive innovation differently. The question is only whether such differences relate to variables within the firm, as well as such factors as size of operation (Kivlin and Fliegel, 1967; Hayward and Masterson, 1977 etc) or some others indicated by Rogers and Shoemaker (1971):

> "It is possible (and we feel it would be profitable) to split samples of respondents on variables other than farm size, for example, adopter categories. Innovators undoubtedly perceive the same innovation in different ways than do laggards. And these differences in perceptions could have important implications for the way change agents might introduce a new idea to each category."

Thus perceptions of innovation are no longer seen as simply determined, the product of a single state which produces a particular form of adoption behaviour. Clearly adoption behaviour is the product of a number of variables, most of which have not been identified, as witnessed by the failure of most diffusion studies to explain the totality of the process. Diffusion of innovation and adoption behaviour are undoubtedly complex, and characteristic studies only provide a partial explanation. Even so, it was possible for other approaches than Differential Perception of Innovation to be selected as likely avenues of enquiry, in the search for clarification of the problems inherent in characteristics of innovation studies. The next chapter, therefore examines the nature and origins of the Differential Perception of Innovation concept and the reasons it appeals to the innovation researcher.

CHAPTER SIX

THE DIFFERENTIAL PERCEPTION HYPOTHESIS: THEORETICAL STRUCTURE

While there are indications of the occurrence of differential perceptions in the literature, researchers have tended to pass over what is really meant by Differential Perception of Innovation. It became clear as the research progressed that differential perception of innovation required some form of definition, which was meaningful in the context of this study. Much of this chapter is concerned with areas of science, particularly social science, which are conceptually similar to differential perception of innovation and in consequence can contribute to this definition. In this way depth was given to the differential perception concept beyond that of 'market segmentation' and thereby established the validity of differential perception as a theoretical notion.

The importance of perception in the adoption of innovation is generally accepted; Baker and Parkinson (1976), for example, wrote of the "decision making unit's perception of facts rather than facts themselves." Kivlin and Fliegel (1967) were probably the first researchers to use the term "Differential Perception." They took the concept of perception of innovation, as indicated by innovation attributes, and examined how perceptual differences might affect the rate of adoption of a farming innovation. As a predictor of difference of perception Kivlin and Fliegel (1967) took farm size and found that there were differences between their groups. These effects could be demonstrated in rate of adoption and attribute perception.

Similarity, rather than difference, of perception of innovation was studied by Brandner and Kearl (1964), when they wrote of congruence.

Essentially they tested the hypothesis that adopters of hybrid corn would adopt hybrid sorghum when the latter became available. Their results indicated that the probability of adopting hybrid sorghum was directly related to prior experience with hybrid corn. It can be argued that the adoption of both these innovations resulted from a similarity of needs and experience, with consequent alignment of perceptions; that the adoption of hybrid corn developed "conceptual tools" (Masterson and Hayward, 1979), which facilitated the adoption of hybrid sorghum.

Differential perception of innovation would appear to arise from an awareness of the importance of subjective analysis within the sciences generally. Subjective analysis is inherent in such diverse fields as the mathematical analysis of decision making (Ozernoi and Gaft, 1977) and the elucidation of schizophrenia by R D Laing (e.g. Laing, 1960, Laing and Esterson, 1964). Implicit in such analysis is that research, scientific development and so on are themselves subjective processes, or at best the product of a consensus of individuals:

> "Reality is socially defined. But the definitions are always embodied, that is, concrete individuals and groups of individuals serve as definers of reality."
>
> (Berger and Luckman, 1966)

Ideas about innovation will themselves be innovative at some stage in the development process, such that concepts like "Cultural Compatibility" can meaningfully be applied. It is argued that differential perception of innovation was generated by and accepted as a result of social and conceptual forces acting upon diffusion researchers. Thus it seemed worthwhile to explore some of the products of and contributors to this climate. In this way a better understanding of differential perception could be achieved through the more developed notions of its 'fellow travellers.' One consequence of this analysis was the final section of this chapter, the "Multidimensional Hypothesis", which brings into question the likelihood of meaningful analysis being made within a simplistic theory of differential perception of innovation.

The Differential Perception Hypothesis

The following general hypothesis was proposed as the basis of all differential perception studies, whether hypotheses be implicitly or explicitly used. The experimental hypothesis was as follows:

H1 : Differences (operationalised by some measurable variable) in the nature of individuals will be reflected in differences in perception of innovation.

with the appropriate Null Hypothesis:

H_0 : Any differences in perception of innovation are attributable to chance alone.

The differences between people which were taken as the independent variable were seen to be differences in 'psychological space.' That is, something in their attitudinal system, belief system, cognitive make-up or 'outlook' was correlated with the independent variable and that this in turn influenced their perceptions of innovation.

The effects of differential perception can be thought of in terms of 'cutting up' reality in different ways. Thus if we take Fig 2 as the universe of attributes of an innovation, different persons might take different parts of this reality, as represented by Figs 3 and 4.

Fig. 2 - Universe of Attributes

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Fig. 3 - Selected Attributes 1

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Fig. 4 - Selected Attributes 2

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The selection process involved in 'cutting up' the reality of necessity suggests that the individuals involved may react differently to technological innovation. Subjectively we are dealing with different innovations, as suggested by Rogers (1977) with the idea of "Re-invention during the innovation process."

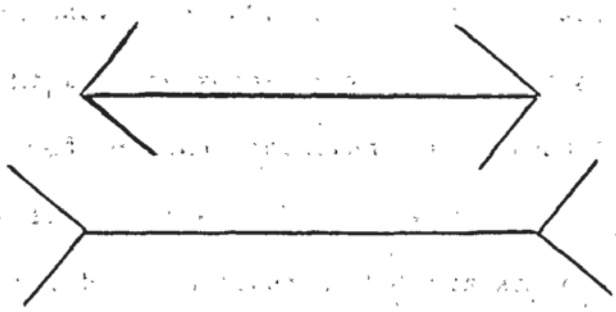
Kivlin and Fliegel (1967) related perception of innovation to farm size, with the expectation that size of operation acted as an influence upon the respondents. Thus cognitive structure can be seen as the product of needs and experience. Their findings and those of perceptual research undoubtably support this proposition. There remains a need, however, to clarify the nature of the process and to establish why it occurs.

Cognitive Psychology

Although perception of innovation is not referring to the perception process as such, being more a 'Cognition of Innovation', the physical perception process does have relevance. It is possible to think of perception as a passive, automatic process, a gathering of information about the world. Information is received by the senses, in the form of appropriate energy, and conducted to the brain, and a picture of the world is built up. This simple view ignores many of the interpretative processes involved in perception. If we take the visual sense as an example, the complexity of the process becomes clear. The image received onto the retina is inverted and the retina itself is incomplete in terms of sensors - the area where the optic nerve leaves the eye is blind. The image we perceive is the right way up and has no holes in it, indicating that the brain makes transformations to compensate for the deficiencies of the organ.

Perceptual activity can be demonstrated to be influenced by cultural factors. Susceptibility to visual illusions, such as the Mueller-Lyer illusion (Fig 5), for example, is more prevalent amongst western societies, than amongst those of a more primitive nature.

Figure 5 - Mueller-Lyer Illusion



Bruner and Goodman (1947) compared the perceptions of coin size by rich and poor children. In the majority of cases the poorer children significantly overestimated the size of the coins, suggesting that their value systems were influencing their perceptual activities. Whorf (1952) suggested that language acted as a determinant of perception, the presence of a linguistic term being a prerequisite of perceiving what the term describes. It does, however, appear more likely that language and perception are both influenced by cultural factors.

The perception of innovation is obviously not quite the same process as experienced during an individual's sensory impressions of the world. While an innovation may provide direct sensory experience, this is not what we mean by "perception of innovation." However perception per se does provide evidence of cultural influences on experiences and behaviour, such as would be expected in the differential perception of innovation approach.

Personality Psychology

Personality theorists, particularly those with a phenomenological leaning such as Rogers (1959), Lewin (1951) and Kelly (1955), have been the psychological group most orientated towards the relationship between the person and behaviour. They have also benefitted, in these terms, from not being so strongly influenced by Behaviourist principles, which reject the concept of "mind", favouring instead a "black box" approach to human functioning under which only observable behaviour is considered. However, even empirically orientated personality workers, such as Cattell (1950), have identified the need to study relationships within the person, which may have consequences for how they behave. He proposes, for example, the "Dynamic Lattice" in which the attitudes, beliefs and emotions were integrated into a complex, personal system. Cattell, however, defined the individual in terms of personality traits, basing his analysis upon generalised trends within a population. Even within the trait approach there is the possibility of relationship between maintained personality trait and the current situation. This was defined within the "Specification Equation":

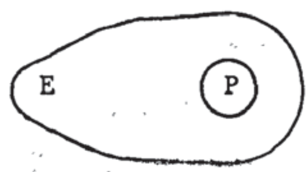
$$R = S_1 T_1 + S_2 T_2 + S_3 T_3 + \ldots\ldots + S_n T_n$$

where R is the behavioural response, (T_1-T_n) the level of particular personality trait, and (S_1-S_n) weightings of each trait in relation to the situation which produces the response. A similar form of equation could possibly be applied to differential perception of innovation, with (T_1-T_n) being the innovation attributes and (S_1-S_n) being weightings of these attributes depending upon the phenomenological viewpoint of the individual who will make response R.

Lewin (1935, 1936, 1938, 1951) proposed a "Field Theory" approach to human functioning. In essence Lewin conceptualised the person and the environment as bounded figures, the principal one being between the person and the environment. Further, certain aspects of the environment were more important to the person, were more real to him, this being known as the "Psychological Environment." The combination of the person and the psychological environment was termed the "Life Space", this being represented as in Fig 6:

Figure 6 - The Psychological Field

Non-Psychological



where P is the person and E the psychological environment. Further, there was differentiation within the person and the environment, certain "facts" being of greater importance to the person. The presence of the psychological "regions" depending upon the identification of psychological "facts" by the person. The relationship between regions of the life space were governed by the nature of the boundaries between them, some boundaries being permeable and some impermeable. Only if a boundary between two regions was permeable could transactions incorporating these two regions occur.

Thus Lewin provided a developed view of the way an individual differentiates aspects of the environment and himself, in reaction to needs and experience. Such an approach could be applied to the way that an individual evaluates technological innovation, the nature of the innovation itself forming a part of the psychological environment, the way that it existed within the life space also being a function of the regions within the person. A more sophisticated theoretical structure, which can be used in a similar way, is that of Kelly (1955). Kellian Personal Construct Theory suggests that each individual has a characteristic way of assessing reality, by measuring it against evaluative dimensions, known as "Constructs":

> "Man looks at his world through transparent patterns or templates which he creates and then attempts to fit over the realities of which the world is composed. The fit is not always very good. Yet without such patterns the world appears to be such an undifferentiated homogeneity that Man is unable to make any sense of it."
>
> (Kelly, 1955)

An essential component of the theory proposed by Kelly (1955) is that of "Man-the-Scientist". Kelly was struck by the schism inherent in most social science theories, by which the theory itself applied to "people", when the scientist himself operates in a way defined by another theory - the theory of scientific activities. Inherent to Personal Construct Theory was the idea of the person making hypotheses about reality, based upon judgements made using his construct system; the construct system itself being developed and modified as a result of experience. Like other phenomenological theories, the Kellian approach accepts the importance of subjective reality:

> "In emphasising the prior conviction that life involves the representation or construction of reality, we should not imply that life itself is not real. Sometimes scientists, particularly those who are engrossed in the study of physical systems, take the stand that psychological events are not true phenomena, but are rather epiphenomena, or merely the unreliable shadows of real events. This position is not ours."
>
> (Kelly, 1955)

Personal Construct Theory rests upon a "Fundamental Postulate" and a number of "Corollaries". The Fundamental Postulate was central to the theory and was as follows:

> "A person's processes are psychologically channelised by the ways in which he anticipates events."
>
> (Kelly, 1955)

Thus the way a person "anticipates events", which is itself a function of the psychological structure, controls how he will react. The nature of the assessment will depend upon the nature of the constructs available in the individual's construct repertoire. A construct is a polar dimension, such as hot-cold, against which judgements can be made. Used alone, each construct would have only limited power to evaluate events, and consequently constructs are used collectively, forming the axes of psychological space, in which events can be given meaning.

The constructs and construct sub-systems (rational groupings of constructs) used are individual; however, this does tend to ignore Man as a social animal. When an individual shares construction of events with another, their predictions about the world will be similar and they share experience. A central aspect of groups is that they behave uniformly in many ways:

> "It is an observed fact that certain groups of people behave similarly in certain respects. Some of these similarities are associated with similarities in their ages, some with similarities in what is expected of them by their associates, some with similarities in experience and some with other kinds of constructions of similarity. Indeed, if we wish, we can approach the matter of similarities between persons from any one of a number of angles."
>
> (Kelly, 1955)

Examination of groups, whether in an occupational or other context, suggests that many of the similarities can be thought of in terms of culture, be it a society or a group within society. However, one needs to consider the dynamics of cultural effects:

> "People belong to the same cultural group, not merely because they behave alike, nor because they expect the same things of others, but especially because they construe their experience in the same way. It is on this last similarity that the psychology of personal constructs throws its emphasis."
>
> (Kelly, 1955)

Differential perception of innovation refers to differences in perceptions between individuals and members of groups. Personal construct theory offers the possibility of analysis of the way that a person would evaluate technological innovation and proved a significant influence to Masterson and Hayward (1979). It is necessary when examining differential perceptions to provide a mechanism by which evaluation of innovation can be performed in such a way that different results ensue. Even if it fails to meet the requirements of such a mechanism, it does provide a model of the way that individual characteristics can operate in the adoption of technological innovation.

Sociological Viewpoints

Differential perception of innovation concerns differences in psychological space, attributable mainly to social relationships. There is a body of sociological and organisational knowledge which can be applied to this problem, or which at least is philosophically similar to differential perception. Sociologists who are opposed to the positivist tradition, particularly those who are subject to existential or phenomenological influences, have explored many of the issues of relevance to the student of differential perception of innovation. As will become clear, these workers are also highly aware of the philosophical issues applying to their work.

Probably the most identifiable group associated with this anti-positivist and phenomenological viewpoint are the Ethnomethodologists. These sociologists tend to concentrate their research methodologies upon interpretations of events by the participants, rather than those of the researcher. Essentially no perspective is accepted at face value:

> "According to the ethnomethodological perspective, we cannot obtain those hard facts in sociology which the conventional sociologist looks for and requires in order to be objective. Ethnomethodologists argue that the mistake in conventional sociology is that it operates with the assumption that we have direct access to others which enable us to treat them as raw data. This assumption is dubious. The social world does not exist as some independent phenomenon, as a thing to be observed in the same way as we might observe the pen with which I am writing. Instead, the social world is comprised of active, thinking individuals who behave in terms of ideas, in terms of their own theories about how their social world operates."
>
> (Tilley, 1980)

Thus the ethnomethodologists reject the "objectivity" implied in positivist thought, instead favouring concepts of individual and social reality; wherein all "facts" are the product of the perceiver (Bohannan, 1969). The implications of this position in an organisational context has been expounded by Brown (1978):

> "Organisational realities are not external to human consciousness, out there waiting to be recorded. Instead, the world as humans know it is constituted intersubjectively. The facts (facta) of this world are things made. They are neither subjective nor objective in the usual sense. Instead, they are construed through a process of symbolic interactions. A revision of our symbolic structures, of our shared forms of perception and expression, is thus a revisioning of the world. This is no more true for the artist or the scientist than it is for the citizen or manager or bureaucratic politician."

Knowledge is not an objective thing but a consequence of the construction system. Phillips (1973) questions the validity of sociological methods, particularly those of a positivist leaning. If meaning is the product of the structure that the individual applies, then the researcher is not free from such effects. Moreover the construction of the individuals being studied must also be taken into account:

> "The entities described and analysed by social scientists are, therefore, accessible only from within - via meaning inhabiting the minds of the actors. They exist as motives of actions; and thus, having been reduced to the realm of the subjective, they present no problems of their own and require no distinct cognitive strategy."
>
> (Bauman, 1973)

The ethnomethodologist being aware of the subjectivity of any viewpoint, including his own, must abandon concepts of objectivity:

> "Again since the ethnomethodologist cannot -

> because no one can - claim a privileged position, his account can be given no special recognition as in some way more valid, objective or reliable than any others. Ethnomethodological accounts are merely different, they are no better. Indeed, ethnomethodologists recognise that there can be no question of 'repairing' the accounts which they take as their object of interest. Were reparation possible, then in principle an objective sociology would also be possible, because this would imply that access to social reality would be possible; we should then be able to pin down some social facts. Ethnomethodologists concede, even embrace these implications of their perspective."
>
> (Tilley, 1980)

The consequences of ethnomethodological and similar viewpoints are many, not merely a rejection of positivism. Implicit in the position is the existential acceptance of individual realities and their extension into socially influenced realities. If positivist thinking is correct, then the <u>real</u> aspects of technological innovation should be sufficiently strong to ensure a uniformity of perception. Such is not the finding of researches in this area; suggesting that there is a need for subjective understanding in examining technological innovation. The only reservation which remains about the ethnomethodological stance is the implication for research, for if we must interpret in terms of the individual's understanding, there is no possibility of comparison. Therefore it must be assumed that there is some commonality, upon which subjective factors modulate.

<u>Philosophy of Science</u>

Much of the previous discussion concerns a central debate of any scientific endeavour - objectivity versus subjectivity. As reflected, this is most powerfully experienced within the social sciences, where the concept of any analysis being value laden has the most far reaching consequences. Much scientific thought believes that it is impossible to make objective distinctions, as the value system of the observer will prove to be a significant influence:

> "Let us consider Johannes Kepler: imagine him as a hill watching the dawn. With him is Tycho Brahe. Kepler regarded the sun as fixed: it was the earth that moved. But Tycho followed Ptolemy and Aristotle in this much as least: the earth was fixed and all other celestial bodies moved around it. Do Kepler and Tycho see the same thing in the east at dawn?
>
> "The physical processes involved when Kepler and Tycho watch the dawn are worth noting .... The same configuration is etched on Kepler's retina as on Tycho's. So they see the same thing. Seeing is an experience. A retinal reaction is only a physical state - a photo-chemical excitation. Physiologists have not always appreciated the differences between experiences and physical states. People not their eyes see."
>
> (Hanson, 1958)

Hanson (1958) uses this example to illustrate the way differences in viewpoint influence observations, and concludes:

> "There is a sense, then, in which seeing is a 'theory-laden' undertaking. Observation of x is shaped by prior knowledge of x. Another influence on observation rests in the language and notation used to express what we know, and without which there would be little we could recognise as knowledge."

The framework, as suggested by Hanson (1958) has much in common with the Kuhnian notion of "paradigm" (Kuhn, 1962, 1970). Thus both are concerned with viewpoints which channel the individual's scientific analysis. Kuhn recognises that different professions and scentific groups have distinct psychological frameworks. These constitute the paradigm, a pervasive 'force' in the performance of their work. Again this suggests a subjective analysis, with at most socially defined effects and implies a differential perception process:

> "The infant and the layman can see; they are not blind. But they cannot see what the physicist sees; they are blind to what he sees. We may not hear that the oboe is out of tune, though this will be painfully obvious to the trained muscician."
>
> (Hanson, 1958)

It cannot be assumed that the innovation researcher, whether sociologically influenced or not, is immune to these effects. In considering explanations made of observed events and theories developed for the understanding of innovation adoption behaviour, reference must be made to the prevailing paradigm of the research process. Diffusion research has generally operated in an empiricist manner, commonly using survey type methods, and the current research is no exception. However there would appear to be a trend towards what are essentially more subjective methods, such as case study work (e.g. Bessant, 1982, Bessant and Dickson, 1982; Braun, 1981, Parker, 1983) and an acceptance of more phenomenological theoretical concepts. Differential perception of innovation, it can be argued, is a product of such a movement, a modification of approach. In turn this is a reflection of movements within science generally, even physics, as the next section indicates, as a product of the 'failure' of more restricted, positivist concepts.

The Age of Relativity

A philosophical connection can be perceived between Einsteinian Relativity and social science approaches, such as phenomenology. Both emphasise the 'observer effect', the need to clarify 'where one is' before interpreting what one sees:

> "You might imagine a rabbit and a hippopotamus arguing as to whether man is 'really' a large animal; each would think his own point of view the natural one, and the other a pure flight of fancy."
>
> (Russell, 1969)

Twentieth century physics as influenced by Einstein has been forced to take the perspective of the observer into account, and this analysis can be extended as follows:

> "When two observers perceive what is regarded as one occurrence, there are certain similarities, and also certain differences, between their perceptions. The differences are obscured by the requirements of daily life, because from a business point of view they are as a rule unimportant. But both psychology and physics, from their different angles, are compelled to emphasise the respects in which one man's perceptions of a given occurrence differs from another man's."
>
> (Russell, 1969)

Differential perception of innovation too, seeks to incorporate the construction of the observer, taking this as a significant dynamic of what is being perceived. Consequently it appears valid to argue that both Relativity and Differential Perception of Innovation belong to the same cultural climate, and to justify the veracity of the latter notion by reference to the former; to reinforce the essentially subjective quality of experience:

> "In such matters what is seen does not belong solely to the physical process observed, but also to the standpoint of the observer. Measurements of distances and times do not directly reveal properties of the things measured, but relations of the things to the measurer. What observations tell us about the physical world is therefore more abstract than we have hitherto believed."
>
> (Russell, 1969)

The Multidimensional Hypothesis

The concept of Differential Perception of Innovation as proposed by Kivlin and Fliegel (1967) and adopted by Rogers and Shoemaker (1971), amongst others, appears to have high credibility. The findings of characteristic of innovation studies become explicable if one incorporates an awareness of the importance of subjective experience, as has been done by researchers working in other areas. The impact of such analysis must, however, be tempered by knowledge of the difficulties inherent to it. Phenomenological or similar constructions are in many ways insubstantial and offer little posibility of finding "hard facts" (Tilley, 1980). Moreover, one is left with the possibility of finding only 'unique' perceptions of innovation, rather than establishing "how perceptions of innovations differ for various groups" (Rogers and Shoemaker, 1971).

Although, in absolute terms, there is no way of proving that individuals share any experience that anything is real, it seems reasonable to believe that we do, and to use such 'evidence' as is available:

> "If there were no reality in the physical world, but only a number of dreams dreamed by different people, we should not expect to find any laws connecting the dreams of one man with the dreams of another. It is the close connection between the perceptions of one man and the (roughly) simultaneous perceptions of another that makes us believe in a common external origin of the different related perceptions."
>
> (Russell, 1969)

While we can accept that we share a 'real world' in common, we also must recognise that the observer himself has a part to play in the detail of that 'real world.' Thus while it is possible to identify when and where an event occurs in space-time in a relativistic universe, we must have information about the observer, where he is in the space-time continuum. Even then, we can only position one event in relation to others.

Many theories of perception, for example Bruner (1951), take the individual as an active, information gathering creature, who selects which aspects of the environment to attend to and who predicts future events. Factors such as culture, emotion, current needs and physiology all influence a perceptual event. It is only necessary to compare the visual experiences of two observers, one of whom is colour blind, to demonstrate that such experience is not universal, and while this is an extreme and physiologically orientated case, the logic can be applied to other differences. It becomes clear that perception requires the presence of 'mental tools', appropriate to particular forms of stimuli, for the latter to impinge on the human consciousness; although whether perception is dependent on language, as Whorf (1952) would suggest, remains unclear.

Philosophy of science, too, recognises the impact of conceptual structures in understanding the world, as witnessed by Kuhn (1970) and his analysis of scientific paradigms. Implicit in this work is the importance of such structures, as operationalised in terms of models, theories, accepted notions and methodological recipes, for the cohesion and operation of scientific groups. Again we must conclude that conceptual structure is the major determinant of the scientist's functioning, the way that problems are formulated and the acceptable solutions. If like Kelly (1955) we extend the ways of the scientist to the population at large and see all individuals as theory orientated, hypothesis testing creatures, we must accept that all members of society maintain one or more paradigms; and further, that because these different paradigms are applied, a person's idea of reality will be unique to himself or to the group with which he is associated and which communally maintains this conceptual structure. Hence, the ethnomethodological stance, the need to seek understanding of behaviour in terms of the structure which generated that behaviour.

Individual and group differences of this nature have become increasingly important to the diffusion researcher in the last fifteen years and it would appear that situational factors, applying to one or more individuals who behaved in the same way, determined their adoption behaviour. However, if we incorporate an observer effect within perception of innovation, we must attempt to position that observer in terms of appropriate variables. If each individual has a unique perception of innovation, then each will be found in a different position. To study differential perception in any meaningful way it must be assumed that there is some commonality of view-point, the "simultaneous perceptions" of which Russell (1969) wrote. Consequently we arrive at a position somewhere between unique perception and a uniform perception of technological innovation. The question then arises: How many factors define a perceptual viewpoint? The experiences of earlier characteristic studies suggest that the use of a single variable, whether it be adoption behaviour, farm size, or experience with hybrid plant varieties (Brandner and Kearl, 1964), which may have some explanatory power, is insufficient to account for all differences in perception of innovation when used alone. Thus it must be assumed that the position of the perceiver of innovation will be defined by a number of variables, that it is 'fixed' in terms of a number of dimensions. This can be described as the Multidimensional Hypothesis.

<u>The Multidimensional Hypothesis</u>

H_1 : perception of innovation will be defined in terms of many dimensions, arranged in multi-dimensional space, such that similarity can only be properly determined using all these dimensions, as operationalised by variables chosen for study.

There are three corollaries to this hypothesis:

1) If only one dimension of perceptual difference is considered only a part of the variation will be explained. This amount will be proportional to the importance of this variable in the perception of innovation process.

2) The importance of a particular variable in determining perception of innovation will vary between individuals. The combination of dimensions will also vary when individuals are compared.

3) The person is seen as a dynamic, rather than static organism, such that his position in relation to a particular innovation may well vary over time.

A major consequence of the Multidimensional Hypothesis was the need to compare individuals in terms of a number of different dimensions simultaneously, for a realistic comparison of determinants of perceptions of innovation to be made. Further, because perceptions are determined by social processes, there is a likelihood of groupings based upon 'stepwise linkages', which would have the following structure:

> "... let us assume this time, not a budding family of parents and children, but a piquant triangle of a male A, a bisexual female B, and a lesbian C. We need not belabour the point that the sexual relevances of these three individuals will not coincide. Relevance A-B is not shared by C. The habitualisations engendered as a result of relevance A-B need bear no relationship to those engendered by relevances B-C and C-A. There is, after all, no reason why two processes of erotic habitualisation, one heterosexual and one lesbian, cannot take place side by side without functionally integrating with each other or with a third habitualisation based on a shared interest in, say, the growing of flowers (or whatever other enterprise might be jointly relevant to an active heterosexual male and an active lesbian). In other words, three processes of habitualisation or incipient institutionalisation may occur without their being functionally or logically integrated as social phenomena."
>
> (Berger and Luckmann, 1966)

Beyond the inherent difficulties of the application and analysis of such modelling, is the need to identify all, or at least the most important, variables involved in the process. While the assumed differences between individuals will complicate matters, the social nature of differential perception should ensure some commonality, such that worthwhile variables are likely to be found. An obvious source of information about variables found significant in the innovation process is relevant literature. The next chapter explores some of the literature pertinent to the area chosen to operationalise the differential perception of innovation concept - the adoption of technological innovation, within the industrial/organisational context.

CHAPTER SEVEN

ADOPTION OF INNOVATION IN THE ORGANISATIONAL CONTEXT

The need to provide a context for differential perception, within this study, was mainly satisfied by three large manufacturing companies with consequently complex organisational structures. Organisational factors undoubtedly influence how a person will behave, and will set limits as to what is or is not acceptable. The adoption of innovation in the organisational context is also likely to be the product of a group decision-making process, with the individuals involved having different backgrounds and needs.

It must also be recognised that beyond the collective nature of the organisational adoption are constraints attributable to the organisational climate, such as the mechanisms for arriving at and implementing decisions:

> "Different structures might, then produce different climates, specialised, highly prescribed roles in a centralised authority system are unlikely to encourage entrepreneurial risk taking, for example."
>
> (Payne and Pugh, 1976)

The origins of the organisational paradigm are likely to be many. For example Woodward (1958) examined successful organisations in different industries and found that different technologies were characterised by different organisational structures, with consequent effects on management:

> "The widely accepted assumption that there are principles of management valid for all types of production systems seemed very doubtful ..."
>
> (Woodward, 1958)

It is also possible to typify organisations in terms of the management methods employed, as did Burns and Stalker (1961). These were termed "mechanistic" and "organic"; in the former "the individual pursues his tasks as something distinct from the real tasks of the concern as a whole, as if it were the subject of a subcontract"; whereas in the latter "jobs lose much of their formal definition in terms of methods, duties and powers, which have to be redefined continually by interaction with others participating in the task". Child (1973) examined the effects of size on organisational structure in terms of "structural differentiation".1 Using data from his own study and Blau and Schoenherr (1971) he examined factors such as Functional Specialisation, Role Specialisation and Vertical Span of Control. While regression curves of this data tended to be curvilinear, there was a reasonable correlation between these factors and organisational size, with an expectation of increasing functional specialisation with increased size. There would, therefore, be greater scope for differential perception of innovation within a large organisation than in a small one.

Child and Ellis (1974) examined variations in management roles as dependent upon industry, as well as organisational, performance and environmental factors. They found a number of predictors of variation in management roles, which were seemingly reflected in the attitudes of management. This kind of variability offers great potential for differential perception of innovation effects, as undoubtably management groups are not homogeneous:

> "These findings, together with those of other studies we have cited, lend support to our opening theme. This stressed the advantages of moving away from a conception of management as a homogeneous occupational group, and instead, of seeking to

1. Structural differentiation is seen as having a horizontal dimension in terms of number of divisions and division of labour and a vertical dimension in terms of number of hierarchical levels.

> identify variations in managerial roles and to locate these meaningfully in their situational context. Our argument in fact casts some doubt on the validity and utility of the 'manager' as a generalised concept. At the very least, it raises the question of how significant are the characteristics common to all managers compared with those which differentiate managers into separated categories."
>
> (Child and Ellis, 1974)

Consequently if we deal with the adoption of innovation which involves a number of individuals it is likely that differential perception of innovation effects will be evident. However, before examining such adoption it is first necessary to look at the 'mainstream' of industrial/organisational innovation research.

Industrial and Organisational Innovation

The study of diffusion in the industrial/organisational context is one that has been of increasing importance in recent years. It is in many ways a more complex area than the consumer type studies, common in the past. To begin with it is more difficult to identify the prime mover in the adoption process, as it is likely that more than one person is involved[2] and secondly, particularly for Manufacturing Innovation:

> "....existing theory is deficient in two more respects. First it treats manufacturing innovation simply as a diffusion process. Although it is true that the introduction of, say, numerically controlled machine tools may be regarded as the diffusion of somebody else's product innovation, in doing so one overlooks much pioneering effort and truly innovative activity associated with the introduction of new manufacturing procedures into an organisation. In many cases, and especially when electronic controls are added to existing machinery, diffusion is not the essential feature of activity. Secondly, in concentrating on product and process innovation and disregarding manufacturing innovation, much existing work over-emphasises the role

2. While this is not true of all industries, e.g. British Flour Milling (Hayward and Masterson, 1977) it is expected to hold true in the majority of cases.

of deliberate R & D activities."

(Braun, 1981)

Industrial/organisational innovation research developed from earlier work, particularly that of the Rural Sociologists. Rogers (1975) pinpoints the work of Ryan and Gross (1943) as one of the most significant studies in the diffusion and adoption of innovation field:

> "The hybrid corn study in Iowa by Ryan and Gross (1943) set forth a new approach to the study of scholars in a wide variety of scientific fields."

In reference to organisational innovation Rogers (1975) went on to write:

> "In my opinion this sub-college received a powerful stimulus from its roots in the classical diffusion model, but it has been stunted in its intellectual potential by the burden of this academic ancestry."

The influence of the Ryan and Gross approach, with its attempt to establish correlates with innovativeness (e.g. cosmopoliteness, economic status, etc) can be clearly perceived in the industrial/organisational area. Although Rogers (1975) seems to feel that organisational diffusion is more innovative than some other aspects of the field , he does criticise the mechanistic use of what he describes as the 'dominant paradigm':3

> "Originally, the individual-orientated diffusion model was too directly applied to the newer situations. The organisation was simply substituted for the individual in these investigations of 'organisational innovativeness', without much attention to organisational structural variables or to other distinctive aspects of organisations as decision-making units."

In line with the Ryan and Gross approach, organisations have been examined for correlates with innovativeness. Examples of the factors

3. That used by Ryan and Gross (1943).

studied are as follows:

1.	Size)	Brown (1957), Caplow (1964),
2.	Market Structure)	Mansfield (1963)
3.	Slack	Cyert and March (1963), Knight (1967)
4.	Unprogrammed Goals	March and Simon (1958)
5.	Diversity in Task Structure	Wilson (1966)

These characteristics are self-explanatory, with the possible exception of "slack". This was referred to as follows:

> "Slack conditions occur when the organisation is rather contented with itself. Under these situations we expect to find wide search on the part of the organisation for new ideas."
>
> (Knight, 1967)

Seemingly success breeds success, both Mansfield (1963) and Knight (1963) found that successful firms made more radical and more frequent product and process innovations than the unsuccessful firms. Cyert and March (1963) hypothesised that a company in difficulties will try internal re-organisation, in an attempt to be competitive. This remains untested, probably because of the concentration on innovative change and the difficulties involved in gathering data on company failure. Cyert and March (1963) also hypothesised that a company's innovative behaviour would depend upon how successful it perceived itself to be. Knight, Leavitt and Friedheim (1962) tested a similar hypothesis and found that companies exhibit different behaviour under conditions of success, moderate success and failure. However, it is clear that technological innovation is a vital component of competiveness:

> "Several instances can be quoted where firms have declined from positions of dominance twenty-five years ago to positions of near-oblivion today because they failed to update their machines sufficiently and to produce new models."
>
> (Rothwell, 1980)

Carter and Williams (1959) measured company innovativeness on 29 characteristics and found that producers of innovative products tended to be early adopters of innovation, when acting as consumers. Project SAPPHO[4] examined a number of companies who were producers of innovation. They compared 21 pairs of innovations, one of each pair being commercially successful and the other unsuccessful. They found that firms which introduced successful innovations generally:

1. Paid more attention to user needs.
2. Did better marketing.
3. Performed development work more efficiently.
4. Made more use of outside technology.5

Rothwell (1977) reviewed a number of studies concerned with "successful innovators and technically progressive firms", as well as success and failure in innovation. Factors which he highlighted as important were:

1. Communication effectiveness, both internally and externally.
2. Level of cooperation and co-ordination.
3. Efficiency of development work.
4. Use of planning and management techniques.
5. Quality of management, personnel policy and management style.
6. Marketing.

5. They were not affected by the 'Not-invented-here' syndrome.

4. Archilladeles et al, (1971).

7. After-sales and user education.

8. The presence or absence of a product champion.

However, he concluded:

> "It has clearly been demonstrated that explanations for success and failure in innovation are pluralistic and interactive and that there are no easy explanation or process available to offer management; the innovator if he is to be successful must take care in all the areas of competence encompassed by the innovation process."

Braun (1981) reinforces the view that the adoption of innovation is indeed complex and suggests that it will "require a constellation of various circumstances to be propitious for the event to occur".

One variable that has been studied is the kind of communication involved in gathering information necessary for making adoption decisions. Czepiel (1974), amongst others, has examined the effects of personal influence upon adoption of industrial innovation. The classic diffusion model suggests that word-of-mouth communication is highly important in the adoption process. Czepiel (1974) identified an 'informal community' in the steel industry, although he does comment:

> "... this finding may be a function of the maturity of the steel industry and the strong similarity among all the firms in the industry insofar as basic production and technical problems are concerned. It is less likely that such a seemingly active society could be said to exist within an industry such as petrochemicals or electronics wherein production technology may yield significant competitive advantage and therefore may demand a higher level of secrecy."

The five innovation characteristics described by Rogers (1962) (Relative Advantage, etc) have acted as the basis of most industrial innovation attribute studies, as they have elsewhere.6 The importance of innovation

6. e.g. Fliegel and Kivlin 1962 (a), 1962 (b), 1966, 1968.

characteristics in the adoption of industrial innovation has been recognised. For example Lancaster and White (1977), in reference to product innovation, wrote:

> "An economic assumption would be that a business should strive to optimise new product diffusion (i.e. the greatest number of adopters in the shortest possible time having due regard to the financial, logistical, etc. constraints). Success is, therefore, dependent upon matching the product attributes or characteristics with those of the market and the needs of the individual customer."

To satisfy these requirements it is first necessary to identify the "needs of the individual customer" or at least those of the potential adoption group:

> "Innovation is essentially a two-sided or coupling activity. It has been compared by Schmookler(1966) to the blades of a pair of scissors. On the one hand it involves the recognition of a need or more precisely in economic terms, a potential market for a new product or process. On the other hand it involves technical knowledge, which may be generally available, but may also often include new scientific and technological information, the result of original research activity. Experimental development and design, trial production and marketing involves a process of 'matching' the technical possibilities and the market."
>
> (Freeman, 1974)

Research on the attributes of innovation, generally, indicates that their effects upon adoption can be somewhat unpredictable. The case of the "Pill that Failed", featured in Rogers and Shoemaker (1971) is a good example. The innovation in question was a pain killer that could be taken without water. Consumer tests were favourable and the product was introduced to the market, with strong marketing and advertising. Sales were so poor that the manufacturer rapidly withdrew the product from the market. A post-mortem into this product failure concluded that it was the lack of water, which had been thought a selling point, which made it unacceptable to the consumer - the taking of water being associated with the cure. Apodaca (1952) illustrated the case of innovation failure due to its lack of compatibility with the needs of the adopters. It concerns the introduction of a hybrid corn variety to a New Mexico county. Although it was adopted readily at first, discontinuances were so high that only a few users were left, by the second year after its introduction. The hybrid corn produced the high yields expected, but unfortunately made poor tortillas, a significant part of the staple diet in the area.

Characteristic methods have been used widely within the analysis of the innovation process in the industrial environment. Myers and Marquis (1969), for example, examined industrial innovation in five industries and included innovation characteristics in the design. Utterback (1975) re-examined the Myers and Marquis (1969) data, utilising multivariate techniques. Utterback's analysis supported the Myers and Marquis view that:

> "The patterns of characteristics of innovations in the five industries revealed many more similarities than differences between industries in spite of differences in structure, market and technology."
>
> (Myers and Marquis, 1969)

Specifically 27% of variation between industries was accounted for by innovation characteristics; Utterback (1975) also refers to the kind of approach to innovation that might be expected in different industries:

> "Differences in firm's strategies for competition and growth may be considered a function of their environment including their rate of technological change and related to types of innovation attempted and the sources of these innovations. Firms which compete primarily on product performance might be

> expected to undertake innovations which are more original, require a greater degree of change or invention and cost more to develop. They also introduce innovations rapidly when they become available.
>
> "Conversely firms which compete on the basis of product cost would tend to focus on process innovations. They would tend to quickly adopt minor changes in process technology, but reluctantly make major changes or make large fixed investments obsolete unless attracted to do so by rapidly expanding markets or changes made by a competitor."
>
> (Utterback, 1975)

Manufacturing companies tend to "compete on the basis of product cost" and are attracted to innovations which contribute to production improvements:

> "The ideal case for any manufacturer would be to have production efficiency limited only by the characteristics of the process itself. Manufacturing innovation contributes to this in a number of ways - labour saving, energy saving, time saving, material saving, quality improvement, range of products increasing, variablity decreasing, yield enhancing - and so on. The decision to adopt is strongly influenced by the pattern of these relative advantages offered in the innovation."
>
> (Bessant, 1982)

Rothwell (1977) compared the two main groups/industries involved in the innovation process, i.e. the producers and users. He examined the perception of innovations by the two groups in the textile industry. In reference to technical characteristics he wrote:

> "It can be seen that there is good agreement between the aggregate data rankings from textile companies and the rankings from the textile machinery characteristics on a number of crucial points."

As could be expected agreement tended to be on such factors as reliability, productivity and the end-product quality, which would appear highly important considerations. It should be pointed out that the British textile industry is a fairly integrated one, with good communications between users and producers. However, one is still left with a proportion of variability unaccounted for, with which the "classical diffusion model" was unable to cope. To clarify this matter and to provide a practical experimental paradigm it is necessary to move beyond the earlier approaches and explore collective adoption decisions.

The Group Adoption Decision and Differential Perception of Innovation

> "None of the diffusion studies so far has focussed on groups as adopting units."
>
> (Czepiel, 1974)

> "Almost all past diffusion research has been based upon the implicit assumption of optional decision-making by individuals, rather than collective decision-making within (as opposed to between) social systems. What is different about the diffusion and adoption of innovations when the decision is made by a collectivity rather than by an individual?"
>
> (Rogers and Shoemaker, 1971)

The Rogers and Shoemaker quote is most of the introduction to a chapter of their book, which examines "Collective Innovation-Decisions". However the lack of suitable research caused them to explain:

> "It is well to remember that none of the community power or small group participation investigations were conducted, at least explicitly, in a diffusion research framework.
>
> "The more individuals involved in an innovation decision, the slower it will proceed. When information about a new idea must be communicated to a larger number of individuals, there is greater opportunity for message distortion, more room for differential perceptions of an identical stimulus, and a greater likelihood that consensus will be reached more slowly. Each individual brings to a

> joint discussion his own storehouse of opinions and beliefs, and these colour his attitudes toward the innovation in a way different from that of his peers."

That industrial innovation adoption decisions are not generally made by an individual, but rather by a group, is not in question; instances of its occurrences have been referred to in the literature. For example Baker (1977) found evidence of this in his study of the JCB110 crawler-loader machine and wrote:

> "... the number of managers involved in this purchasing decision tended to vary from company to company, with more than one manager being involved in the decision more than 66% of the sample (33 companies)."

It is also clear that technical change is modifying the nature of the personnel involved, with an increasing trend towards specialisation:

> "The increasing incidence and growing commercial importance of radical technical change has been reflected in an increased requirement for companies to employ graduate-level engineers and scientists, and to establish formal R & D departments. The most successful post-war textile machinery innovations have been associated with the presence of one or more graduates in the firm, and with a formal, systematic R & D activity......The employment of technically skilled managers, particularly graduate-level managers, is also increasingly important.
>
> (Rothwell, 1980)

The lack of research in this area by diffusionists is further aggravated by the lack of psychological research applicable to the kind of group processes expected in this area, as indicated, again, by Rogers and Shoemaker (1971):

> "Unfortunately for our present purposes, the Lewin (1943), Levine and Butler (1952), Griffin and Ehrlich (1963) and Bennet (1952) inquiries were all more concerned with optional decisions than with collective innovation choices."

The problem with most group dynamics experiments, for example Lewin (1943), Sherif (1947) and Asch (1956), is that they bear little relationship to the group decision-making involved in adoption of industrial innovation. The members of groups involved in such decision-making do not sit down together and decide on the best course of action - or if they do, this is only part of the process. The formal discussion will most likely take place through documents passed between members, or discussions involving small numbers of members. Also such groups are not voluntary, in the sense that the members choose to belong to them. The fact of belonging to the organisation and the imperatives of a particular need in, for example, the manufacturing process brings them together, or at least gives a basis for a particular aspect of their interaction. Probably the only adoption of innovation study which has taken group decision-making into account, is that of Ozanne and Churchill (1971). They described the need as follows:

> "With the exception of anthropological studies that focus on the acceptance of an innovation by a social group, research in adoption and diffusion takes the individual as the relevant adopting unit. However, there are instances where focusing on a group produces more meaningful results: the adoption process model implicitly recognises that a decision-making group is the most likely unit of adoption for industrial innovation."

A more fruitful source of collective decision-making studies proves to be that of industrial purchasing and after all:

> "The adoption of most innovations involves sale of a new product...."
>
> (Rogers, 1976)

Harding (1966) reviewed a study which examined purchasing decisions, to evaluate who instigated these and who had final say. The findings suggested that the role of middle management is underestimated and that of the purchasing department and top management inflated. It was found that 88% of all purchases were instigated by middle management and that for 74% of purchases, they also named the "supplies pool". In only one case did top management take a decisive role, and this was the purchase of a carpet. Although top management had to sign purchasing authorisation, particularly for high cost purchases, they tended not to be too involved in the actual decision-making process.

Webster (1965) points out that there is little in the way of analytic framework in which purchasing decisions can be evaluated. Even within industries, markedly different purchasing patterns are found. Industrial purchases appear highly segmented and in reference to a study of markets for particular chemicals Webster (1965) wrote:

> "In one subsegment, the purchasing agent exercised the major influence, but relied heavily upon laboratory personnel for analysis and recommendations. In another subsegment, major influence was exercised by the foreman of the production process who relied upon production engineering for advice and recommendations."

Faris (1967) described a study of industrial purchasing and points out that industrial marketers:

> "... tend to segment or group, customers in three ways: according to product being sold (window air-conditioning versus commercial units), the customer's end use (an oil company sells different lubricants to a metal working company than it sells to a textile company), or geographic location of customer (snow blowers sell better in Toronto than they do in Texas)."

However Faris suggests that industrial marketers should instead focus on the"buying situation", of which he identifies three:

1) New Task - "a problem or requirement that has not arisen before."

2) Modified Re-buy - "a continuing or recurring need or problem."

3) Straight Re-buy - "involved a continuing or recurring need handled on a routine basis."

The purchasing process involved in these different situations will vary, for example:

> "... the information needs are very great in a new task situation, moderate in a modified re-buy situation and very low in a straight re-buy."
>
> (Faris, 1967)

Choffray and Lillien (1978) also reject the more usual market segmentation strategies, merely using such characteristics as size, location, etc. They propose instead a segmentation based upon both macro and micro classification:

> "The first step, macrosegmentation, characterises those organisations that are likely to react to a product offering differently because of their industry, geographic location, or other observable characteristics. Most data needed for this screening can be drawn from secondary sources. Once macro segments are developed, they are further divided on the basis of similarities between decision making units."

The microsegmentation utilises a "decision matrix", which measures involvement in the buying process. Each survey respondent was asked to indicate the percentage of task responsibility in each phase of the purchasing process. Also to give his perceptions of the relative importance of each task involved as:

> "A category may be involved only a small percentage of the time but be very influential."
>
> (Choffray and Lillien, 1978)

In reference to an earlier study[7] of the market potential for a new type of industrial air conditioning system, Choffray and Lillien (1978) identified those individuals involved in the purchasing process:

Company Personnel - Production and maintenance engineers
Plant or Factory manager
Financial Controllers or Accountants
Procurement or Purchasing Department Personnel
Top Management

External Personnel - HVAC/Engineering Firm
Architects and Building Contractors
A/C Equipment Manufacturers

The constituents of the 'decision-making units' were used for the micro-segmentation procedure, using hierarchical cluster analysis. Based upon this analysis characteristics of organisations in particular segments were identified, as well as the issues found important by different participants in the decision-making process. These issues can be seen in Table 1 (taken from Choffray and Lillien, 1978). Some of the results were summarised as follows:

> "For example, compare top managers with HVAC consultants. Top management are interested in modernity, operating costs and energy savings; precisely those issues that are of least importance to HVAC consultants. Linking these results with those of the micro-segmentation analysis, it appears that segments 1 and 4 have prime decision participants with almost opposite requirements! To

7. Lillien et al, 1977

be successful in this market, manufacturers must very carefully target their product offerings and communication strategies."

(Choffray and Lillien, 1978)

	Key Importance	Less Importance
Production Engineers	Operating Cost Energy Savings Reliability Complexity	First Cost Field Proven Substitutability of Components
Plant Managers	Operating Cost Use of Unproductive Area Modernity Power Failure Protection	First Cost Complexity Substitutability of Components
Top Managers	Modernity Fuel Rationing Protection Operating Cost Energy Savings	Noise Level in Plant Reliability
HVAC Consultants	Previous System Experience Ease of Installation Reliability	Modernity Operating Cost

Table 1 Issues of Importance for Each Category of Decision Participant

What then are the differences between the individual adoption process and that performed by a group? Obviously the process will be different, as Rogers and Shoemaker (1971) wrote: "The more individuals involved in an innovation decision, the slower it will proceed."; "there is greater opportunity for message distortion" and "more room for differential perceptions of an identical stimulus." The last point is an important one for industrial, group decision-making, particularly if, like Nealey and Fiedler (1968), one questions the assumption that managers can be treated as a homogeneous occupational group; if in practice "a manager is a manager...". The role of the individual appears a vital aspect of their perceptions of innovation. Ozanne and Churchill (1971) recognised this in their study of group adoption decisions and studied a number of characteristics applying to members of the decision-making group. They concluded that role effects were important, particularly the "member's level in the organisation hierarchy." The evidence from industrial purchasing, particularly the work of Choffray and Lillien (1978), clearly indicates that individuals occupying particular roles perceive new technology differently from those occupying other roles. However, it is necessary to examine the concept of role, which can be defined as follows:

> "The word role is borrowed from the theatre and there is little in its social-psychological sense that is not prefigured in its theatrical sense. A role in a play exists independently of any particular actor and a social role has a reality that transcends the individual performer. Roles in society, too, are prescribed actions and words rather than persons."
>
> (Brown, 1965)

Role then appears to be a collection of habits and norms which the individual adopts when required to function in a particular way. Guetskow (1970) describes the relationship between role formation and task as follows:

> "Role formation would seem to be intimately associated with the functions demanded by the tasks. Our operational description of the three roles in terms of the components of the task is information exchange, solution formation, and answer exchange. But the task characteristics did not determine just how the components should be assembled into differentiated roles - nor whether these roles need be continuously played by one set of individuals or interchanged among them ... we hypothesised the various combinations in which the task functions might have been assembled in functional roles. All but one were found to occur."

How then does the work role, however it is defined, affect the individual's perceptions of innovation and the decisions he makes about them? Hard evidence is sadly lacking, though some slight indicators are available. That management roles differ has been demonstrated, for example by Child and Ellis (1974), and Ellis and Child (1973) who wrote:

> "there are ... identifiable bases of differentiation in the attitudes of managers."

Carter and Williams (1959) suggest that innovativeness of firms is to some extent influenced by the nature of the personnel involved in policy making; firms with more specialist groups, such as engineers and scientists, in this role being more innovative. Wind (1967) suggested that the individual's role would define the kind of information he would need when evaluating innovation:

> "The R and D engineers are basically concerned with the performance and quality of the products which they design and develop. The buyers on the other hand are concerned with maximisation of cost savings subject to satisfactory performance of their jobs."

In the terms of Kelly (1955), referred to in the previous Chapter, role can be seen as a particular construct sub-system, which has a "Range of Convenience" defined by that role. Given that constructs are tested against reality and therefore over time the construct sub-system becomes increasingly relevant to its area of usage,8 role construct repertoires maintained by individuals would be expected to converge, in reaction to similar experience. The perceptions and behaviour of those operating within a particular role should consequently be similar. This expectation is, to some extent, both indicated and supported by Lawrence and Lorsch (1967):

8. Assuming, of course, that the individual conducts 'fair' tests and abandons constructs which have no predictive power and adopts new constructs which are more appropriate.

> "If these managers were to be effective in doing their specialised tasks, they must focus their attention clearly on objectives and goals directly related to them. Sales managers must be concerned with accomplishing market objectives. Manufacturing managers must pay attention to such techno-economic goals as processing costs, raw materials costs, and the quality of the finished product. Research personnel must be primarily concerned with both the development of new scientific knowledge and its successful applications to products and processes."

and:

> "Our prediction in this area also turned out to be largely true. Sales personnel in all six organisations indicated a primary concern with customer problems, competitive activities and other events in the market place. Manufacturing personnel were all primarily interested in problems of cost reduction, process efficiency, and similar matters."
>
> "In the research laboratories, however we did not find so strong an orientation as we had expected toward scientific objectives."

Pettigrew (1973) made an intensive study of the adoption of computer technology within one company (known as Michael's), in which he identified the importance of differences between members of the buying team involved in the adoption decision. He also recognised the need to take account of the way the actors perceive the process:

> "The following analysis relies on the participants own perception of the determinants and impact of uncertainty on the computer decision."

In practice this led to widely differing recommendations in terms of which manufacturers should receive the contract, forms of input required and so on. However, Pettigrew (1973) saw these differences as the product of a political process, with occupational grouping and associated expertise being used as a power base:

> "The expert, however, need not simply rely upon his presumed dependency of others that his mystical powers can give him. He can seek support for the demands he is making."

Position in the hierarchy can also be used as a method of controlling the nature of the decision making. Kenny (one of the actors in Pettigrew's study) controlled information in such a way:

> "The potential to bias information is maximal in the gatekeeper role where the information passed is complex and uncertain. Kenny occupied such a role. It was a major factor in his ability to control the decisional outcome. Kenny was a gatekeeper along two communication channels: first, the channel between his technical subordinates and the Michaels Board and, second, that between the computer manufacturers and the Michaels Board."
>
> (Pettigrew, 1973)

Pettigrew's study highlights the importance of organisational structure and functional specialism in the "non-programmed innovative decisions", albeit as factors in a political process. While the present research mainly takes a different focus, both were responses to the inadequacies of theories of decision-making in the organisational context. As will become clear, the lack of research on how an individual evaluates information, and on the effects of functional specialism within an organisation and the nature of organisational group decision-making, was a source of concern throughout the research. Indeed, a major recommendation arising from the present research, is for attention to be given to these issues, in order that those who investigate problems within the organisational context in the future have a firmer knowledge base.

PART THREE

THE RESEARCH AND FINDINGS

CHAPTER EIGHT

INTRODUCTION

To translate theoretical ideas into means of generating further information about the topic it is necessary to operationalise the problem in some way. For the study of differential perception of innovation there is a need to identify a population which is involved with the adoption of innovation wherein recognisable sub-groupings can be found. If one were to follow the individual-adoption paradigm (Rogers and Shoemaker, 1971) sub-groups would have to have been identified using appropriate variables, such as the "farm size" used by Kivlin and Fliegel (1967). In practice this is likely to prove problematic, for it would be necessary to be highly familiar with the area (industry, etc) to identify suitable variables. However, the analysis of the group adoption decision indicated that here roles were evident which would be likely to have distinctive perceptions of innovation. The only real difficulty was the lack of research on group adoption of innovation (Czpiel, 1974), and as documented earlier, the sparsity of research on related topics such as group decision-making and industrial purchasing.

The first step in identifying individuals involved in the adoption of innovation in an organisational context was to find an organisation which would cooperate in the study. Initially two large companies were approached for assistance and both agreed to collaborate; these were termed Company X and Company Y; later an opportunity arose to study the development of a Computer Aided Design system within one company, called Automotive Systems Ltd for the purposes of this research. All are manufacturing companies who have applied an innovative policy to manufacture as a mechanism for maintaining competiveness:

> "The second role of technological innovation in determining the competitive position of the firm is in production technology. Unless a firm keeps its production technology up-to-date, which means that it engages either in process innovation when appropriate or in manufacturing innovation, it will suffer loss of competitiveness by losing out on productivity or on quality of production or both."
>
> (Braun, 1984)

It was decided to concentrate upon manufacturing innovation for the purposes of this research as "manufacturing innovation can be seen as one of the major weapons in the battle for world markets of established products" (Braun, 1981). Such innovation, while not of a radical nature, is therefore highly important:

> "... it can be argued, as for example by Gilfillan and Hollander, that the myriad of minor improvements and 'new models'are as important for technical progress as the more radical 'break-through' innovation."
>
> (Freeman, 1984)

Moreover, it is highly suitable for the study of differential perception of innovation as:

> "... the nature of this innovation is such that it may be relatively cheap, and its introduction may be built into the day-to-day production budget, under the control of production managers, supervisors etc. This implied shift from <u>strategic</u> level to <u>tactical</u> level in the decision-making process is another differentiating feature of manufacturing innovation."
>
> (Bessant, 1982)

It was, therefore, thought likely that teams of middle and junior managers would be involved in such decision-making processes, this being confirmed in practice.

Data collection was performed in three distinct stages. The first of which, termed "Survey I" was performed within Company X and Company Y. To identify individuals who had been involved in the adoption of manufacturing innovation, the companies were asked to suggest manufacturing innovations adopted by the company in recent years. Seven innovations were suggested by Company X and six by Company Y. The manufacturing innovations studied within Company X ranged from the introduction of a cold forming machine to an automatic wrapping machine and those for Company Y ranged from the installation of a computer aided design system to the purchase of an advanced numerically controlled milling machine. While many of the innovations were of an incremental nature they were all 'new to the firm'. Involvement with any of these innovation adoptions was used as a decision rule for inclusion in the study. In the event the same individuals were involved in a number of these innovations, which restricted the sample size.

For the purposes of this study each manufacturing innovation was given an "innovativeness rating" of Low, Moderate or High, depending upon how it appeared to be viewed by the company members. Some of the manufacturing innovations were purchased complete and installed, some purchased and modified, some developed in-house, and in two cases Company X 'underwrote' a development undertaken by the supplying company. These different avenues in the adoption of manufacturing innovation having been identified:

> "Those firms which decided to innovate through the use of new machinery followed one of two possible paths: either the entire process remained internal, or equipment was bought in and possibly modified. In the former case, any solution depended upon the existence of strong in-house R&D facilities and was, therefore, generally confined to the larger firms in our sample."
>
> (Braun, Moseley and Wilkinson, 1981)

A description of the manufacturing innovations studied within Survey I, the needs they were to satisfy and the innovativeness rating can be found in Appendix 1.

To provide a measure of perceptions of innovation a methodology was developed which allowed for high variability. It was felt that if the respondents were restricted in 'putting their signature' on the data, this would limit the usefulness of the study; moreover in using a high variability method experimental error would tend to make it more difficult to prove a case, thus increasing the validity of any findings. A number of approaches to eliciting perceptions were examined and rejected, for example the Repertory Grid Test (Kelly, 1955), which looked promising, was piloted and found wanting. The Repertory Grid Test, although it has been found successful in personality assessment and other such uses, requires a level of expertise on the part of the respondent, that was lacking in those assisting with the pilot study. In its 'normal' usage, the Repertory Grid Test examines a person's evaluation of other people, where expertise is obviously high. It was, therefore, considered too risky to use for the main study. More usual characteristics methods, commonly applied to perceptions of innovation, were thought of questionable value, although they were found satisfactory by Kivlin and Fliegel (1967):

> "The present study attempts to build upon our previous work in which it was shown that perceptions of attributes of innovations could be measured, and that the perceived attributes were related to rate of adoption in a meaningful way."

The limited success of characteristic techniques in explaining observed variation in adoption behaviour (Rogers and Shoemaker, 1971) suggested that such a technique should not be used alone. The method developed for this research presented the respondent with a list of characteristics from which he selected those he would use to evaluate technological innovation, which were subsequently rank-ordered as to importance and finally used in a polar form to provide characteristic ratings of the manufacturing innovations with which he had been involved; these being known as "Characteristc Choice", "Characteristic Importance" and "Characteristic Ratings" respectively.

To supplement the data gathered in Survey I, a second survey was embarked upon - Survey II. This used a questionnaire developed from the "Characteristic Choice" method used in Survey I, combined with questions asking for job title, age, educational background and so on; these having also been obtained in Survey I. This information was used to group individuals in terms of the "Classifying Variables" - Occupational Role, Management Level, etc which were utilised in the analysis of the survey data. To assist this use of the Classifying Variables, a chapter in this section has been devoted to providing operational hypotheses relating to their impact upon differential perception of innovation and, in the case of the Occupational Role variable, to generating predictions as to the characteristics that might be 'valued' by the respective occupational groups (eg engineers, accountants).

The third part of the data collection examined the development of a Computer Aided Design system by a large manufacturing company, for its own use. As the company had no previous experience of CAD, this was highly a innovative venture for them, although it must be considered an "incremental innovation" (Bessant, 1982) as the actual nature of the drafting process remains essentially the same. The nature of the area suggested that a case study would be an appropiate vehicle and information was gathered by means of interview and reference to documentary evidence. It became clear in the course of the interviews that effects attributable to differential perception of innovation were in evidence, albeit within the context of a political process. The development involved, amongst others, members of the Computer Services Department and engineers in the area where the system was to be used - Body Design - and produced a number of disputes, indeed at one stage nothing else. Hence, the political nature of the process:

> "The divisions of work in an organization creates sub-units. These sub-units develop interests based on specialized functions and responsibilities. Although such sub-units have specialized tasks, they may also be interdependent. This interdependence may be played out within a joint decision-making process. Within such decision-making processes, interest-based demands are made. Given heterogeneity in the demand-generating process and the absence of a clearly set system of priorities between these demands, conflict is likely to ensue. Sub-units with differential interests make claims on scarce organizational resources. The extent of the claims is likely to be a reflection of the unit's perceptions of how critical the resources up for negotiation are to its survival and development. The success any claimant has in furthering his interests will be a consequence of his ability to generate support for his demand.
>
> It is the involvement of sub-units in such demand- and support-generating processes within the decision-making processes of the organization that constitutes the political dimension."
>
> (Pettigrew, 1973)

Much of the political activity at Automotive Systems was directed at controlling the nature of the development in terms of the facilities it offered and how they were achieved, demonstrating differential perceptions of this manufacturing innovation. The effects of particular occupational specialities upon perception of innovation were investigated further in the subsequent two chapters, using data from Survey I. The first of these, termed "Basic Measures" grouped individuals in terms of their Occupational Roles and calculated percentage frequencies for Characteristic Choice and mean importance values for the Characteristic Importance data. This approach, while demonstrating differential perceptions of innovation, did not do so in a way which was amenable to simplistic analysis and, consequently the second of these chapters details further investigation. The strategy for this analysis differed from that of the "Basic Measures", in as much as, rather than individuals being grouped according to a Classifying Variable and similarities and differences in perceptions attributable to the groupings being sought, they were grouped into clusters in terms of their perceptions of innovation as suggested by Lin and Zaltman (1973). Perceptually similar individuals were then examined for similarities, in terms of the Classifying Variables which could explain their common perceptions. It was found that thirteen classes of explanation were necessary to cover the range of causes of perceptual similarity encountered, some being multidimensional and some only interpretable in phenomenological terms. It was clear, however, that perceptual similarity cannot be directly related to a small number of causal variables and that the roles individuals occupy within organisations are not rigid and deterministic.

The original purpose of the differential perception of innovation concept, to explain the inability of earlier approaches to the study of diffusion of innovation, is explored in relation to the findings of the study. The suggestion that a population of potential adopters is constructed of distinct sub-groups, each with their own perceptual outlook, is refuted. Instead a more complex pattern is proposed in which localised factors combine to produce the perception of innovation displayed and in which the realities of organisational life significantly confound the analysis of differential perception of innovation. One major conclusion from this study must be that it was the phenomenological field of the individual which determined his perceptions of innovation. The effects of the dynamics, represented by the Classifying Variables, were to influence the phenomenological field and in this sense their action upon perceptions of innovation was indirect.

To define an individual's phenomenological field is undoubtedly very difficult; to compare the fields of a number of individuals, in order to establish trends, is more difficult still. Consequently the methodology and analysis of the research have, of necessity, to make incremental progress towards an understanding of the nature of differential perception of innovation in the organisational context. Moreover, in reality this has followed an iterative procedure, rather than the linear progression which this document may suggest. However, such movement, the use of approximations and so on, must be considered inevitable:

> "We have often heard it maintained that sciences should be built up on clear and sharply defined basic concepts. In actual fact no science, not even the most exact, begins with such definitions. The true beginning of scientific activity consists rather in describing phenomena and then in proceeding to group, classify and correlate them.... ......It is only after more thorough investigation of the field of observation that we are able to formulate its basic scientific concepts with increased precision, and progressively so to modify them that they become serviceable and consistent over a wide area."
>
> (Freud, 1957, p 117)

CHAPTER NINE

METHODOLOGY AND SAMPLES

The aims of the study - to identify Differential Perception of Innovation and to clarify the nature of the process - suggested the desirability of multiple methods (Pettigrew, 1973). To this end two surveys and a case study were performed. The first[1], Survey I, combined a characteristic checklist,[2] characteristic importance rankings[3] and characteristic ratings utilising a Semantic Differential.[4] To augment the data produced by Survey I, a questionnaire technique, based on the checklist[5], was constructed and used in Survey II. The Case Study used non-directed interview and documentary evidence to develop a picture of the operation of differential perception within an innovative development process. Thus it was possible to identify the presence of differential perception of innovation effects, explore their nature and investigate the consequences of their operation.

Previous methodologies used for the analysis of the perceptions of innovations were rejected as the major source of data, having been identified by Rogers and Shoemaker (1971) as accounting, on average, for only 44.12 per cent of the variance observed. To allow for the range of variation possible in perceptions of innovations, a methodology which allowed

1. Within this chapter the chronological order of the performance of the work has been used to organise the material presented.

2. Check list techniques have been used in a variety of areas, see for example: Belson and Duncan, 1962; Campbell and Mohr, 1950; Lindzeg and Guest, 1951; Nowlis, 1965 and Thayer, 1967.

3. Collins, 1961; Ostlund, 1974.

4. Osgood, 1952.

5. See Bessant, 1982 who performed a similar development.

high variability to be expressed was thought desirable as a primary research tool. However, it was decided to base the methods upon the use of characteristics of innovation as is common practice within the field.

Selection of Characteristics

The methodology of Survey I and consequently that of Survey II required the creation of a list of innovation characteristics[6], suitable for the study of manufacturing innovation. This was achieved by researching the relevant literature (e.g. Fliegel and Kivlin, 1966; Rothwell, 1977) and extracting the innovation attributes that had been used. Using these as an example, industrialists (mainly within the companies collaborating in the study) were consulted as to what they thought the most salient characteristics of technological innovation. The combination of the characteristics derived from both these sources produced a list of the total attributes that could be found. Examination of this list indicated that some characteristics were duplicated and so these were removed, others which had some similarity to others or which appeared unimportant were dealt with in the same way. The remainder, twenty-nine characteristics in all, were presented again to industrialists and their comments elicited. Limited piloting as to the intelligibility of the characteristics was also conducted. These checks having been completed successfully, the list was accepted and can be seen in Table 2.

An 'organic' approach was taken to the use of the methodology and it was decided that the early stages of the Survey I data collection could be seen as either the pilot study or the beginning of the main survey. If difficulties had been encountered, which would have necessitated major alterations to the method, then the survey would have been restarted following these changes. Minor alterations on the other hand were seen

6. These were also used in a limited way as guidelines in the analysis of the case study material.

Table 2 - The Innovation Characteristics

1. Initial Cost
2. Running Cost
3. Rate of Return
4. Raw Materials Costs
5. Re-sale Value
6. Relative Advantage
7. Time Saving
8. Reliability
9. Ease of Maintenance
10. Energy Requirements
11. Space Requirements
12. Effects on Quality
13. Variations in End Product
14. Ease in Operation
15. Need for Retraining
16. Operator Comfort
17. Effects on Labour Requirement
18. Effects on Noise
19. Complexity
20. Compatability with Existing Equipment
21. Trial on a Small Scale?
22. Observability of Results
23. Perceived Risk of Adoption
24. Possibility of Modification
25. Supplier's Reputation
26. After-sales Service
27. Unit Costs
28. Availability of Technical Advice
29. Sophistication of Machine
30. Effects on Safety

as part of a development process which would not seriously jeopardise the eventual outcome. For example, respondents were given the option of adding to the characteristic list if there was something they thought important which was not present. It was decided that any characteristic which was mentioned a number of times would be included in subsequent presentations. This happened for Characteristic 30: Effects on Safety, which appeared several times in the early interviews. It was incorporated in the list and used in all subsequent interviews.

The purpose of the characteristic list was to provide a wide range of dimensions from which the respondents could choose those most relevant to themselves. To this end characteristics applying to financial, engineering and other aspects were included. In some cases (particularly the financial) there was some overlap between characteristics, though none were exactly the same. It was felt that it would allow respondents who were sophisticated in a particular area to demonstrate this by the fine level discriminations they could make. For example, an accountant could be expected to make a greater distinction between the financial characteristics than, say, an engineer. Unit cost, for example, takes into account such factors as Initial Cost, Running Cost, Energy Costs, etc, but is not equivalent to any one of them. While the latter elements contribute to the former, the Unit Cost may be low even though one or more of them is high, their contribution being offset by another factor. Consequently it was expected that certain individuals would be more likely to select certain characteristics than others.7

Survey I

Data were collected using a face to face card presentation method. In operation the technique consisted of three parts: Characteristic Choice, Characteristic Importance and Characteristic Ratings. Before proceeding with the application respondents were told, in general terms, the purpose of the research. Obviously this could not be in too great a detail as it might have influenced them.

Characteristic Choice

The respondent was presented with a deck of 30 cards, each having a characteristic name and an identification number. Between them these cards made up the characteristic list (see Table 2). Examples being as

7. This viewpoint was confirmed by experience during the data collection, some respondents did ignore certain financial characteristics on the grounds that they were the same as others and said so.

follows:

(4) Savings in Raw Materials

(15) Need for Operator Re-training

For each presentation the cards were placed in random order - a different one for each respondent. The respondent was told - "Here is a list of characteristics which may be important when judging technological innovation. I would like you to go through the cards and pick those which are important to you[8] when judging an innovation."[9] As a further clarification the respondent was told that the eventual aim was to produce two piles - one for those he believed to be important and the other for those he thought unimportant. It was also made clear that one pile was acceptable, if he was of the opinion that all, or none, of the characteristics

8. If the respondent asks or seems unclear about this, it is further reinforced.

9. At this stage any technological innovation, i.e. a general case.

were important. The respondent was also told that any characteristic which was believed to be important, but which was not in the deck would be written up and included in the list - the interviewer carrying spare blank cards with him at all times.

At this point, and later while the respondent was doing the sorting, a certain amount of dialogue often took place. Some respondents were concerned about the decision rule they should use to select the 'important' characteristics. Although they were told that they could choose all or none of the characteristics, if they so wished, usually the idea was to pick out only some of them. Problems could also occur as to definitions of the characteristics. In either case the interviewer discussed the difficulty with the respondent until it was clear that understanding had been reached. Again, caution was observed in this, to reduce any possible interviewer bias influencing the respondent.

During the sorting procedure, respondents often vocalised their reasoning in separating the characteristics, or explained the method they were using - if, as was often the case, they initially used more than two piles. A few respondents asked the interviewer in which pile should they place a particular characteristic (usually near the end of the procedure). The interviewer initially evaded the question, saying something like: "It's up to you" or "it's your view we need". If the respondent could not decide alone the interviewer and respondent talked about the problem until the respondent finally made up his mind. At no time did the interviewer make a decision himself. When the respondent had completed this task, the 'reject' pile was taken to the interviewer's side of the table and the respondent asked to retain the other pile. The process then moved on to the next stage.

<u>Characteristic Rankings</u>

The respondent was now asked to rank-order those characteristics he had chosen as to importance. This request often brought a reaction from the respondents, particularly those who had chosen a large number of characteristics. The interviewer apologised to the respondent for this laborious task and all respondents performed it without real complaint - some even said they were expecting it.[10] Respondents were told that they could organise the characteristics as they wished, ties being allowed. Some indicated that they were utilising a complex structure and note was taken of it.

While the respondent performed the ranking the interviewer marked the response sheets (see Appendix 2) by putting a line through those boxes relating to the rejected characteristics. There were two response sheets, one for the Characteristic Choice/Rankings and the other for the Characteristic Ratings; both were treated at this time. When this had been completed, the second deck of cards, used for the Characteristic Ratings (see next section for examples) was prepared; all rejected characteristics being removed.

If, as was often the case, the respondent had not completed the ranking by this time, the interviewer waited, as inconspicuously as possible, perhaps pretending to be doing something. However, all the time the respondent was performing the tasks, he monitored their progress to be ready to assist if required. When the respondent had finished and was satisfied with his rankings, the interviewer took the cards and checked that the most important was on the top (some organised them from the bottom up). The deck may not have been uniform, some cards being offset to indicate ties. The rank ordering was entered into the response sheet and the procedure

10. Respondents were not told about this task until they were required to perform it, in case it influenced the number chosen in the first stage.

moved on.

Characteristic Ratings

The final part of the presentation consisted of the respondent going through the second deck. For this procedure the characteristics were presented in a polar form, with a seven point scale in between:

7) Saves Time 1, 2, 3, (4), 5, 6, 7 Takes Longer

The cards were numbered back and front for identification, and as an extra aid the interviewer had the characteristic names available on his response sheet. The full list of this form of the characteristics can be found in Table 3.

At this point the interviewer checked with the respondent that he had been involved with the adoption of those innovations he was thought to have (as part of the sample location, individuals associated with particular innovations had been identified - see later section on sampling). The names of the innovations were then entered on the response sheet.11 The respondent was shown the deck and told "Here is another deck of cards, containing the characteristics you have chosen. However, this time they are in polar form, with a rating scale in between". The individual was now shown one or two cards to illustrate

The interviewer went on to explain that the respondent was now required to work through the deck rating the innovation on each characteristic. To explain further, the respondent was shown one of the cards (often Initial Cost as it was No 1) and told: "If you think the innovation

11. This had to be left until after the check as some respondents felt unable to comment on particular innovations. Although they had been involved in the purchase decision their knowledge of it was not extensive - this generally applied to higher management who had just backed their subordinate's judgement about a particular innovation. (See Harding, 1966).

(often the name of one of those he was to rate was given) had a high initial cost, then you would put it at this end" (Interviewer points to the high end). "If you thought it had a low initial cost, then this end. If it was medium, then you would say 4" - the centre point of the scale and delimited by brackets. The respondent sometimes asked "High (or Low) in relation to what?". The interviewer explained that the primary relationship was to that which it replaced. However, where this might have been misleading,12 he was given the secondary yardstick of 'for a machine of the type'. Even if the respondent does not ask, this point was made clear, as was the fact that we wished his opinions at the time of purchase to be given, rather than those he held now.13

Table 3 - Polar Form of the Characteristics

1)	Low Initial Cost	High Initial Cost
2)	Low Running Costs	High Running Costs
3)	Fast Rate of Return	Slow Rate of Return
4)	Uses Less Raw Materials	Uses More Raw Materials
5)	High Resale Value	Low Resale Value
6)	Relative Advantage	No Relative Advantage
7)	Saves Time	Takes Longer
8)	More Reliable	Less Reliable
9)	Easy to Maintain	Difficult to Maintain
10)	Low Energy Requirements	High Energy Requirements
11)	Needs Little Space	Needs Much Space
12)	Improves Product Quality	Reduces Product Quality
13)	Variations in End Product	Only One End Product

12. This can occur if the innovation was greatly advanced in relation to that which it replaces, e.g. an n c v's manual lathe, where the new machine was expensive, but had labour savings to offset this.

13. While there were obvious difficulties with this, in common with all recall approaches, it was the adoption decision we wished to examine.

14)	Easy in Operation	Difficult in Operation
15)	No Operator Retraining Necessary	Operator Retraining Necessary
16)	Improves Operator Comfort	Reduces Operator Comfort
17)	Reduces Labour Requirements	Increases Labour Requirements
18)	Reduces Noise	Increases Noise
19)	Easy to Understand Machine	Difficult to Understand Machine
20)	Compatible with Existing Plant	Incompatible with Existing Plant
21)	Can be Tried on a Small Scale	Full Scale Use Only
22)	Results Easily Observed	Results not Easily Observed
23)	Low Risk Involved in Adoption	High Risk Involved in Adoption
24)	Possible to Modify the Operation	Impossible to Modify the Operation
25)	Supplier has Good Reputation	Supplier has Poor Reputation
26)	Good After-Sales Service	Poor After-Sales Service
27)	Low Unit Costs	High Unit Costs
25)	Supplier has Good Reputation	Supplier has Poor Reputation
26)	Good After-Sales Service	Poor After-Sales Service
27)	Low Unit Costs	High Unit Costs
28)	Technical Advice Available	Technical Advice Unavailable
29)	Technically Sophisticated	Technically Unsophisticated
30)	Greatly Improves Safety	Slightly Reduces Safety

The respondent was asked to work through the ratings for a particular innovation (the name of the first was given), the others being rated successively (if there were any). Respondents were not always totally clear about this, but were quickly put on the right track. They were also asked to place the cards face down, so that they were in correct order for next use. In operation the respondent picked up the first card, evaluated it and called out the appropriate number. The interviewer entered the response[14] and the respondent put that card down and picked up the next. This was performed for all characteristics and if the individual had been involved with more than one innovation, the process was repeated for these. The number of innovations rated in this way, for each respondent, varied from one to six. The procedure went very smoothly, excepting a little hesitation at the beginning, although some respondents gave more than one value (say - "It's 2 - 3" etc). When this happened the interviewer asked for clarification. This completed the main part of the data collection.

Completion

The remaining interview time was taken up with a self-completion questionnaire (see Appendix 2) which asked for details such as age, present and past job titles and qualifications, if any. This was presented as a voluntary contribution, as to the whole questionnaire or parts of it. Most respondents, however, did complete it. Depending upon how busy the respondent was, this could either be completed on the spot, or later and posted on. If time was not pressing a discussion of the innovations, company purchasing policy, etc would often ensue. Notes were taken of comments made at this time or earlier in the procedure, if they appeared to have relevance to the analysis of the adoption process.

The Individual Data Base

At the end of each interview the following information was available:

1. Which characteristics the individual felt were important.
2. The relative importance of the chosen characteristics.

14. The interviewer monitored these and if the respondent said, for example, "It's high" and gave a value at the low end, challenged him until a true picture emerged.

3. Characteristic ratings applied to one or more innovations.

4. Information about the respondent's background.15

Each response sheet was given a code number, which could be used both to identify the individual and the company he worked for. At some point following the interview (usually the same day) this information was added to sheets applying to the relevant data bases, which were as follows:

1. Overall data base of Characteristic Choice/Rankings.16

2. The company's data base of Characteristic Choice/Rankings.

3. The data bases applying to each innovation.

The Sample

The sample was constituted of 47 managers, accountants and so on, from two large manufacturing companies who had agreed to cooperate with the research project; they were termed Company X and Company Y. Discussions were entered into with individuals in the companies to select manufacturing innovations, adopted by the company in recent years; in all seven innovations were suggested by Company X and six by Company Y. Involvement in the adoption of one or more of these innovations was used as the criterion for the selection of respondents, thus ensuring that the information obtained related to actual practices within the organisations. Forty-seven respondents contributed to the study - 17 from Company X and 30 from Company Y.

The overall sample size relates only to the Characteristic Choice/Ranking data, that applying to the Characteristic Ratings being as

15. Provided the respondent did not refuse this information.

16. The same sheet contains both - for obvious reasons.

follows:

Company 'X' Innovations[17]

Form Flo	- 6
Hot Ball Rolling	- 5
Fluid Fire	- 6
Autowrap	- 7
Ball Dispenser	- 6
Ball and Half Cage Unit	- 4
Ring Storage Device	- 6

Company 'Y' Innovations

Max-E-Trace	- 6
Hardinge HNC Lathe	- 15
Wadkin SCD 50T	- 6
Marden Wire Wrapper	- 11
Computer Aided Design	- 13
Transdata Terminal	- 8

The respondents were also grouped in terms of the Classifying Variables (see next chapter for a description), sample sizes being as follows:

a) Occupational Role

1. Organisational	- 7
2. Production Engineering	- 5
3. Production	- 11
4. Engineering	- 11
5. Finance	- 5
6. Computing	- 8

17. For a description of these innovations, see Appendix 1 .

b) Management Level

1.	Top Management	-	7
2.	Upper Middle Management	-	16
3.	Middle Management	-	7
4.	Lower Middle Management	-	6
5.	Supervisory	-	9
6.	Operative	-	2

c) Age Range

1.	21 - 30	-	3	
2.	31 - 40	-	10	
3.	41 - 50	-	11	M V = 12
4.	51 - 60	-	9	
5.	61 +	-	2	

d) Educational Level

1.	None	-	4	
2.	City and Guilds	-	5	
3.	HNC	-	14	M V = 16
4.	First Degree	-	7	
5.	Higher Degree	-	1	

e) Size

Both companies were of the same size within the range 2,501-5000 employees (size 6), constituting one group of 47 individuals.

Survey II

To support the data generated by Survey I, which while having depth, lacked number, a second survey was embarked upon. It was decided that rather than using the time-consuming face-to-face method, a questionnaire be devised which could be applied in group testing situation or by mail. Examination of the Survey I methodology indicated that the Characteristic Choice would be the most suitable for this application. The Characteristics Importance approach was rejected as it is a cumbersome, time-consuming procedure, which is extremely difficult to perform with just paper and pencil. The card-sort method of Survey I made this technique viable as the respondent could physically manipulate the cards, arrange them on the table and modify judgement as he went along. Such practice is obviously not possible with a paper and pencil test. Characteristic Ratings, although considered, would have meant the identification of an potential adoption population, preferably one of which Company X or Company Y were members.

Having decided that Characteristic Choice was the best method it was necessary to translate it into questionnaire form. In essence each characteristic name was printed with a pair of brackets to indicate where a tick should go. Alongside the brackets was a computer code number so that the information could be punched directly from the questionnaire. The information which had been requested by the self-rating questionnaire was also incorporated into the Survey II questionnaire. The questionnaire also contained brief instructions as to how it should be completed (see Appendix 2).

The testing was performed on a group basis, twenty or so respondents at a time. All respondents were industrial or commercial practitioners who were engaged in part-time management education, particularly the

Diploma in Management Studies. Thus a sample was gained for Survey II which was comparable to that obtained in Survey I. The respondents were told very little prior to completing the questionnaire, other than it was part of a study concerning technological innovation. They were also told to fill in the questionnaire reasonably quickly, rather than agonising for long periods over each characteristic. On average the respondents took around ten minutes to complete the questionnaire. When all members of the group had completed the questionnaire a de-briefing was given, explaining the aims of the study.

Each questionnaire was given a number for identification, and the job title, information on qualifications and company size were coded into appropriate numerical values representing Occupational Role, Management Level and so on.

The Sample

The sample was constituted of 124 managers, accountants etc who were engaged in part-time management education. One modification made necessary for Survey II was an extension of the Occupational Role variable to include a new category - Administrative. As there was high variability of company size in this sample, this variable became much more important. Like Survey I, this sample identified the respondents in terms of the Classifying Variables: Occupational Role, Management Level, Age Range, Educational Level and Company Size. The sample breakdowns being as follows:

a) Occupational Role

1. Organisational - 12
2. Production Engineering - 19
3. Production - 31

4. Engineering - 35
5. Finance - 2
6. Computing - 5
7. Administrative - 20

b) Management Level

1. Top Management - 2
2. Upper Middle Management - 14
3. Middle Management - 25
4. Lower Middle Management - 56
5. Supervisory - 25
6. Operative - 2

c) Age Range

1. 21 - 30 - 49
2. 31 - 40 - 56
3. 41 - 50 - 14 M V = 1
4. 51 - 60 - 4
5. 61+ - 0

d) Educational Level

1. None - 13
2. City and Guilds - 31
3. HNC - 41
4. First Degree - 29
5. Higher Degree - 10

e) Size

1.	20 or less	- 4	
2.	21 - 100	- 15	
3.	101 - 500	- 33	
4.	501 - 1000	- 11	M V = 5
5.	1001 - 2500	- 24	
6.	2501 - 5000	- 27	
7.	5001 or more	- 5	

The Case Study

Information for the case study was principally gained by tape recorded, non-directed interviews. The respondents were told what the study was about - the development of a Computer Aided Design system by the company - and asked to tell the researcher about the innovation. They were also asked if they objected to being tape recorded, which none did. The respondent was encouraged to talk, with the interviewer remaining neutral as to what was said, simply making encouraging nods or statements like "I see", to ensure against bias. The only interventions made by the interviewer were requests for further information or to encourage the respondent to say more. In all, six interviews were conducted.

The tape recordings were transcribed and surveyed for significant information. Further data was gained from documentary sources and two informal discussions with other company members. One telephone interview was also conducted, the interviewee being a computer consultant employed by the company to assist with their CAD development. From these sources a quantity of information was generated which allowed a picture of the development to be constructed, the product of which was the case study.

Conclusion

The case study and the two surveys form the total of data generated for the study. Although in the case of Survey I the collaboration with the two companies also gave some idea of the activities of the companies through informal contacts with company personnel during interviewing sessions and other visits. The combination and contrasts of the findings of the three approaches are believed to provide a worthwhile analysis of differential perception of innovation.

CHAPTER TEN

THE DIFFERENTIAL PERCEPTION HYPOTHESIS: OPERATIONAL DEFINITIONS

In Part 2, the concept of Differential Perception of Innovation was analysed to try to clarify the parameters of the term. To apply it to a specific research problem, the general hypothesis needed to be operationalised. Examination of perception of innovation in an organisational context indicated that there were a number of factors which would appear important. Some of these were considered appropriate for this study and applied in the survey work that was performed. The present chapter seeks to provide variable specific hypotheses and indicate expectations of likely perceptions of innovation. In practice five variables were taken as measures of cognitive influences upon perception of innovation:

1. Occupational Role
2. Management Level
3. Educational Level
4. Age
5. Organisational Structure/Size

Occupational Role refers to the person's professional speciality (e.g. engineer, accountant); Management Level refers to his hierarchical position within an organisation; Educational Level, in terms of qualifications possessed, and Age are self-explanatory. The definition of Organisational Structure varied, depending upon where it was applied in the study. For Survey I and the Case Study, it was primarily concerned with departmental relationships within an organisation; for Survey II it was defined in terms of organisational size.

The experimental hypotheses will now be outlined, along with the associated measures. The Null Hypothesis will be ignored here to avoid repitition, as it follows the same form as that of the general Differential Perception Hypothesis. As in Chapter 7 we will finish with the Multidimensional Hypothesis.

The Occupational Role Hypothesis

H_1 : Individuals with similar Occupational Roles are more likely to perceive technological innovation in the same way, than individuals with different Occupational Roles.

Perception of innovation should allow the discrimination of individuals on the basis of their occupational roles. In cases where perceptions are found to be similar but the roles different, it would be expected that these roles would be functionally similar. For example, it would be expected that Engineers and Production Engineers would be more cognitively similar than Engineers and Accountants.

The Management Level Hypothesis

H_1 : Individuals of the same or similar Management Level are more likely to perceive technological innovation in the same way than individuals with different or greatly different Management Levels.

Management Level refers to the individual's position within a hierarchical organisation structure. Definition of this variable proves somewhat problematic, though in practice an individual's level can be readily perceived.[1] Factors involved include salary, status, capital

1. As a check, a regression analysis was performed on the Survey I sample, which tested the "goodness-of-fit" when each individual's management level value was altered. In the majority of cases the level attributed to the individual was confirmed; for some respondents the management level value was altered, provided the change appeared sensible.

and staff under his control, though not all of these will necessarily be involved in a particular case. For example in Petrochemicals, managers commonly have few employees to control, but a large amount of capital in terms of plant - this being a capital-intensive industry. Thus we cannot define level in terms of a small number of ever-present variables, though we can recognise a linear relationship, both in terms of status and in terms of task, which runs through an organisation. This can probably be summed up as 'responsibility', the higher an individual's Management Level, the greater the consequences of his decisions.

Management Level, therefore, is an ordinal variable, in which each movement up or down the hierarchy is an increment or decrement of 'responsibility'. As there was a linear relationship between the levels, some leeway was acceptable with the Management Level variable, provided that the levels, though different, were not far apart.

The Educational Level Hypothesis

H_1 : Individuals of the same or similar Educational Level are more likely to perceive technological innovation in the same way, than individuals with different or greatly different Educational Levels.

The basis of this variable and the gradation of Educational Level is defined by the structure laid down within the educational system. Certain qualifications are accepted as being of greater status, of a higher level, than are others. The variable used in this study is based upon these distinctions and is of an ordinal nature.

The Age Hypothesis

H_1 : Individuals of similar Age are more likely to perceive technological innovation in the same way, than individuals of different Age.

Age is an interval scale variable which enables direct comparison to be made. Similarity of age can be assessed directly by statistical technique, however it should be noted that for some analyses age was classified in terms of age-range, offering ordinal scaling only.

The Organisational Hypothesis

H_1 : The closer individuals are in organisational terms, the greater the likelihood of similarity of perception of technological innovation; whether this be within an organisation or between them.

For the purpose of this study 'organisational similarity' can be considered a measure of 'company climate' or 'departmental culture'. For Survey I the root level of distinction between individuals is taken at the company boundary, thus belonging to one or other of the companies gives a clear distinction. It is also possible to move within the company to departmental level or beyond companies to industrial sector. For Survey I the intra-company culture is believed important; individuals who belong to the same department or who are involved in a team which advocates the adoption of a particular innovation, may well prove tests of this hypothesis. Caution will be necessary, however, to avoid confusion with Occupational Role, where membership of a department is dependent upon a particular professional speciality.

For Survey II, organisational similarity has been taken in terms of organisational size. It would appear likely that size of organisation will have an influence upon an individual's perceptions of innovations. Certainly it has been found a useful variable, both within innovation studies (e.g. Brown, 1957; Caplow, 1964 and Mansfield, 1963) and outside (e.g. Tannenbaum et al, 1974).

Operationalising the Hypotheses

The Classifying Variables were characteristics of the respondents which were expected to provide predictors of perceptions of innovation and as such were central to the hypotheses used. It was therefore, necessary to define each variable and attempt to predict how differences in perceptions might be demonstrated. In practice such a priori expectations were limited, though the nature of each variable could obviously be explored.

(1) Occupational Role

This variable was constituted of seven groupings:

Role 1 - Organisational
Role 2 - Production Engineering
Role 3 - Production
Role 4 - Engineering
Role 5 - Finance
Role 6 - Computing
Role 7 - Administrative (only for Survey II)

These roles were developed by reference to the range of job titles found within the surveys. For Survey I, Role 1 proved to be synonymous with Management Level 1 and forms the top management group. Role 7 was only encountered in Survey II and as such is only used in application to this data. The parameters of the Occupational Roles would suggest that perceptions consistent with the role could be expected. In practical terms this would be demonstrated in the choice or consideration as important, of characteristics which were suggested by the needs of the role. The characteristics which were expected to be associated with particular roles, in this way, were as follows:

ROLE 1 - ORGANISATIONAL

This role refers to a general management function and was commonly ascribed to higher management, those who had something like the final control of events. The generality of the function of those who perform in this role makes it difficult to give predictions of characteristics likely to be selected. It would be expected, however, that these would choose a large number of characteristics; reflecting the generality of viewpoint and the predominance of Management Level 1 individuals.

ROLE 2 - PRODUCTION ENGINEERING

This group should be orientated towards practical production and engineering concepts. This would be reflected in the choice and importance of the following characteristics:

6) Relative Advantage
7) Time Saving
8) Reliability
9) Ease of Maintenance
10) Energy Requirements
14) Ease in Operation
20) Compatibility with Existing Equipment

ROLE 3 - PRODUCTION

This group would be expected to be concerned with practical, operational concepts, though possibly also some which are more properly engineering ones. This would be reflected in the choice and importance of the following characteristics:

6) Relative Advantage
7) Time Saving
8) Reliability
9) Ease of Maintenance
10) Energy Requirements
11) Space Requirements

12) Effects on Quality
13) Variations in End Product
14) Ease in Operation
15) Need for Retraining
16) Operator Comfort
17) Effects on Labour Requirements
18) Effects on Noise
20) Compatibility with Existing Equipment
21) Trial on a Small Scale
25) Supplier's Reputation
26) After-sales Service
28) Availability of Technical Advice

ROLE 4 - ENGINEERING

This group would be expected to be orientated to the technical aspects of innovation. This would be reflected in the choice and importance of the following characteristics:

6) Relative Advantage
7) Time Saving
9) Ease of Maintenance
10) Energy Requirements
17) Effects on Labour Requirements
19) Complexity
20) Compatibility with Existing Equipment
24) Possibility of Modification
29) Sophistication of Machine

ROLE 5 - FINANCE

This group should be orientated towards financial concepts. This would be reflected in the choice and importance of the following characteristics:

1) Initial Cost
2) Running Cost
3) Rate of Return
4) Raw Material Costs
5) Re-sale Value
10) Energy Requirements
27) Unit Costs

ROLE 6 - COMPUTING

This grouping is somewhat complex as it is a relatively new area and as such a professional identity is still in the process of being developed. Consequently it is more difficult to predict likely orientation, than for more established groups. However the following characteristics are more likely to be chosen and found important by this group:

1) Initial Cost
5) Re-sale Value
7) Time Saving
8) Reliability
11) Space Requirements
14) Ease in Operation
19) Complexity
20) Compatibility with Existing Equipment
23) Perceived Risk of Adoption
25) Supplier's Reputation
26) After-sales Service
28) Availability of Technical Advice
29) Sophistication of Machine

ROLE 7 - ADMINISTRATIVE

Like Role 1, this group is likely to be generalist in orientation. This description was not originally applied in the study, Survey I being conducted in a production orientated environment. When it was decided that a wider sample, gathered using a questionnaire technique, would be desirable, a number of individuals were encountered who could not be fitted into the original classification system. It was apparent that there was commonality between these individuals, such that they performed administrative work in both the public and private sectors. Such a task has a specific, support orientation, but lacks concrete determinants of perception of technological innovation.

Obviously we can identify similarities in the different roles. We would expect a gradation from Engineer, through Production Engineer, to Production personnel. Consequently there might be an overlap between these groups, in terms of perception of innovation. It would also seem likely that the similarity of perception would reflect this gradation. On the other hand a clear discrimination should be possible between Finance persons and Engineers, the former possibly having some commonality with the Organisational role, who may have to concentrate upon financial considerations. Computing personnel and Engineers could well be similar, particularly as many of the former were previously involved with electronic engineering.

(2) Management Level

This variable was constituted of six groupings:

Level 1 - Top Management
Level 2 - Upper Middle Management
Level 3 - Middle Management
Level 4 - Lower Middle Management
Level 5 - Supervisory
Level 6 - Operative

To further clarify the definitions, examples of job titles associated with each Management Level will now be given:

Level 1 - Director, Technical Director, Area Manager

Level 2 - Works Manager, Works Accountant, Production Manager

Level 3 - Chief of Production Engineering Services, Chief Development Engineer

Level 4 - Drawing Office Manager, Controller Capital Investment

Level 5 - Section Leader, Production Engineer

Level 6 - Computer Aided Design Operative, Toolmaker

We would obviously expect individuals of the same or similar management levels to have comparable perceptions of innovation. This would be demonstrated in terms of the number and type of characteristics chosen and the importance assigned to them. It is not possible to predict which characteristic might be associated with a particular level, though it might be expected that higher level individuals might select more innovation characteristics, as a reflection of a more detailed, wider reaching analysis of the adoption decision. The development of management appears to move from a specific discipline base, such as that of the engineer, to the wider skills of the manager.

(3) Age

Age has been used as a simple numeric variable, except where Age Range was found more convenient. Although it would seem likely that individuals of similar age would have comparable perceptions of innovation, it is difficult to predict in what way it would operate for Characteristic Choice and Characteristic Importance.

(4) Educational Level

This classifying variable was graded according to the qualifications (if any) possessed. The ordering of the qualifications is in line with normal educational practice:

Level 1 - None

Level 2 - City and Guilds or similar

Level 3 - HNC or similar

Level 4 - First Degree

Level 5 - Higher Degree

Where a respondent had a number of qualifications, the level was set at that of the highest qualification possessed. Prediction of the use of characteristics is difficult, though it could be expected that more characteristics would be chosen by more sophisticated individuals, which may be influenced by education.

(5a) Organisational Structure : Survey I

Within the sample, relationships between the perceptions of innovations can be explored in terms of organisational structure. The primary distinction of this variable is between the two companies contributing to the study, generating differences in company climate. Within each company departmental relationships can be identified, which may generate "subcultures" and influence the "social construction of reality" (Berger and Luckman, 1966). Three organisation charts have been provided (Appendix 3, Figs 1-3), two for Company Y and one for Company X. It was decided to concentrate only upon relationships between respondents, rather than the complete, though necessarily larger, organisation charts. The presence of individuals in the sample resulted from their involvement in the adoption of certain innovations suggested by the companies. Obviously not all individuals in the companies were involved in the adoption of these innovations and there are, therefore, gaps in the organisation charts.

Involvement in the adoption of particular innovations, and the membership of adoption groups, may have an influence upon the cognitive structure of the individual. It would be expected that members of such groups would perceive the innovation similarly. For such adoption to occur, some consensus must be reached by the group. The process of coming to terms with the innovation might have had more far-reaching implications for the members of the group, influencing their perceptions of innovation generally.

Diagrams of the adoption groups (Appendix 3, Figs 4-16), indicating the hierarchical relationships, have been produced. They represent the members of the adoption group who were available at the time of the research. Some individuals had left the company between the time of the adoption decision and the data collection, others felt unable to comment on particular innovations.[2]

We therefore have two aspects of the organisational structure - the departmental relationships and those applying to specific innovations. Under certain conditions these dimensions are likely to be correlated - when, for example, the adoption team is primarily constituted of members of a department which is to be the major user of the innovation. Another possibility concerns the use of financial or technical departments as advisors to top management, such that several members of that department would be involved in many adoption decisions. Whatever basis of organisational differentiation is used, there is little scope for the specification of innovation characteristics that might be chosen frequently or found important.

(5b) Organisational Size : Survey II

Organisational structure for this sample was described as size, in terms of number of employees, either of the organisation as a whole, or for the respondent's division, if it were a large organisation. It is likely that within a large organisation, only that part which directly affects the individual has any great influence. Size has been classified into seven groups:

Size 1 - 20 or less employees

Size 2 - 21 - 100 employees

2. For example some of the senior management, although officially members of particular adoption groups, felt unable to comment on the innovations concerned, as they were passive members.

Size 3 - 101 - 500 employees

Size 4 - 501 - 1000 employees

Size 5 - 1001 - 2500 employees

Size 6 - 2501 - 5000 employees

Size 7 - 5001 or more employees

Again it is difficult to predict likely differences in perception of innovation, merely the expectation that they will be different.

Relationships Between the Classifying Variables

A correlation analysis was applied to the Classifying Variables data of the respondents in Survey I. If we are to look at differences in perceptions of innovation, in respect of these variables, it is useful to know if they are related. The result of this analysis can be seen in Table 4.

Table 4 : Correlation Matrix

n = 47

	Role	Management Level	Company	Age	Education
Role					
Management Level	0.7399				
Company	-0.2757	-0.0903			
Age	-0.3575	-0.5743	-0.1438		
Education	-0.1894	-0.2325	0.0358	-0.0461	

The correlation coefficients were examined for statistical significance, by reference to appropriate tables (Siegel, 1956). A small number of statistically significant correlations were established.

Occupational Role/Management Level : 0.7399

Occupational Role/Age : -0.3575

Management Level/Age : -0.5743

The relationship between Management Level and Age is probably the easiest to explain,3 as it can be expected that age will tend to lead to seniority. The relationship between Occupational Role and Management Level was more complex, but was assisted by the fact that Role 1 and Level 1 proved synonymous in this sample. Other facilitating factors were that Production Engineering respondents were confined to Management Level 2, as were those in Production. However there were a number of factors acting against it, for example Computing, which was spread over Management Levels 3-6 and Finance people who belonged to Management Levels 2 and 4. The correlation between Age and Occupational Role cannot be explained in simple terms; it would seem likely that the relationship between both variables and Management Levels was the primary determinant.

The results of the correlation analysis suggested that, with the exceptions detailed above, a degree of independence was present amongst the Classifying Variables.

The Multidimensional Hypothesis

H_1 : Similarity of perceptions of innovations are likely to be the product of commonality in terms of all or a number of the classifying variables; such that the more similar the experiences of the individuals, the lower the level of differential perception.

A number of variables have been identified as suitable for inclusion in the study, as factors affecting perception of technological innovation in an organisational context. While the Classifying Variables were ones which offered significant impact on perception of innovation, they were obviously not the total universe of applicable variables, nor could it be

3. a) It is a negative correlation, as an increase in Management Level is indicated by a reduction in its value.

b) This result is supported by Legget (1978).

expected that a uniform mixture of variables applied to all circumstances. Unlike Kivlin and Fliegel (1967) who used only one perceptual determinant, farm size, the present study uses five. These can provide both single variable analysis and ones in which all five Classifying Variables were combined. However, if only one were chosen overall, it would be necessary for this variable to be believed of paramount importance in determining perception of technological innovation.

The capacity for comparing perceptions of innovations in a number of dimensions simultaneously, allows for the possibility of variation in perception being classified in terms of all these dimensions. As indicated in the discussion of the Multidimensional Hypothesis in Chapter 6, there is a high probability of meaningful explanation being, of necessity, made in this way. Thus it is to be expected that perceptions of innovations which are the product of a combination of Occupational Role, Management Level, Educational Level and so on will be found. However there is a significant complication of this analysis, that is likely to have consequences for this study, that of 'stepwise linkage'. This can be illustrated using a three-subject case:

Subject 1 - Occupational Role = 2, Management Level = 3,
Educational Level = 3, Age = 30 and belonging to Company X

Subject 2 - Occupational Role = 3, Management Level = 3,
Educational Level = 3, Age = 30 and belonging to Comapny X

Subject 3 - Occupational Role = 3, Management Level = 4,
Educational Level = 3, Age = 30 and belonging to Company X

To simplify the nature of the problem, only Occupational Role and Management Level have been varied. Even so it is clear that if these three individuals were found to have similar perceptions of innovation, as demonstrated by cluster analysis for example, it might be difficult to reconcile Subjects 1 and 3. Both have commonality with Subject 2, which is reflected in their perceptions. The similarity of perception of innovation can be identified by some particular level of analysis and shown as a cluster. The extension of this kind of linkage into even more complex forms could provide real difficulties in the analysis of the causes of similarity and difference of perception of technological innovation. The consequence of a multidimensional approach is that findings are likely which are not amenable to simplistic analysis, the only clear-cut examples being the perceptions of individuals who are similar in many ways. Even here nothing is certain, as a person's perceptions of innovation may not be static, but rather in a dynamic fluid form.

CHAPTER ELEVEN

FINDINGS I :

THE TOWER OF BABEL AND AFTER - A CASE STUDY

The case describes the development of a Computer Aided Design (CAD) system, by a medium size company, Automotive Systems Limited (ASL). In many ways this development was made against all the odds, being generally the province of the dedicated software house. Indeed, the development was described by one member of the company, though he was not directly involved, as "Financially disasterous and commercially naive." As will become clear it was a highly contentious project for much of the time and as such a powerful forum for the operation of differential perception of innovation in addition to political and other processes. A primary purpose of the case study, therefore is to place the operation of differential perception of innovation into a meaningful organisational context.

It was decided to describe the events as accurately as possible and leave analysis of events for the "Discussion". The primary focus of the case is documented in the middle two sections, which deal with actual development work.

The Company

ASL is a medium size manufacturer of specialised motor vehicles. It is situated over three sites and is divided into a number of functional departments. One such is Body Design, an area responsible for the development of body shape and as such a department ripe for the introduction of CAD. A number of the engineers who worked in this department at the time of the development were computer literate and became very much involved in the introduction of CAD.

The Technology

Computer Aided Design is constituted of a combination of specialised hardware and software. In essence it transfers the function of a draftsman, from a drawing board to a video screen and as such is clearly a manufacturing innovation. The user is able to produce drawings on the screen, manipulate them in a number of ways and store them on disc for later access. Such a system offers many advantages in use, for example parts of a drawing can commonly be layered and by adding them together a complete drawing built up. Where modifications are made to a particular component, the old drawings can be accessed and the changes made, thus avoiding having to produce the whole drawing from scratch. A further productivity benefit comes from the storing of 'standards' on the system, which are representatives of commonly used components, which can be accessed and included in drawings at will. Output of such a system can be to a plotter to produce paper drawings or to another program or computer for further processing; a common example being for the production of a numerical control tape (see also Appendix 1 for a description of a CAD system).

The Actors

Nigel Braine - a senior designer involved in the early stages of the development process.

Al Green - a systems analyst employed in the Computer Services Department and who was involved in the development of the CAD system.

Fred Jones - a senior engineer, highly respected within the company, who became the head of the designers in Body Design, during the time covered by the case.

Terry Mason - a computer literate engineer who contributed to much of the development. He is highly creative, but was described as "liking to play", to do what interests him.

Barry Richards - a design engineer, who is very keen on technical development. He became interested in computers and was a good FORTRAN programmer; much of the later CAD system development was his work.

Ian Smith - a software consultant, employed by Axis Computer Systems. He is highly experienced in graphical software development and was employed by ASL to assist in the CAD project.

Background

The introduction of Computer Aided Design by the company cannot be considered an isolated event. Rather the decision to explore the benefits of CAD arose from an incremental process, by which computer technology came to be seen as a viable tool in the design process. By the late 1960's when the first computer tools were introduced to the design area, other parts of the company were already well advanced with such technology, for accounting and other purposes. In the event, a device was purchased for part programming work. Essentially this was a machine into which the digitised parameters of a part could be introduced and a numerical control tape generated from them. The designers were not content to simply use it for this purpose, but contrived to modify it so that it would produce drawings if connected to a plotter. This striving for new ways of doing things and the capacity to put their ideas into practice were recurrent features of the activities of the designers throughout the case.

The digitising machine was linked to an available mainframe computer and a suite of programs written to drive it. To produce hard copy, a drafting machine, containing its own minicomputer, was also purchased. The use of this configuration was further enhanced by the purchase of a suite of design programs in 1971 so that they could get "the definition of body shapes and the ability to get sections through those shapes". However, there were difficulties and it was:

> "A long, cumbersome process of defining shapes and getting information back from the computer."
>
> (Nigel Braine)

The use of the mainframe computer was on a time-sharing basis, which caused a number of problems. The suite of programs in use was large and consequently access to them was limited. This was aggravated by the complexity of the data input, which meant that errors could be frequent and it was common to have to have several runs before perfection was achieved. Dissatisfaction with the procedure grew and as a consequence, a design engineer, Barry Richards, who was interested in computers and could program in FORTRAN, produced a set of programs which would run on the mini computer attached to the drafting machine. This proved a great success:

> "Barry produced a suite of programs to run on the minicomputer attached to the drafting machine which did a similar job to the ones available on the mainframe. They were more efficient than the mainframe ones and also more accessible - people had almost immediate turnaround, rather than the twenty-four hour turn around for the mainframe."
>
> (Nigel Braine)

This new suite of programs still required digitised input, rather than the interactive process of later developments. However, it was seen as "pointing the way towards improved ways of working in the future." It appears that this success led to subsequent events and it is to these we now turn.

A Computer Aided Design System?

In the early 1970's the company was becoming increasingly aware of developments in the CAD field. Contact with other manufacturers and the experiences of some of the staff who had seen CAD systems, suggested to the company that they should explore the possibilities of this technology. In 1974 a proposal for an interactive CAD system was developed by a working party which had been set up to explore the potential of the use of computers in technical areas. This was seen as the first step in developing a Computer Aided Engineering capability:

> "Out of that [the Working Party Report] came recommendations about CAD and it became clear that an interactive geometry system was at the heart of all technical computing. Unless you could get the geometry description into the computer as a normal part of the design process, you would never have been able to take the benefits of all other activities and processes."
>
> (Fred Jones)

A review of the geometry systems then available suggested that none of them were suitable for the task:

> "Fred [Jones] had been around, he knew what was happening in the States and various large organisations in the UK. He was convinced that the products already available off the shelf were not quite what he wanted. So they decided to build their own software."
>
> (Al Green)

At the time of this decision Fred Jones, a senior engineer, was leading a Working Party constructed for the evaluation of CAD and the specification of user needs. As a design engineer, not a computer specialist he was aware of his own deficiencies:

> "I came in very cold really, in terms of computers and knowing what was possible and so on. So my first job was to get up to speed, listen to all the so-called experts."
>
> (Fred Jones)

He had, however, been brought in for his design expertise, his knowledge as a potential user of a system:

> "I came in chiefly from the user end. Certainly a lot of our management were keen in developing this way. They wanted someone to take over this development from a user point of view."
>
> (Fred Jones)

The lack of available systems made it clear that the company would have to develop its own. In 1975 a development team was set up to provide a specification for both software and hardware. This team included people who had not previously been involved with plans for CAD or the use of computers in the design process:

> "Having a year's experience behind me I had formed definite conclusions about the way we ought to go. Once the team was formed a battle began. There were people coming into the picture who lacked any experience of it. People who had been pitchforked into this thing and who didn't have the same level of thinking. So first of all there was an education process."
>
> (Fred Jones)

The difficulties were resolved enough to develop a user specification, "what the users really wanted the system to do", although, of course, with some influence from the computer professionals. On the hardware side it was decided to get a minicomputer, rather than time-share in a mainframe:

> "We came to the conclusion that what we wanted could only be met by a dedicated computer. As we saw it, minicomputers were becoming available with sufficient power to do this sort of thing."
>
> (Fred Jones)

To implement the user requirements a group was set up consisting of design engineers, with an interest in computers and specialists from the Computer Services Department. This was the first time that the professionals had been involved in the process and they raised a number of objections to what was being proposed. They had, apparently, been unaware of the developments in the design area, both in terms of software production (the drafting programs) and the growing expertise in, and expectations of, computer technology. In the view of one design engineer:

> "The computer services people, who had been responsible for technical computing had just realised that we'd pinched their ball and run away with it."
>
> (Barry Richards)

The lack of experience, within the company, of the development of CAD systems caused the engineers to propose that expert help be sought. Top management agreed to this and computer consultants, Axis Computer Systems, were approached. In the view of one computer services man, this was mainly advocated for internal support and reassurance:

> "The engineers hadn't a great deal of experience at that time. They felt it would help their case and convince themselves that they were doing the right thing. They decided to call in an outside team of specialists."
>
> (Al Green)

Computer Services were not very happy about bringing in consultants, they believed that the outsiders would lack commitment and let the company down in the end.

The development team now set about trying to "harden-up" the user requirements, to develop a system specification. Differences between the design engineers and the computer professionals, as to how to go about this process became apparent:

> "There was quite a lot of political in-fighting involved at this stage, with the computer professionals saying: 'You tell us what you want and we will go away and make it'."
>
> (Fred Jones)

The design engineers felt unable to work in this way, they could not provide a firm enough specification for the computer specialists to work on. Some of the engineers believed that the computer professionals were being impracticable:

> "My feeling was that if you asked the user what he wanted, he wouldn't be able to tell you, because he doesn't know - the technology is completely beyond him."
>
> (Barry Richards)

and

> "We used to say that we were in the position of somebody who's only ever ridden a horse being asked to design a motor car."
>
> (Fred Jones)

Through 1976 development of the specification and software continued. The involvement of people from different areas of the company made the specification increasingly complex:

> "... because it was a big, committee-ish sort of thing, if you asked anybody what it ought to do, they'd say it ought to do this and it ought to do that. So we built in these great big things it ought to do."
>
> (Barry Richards)

The consultant, supplied by Axis Computers, Ian Smith, was seen as aggravating this by company members of the group. He was seen as interested in "making things complex", though, he sees himself as just wishing to make things as sophisticated and efficient as possible. To Ian Smith the main problems with the development were more to do with internal disputes and conflicting needs, than his own contribution.

Ian Smith felt very much under attack throughout 1976, although it was he who was the expert, the "architect of the system". At project meetings he kept being asked why he had solved a problem in the way he had and while accepting the validity of the alternatives, thought them no better than his own solution, which he had often implemented into usable code. To the engineers this appeared part of a more general feeling within computer services:

> "It started to get very political, the Computer Services people were putting the spoke in, didn't like the way Axis Computers wanted to do things."
>
> (Barry Richards)

and:

> "Al Green had ways that he thought the code should be written and Ian Smith, who was the chief architect, bought in architect of the system, had his way. There was an awful lot of nausea generated at project meetings, it really was horrible."
>
> (Barry Richards)

Along side this debate about the system specification and software development, was one about hardware. The design engineers, recognising their lack of expertise, wanted to get some hardware and experiment with it. They tried to convince management that a "hands-on" approach was the best way to proceed:

> "Give us a computer and we will get ourselves some facilities and from these find out where we're going wrong."
>
> (Fred Jones)

and:

> "Basically he [Fred Jones] had to convince the Resources Committee. At the time he was selling his particular approach, in terms of equipment that he was going to use and the way he was going to use it, there wasn't much else going on in the company. So to a large extent his job was fairly easy at that stage."
>
> (Al Green)

With the help of Axis Computers the design team were able to produce a proposal for a type of minicomputer and graphics screen. The computer was installed in the middle of 1976, the graphics screen being delivered later that year.

With the arrival of the equipment, software development began in earnest. Terry Mason, a computer orientated designer, working under the direction of Ian Smith began to implement code on the computer. It was decided, in the interest of efficiency, to tailor the software to that particular computer and that form of graphics screen. Initially problems were encountered in using the graphics terminal. The programmer supplied by Computer Services was unable to make it work, he blamed these problems on the screen, the manuals supplied and Ian Smith for advocating this kind of terminal in the first place. He was also possessive about the graphics screen, indicating that it was his job and "no one else should touch". In spite of this, Terry Mason did manage to get it to work:

> "He [Terry Mason] picked up the test routines for the graphics terminal, found out how it was working He was the first person to get something on the screen."
>
> (Barry Richards)

With the arrival of the computer in 1976, Barry Richards, Terry Mason and others were able to introduce code to the machine. Obviously prior to the delivery of the graphics screen and for a little while afterwards it was not possible to test them fully. However it had already begun to deviate from the original specification:

> "We were not making precisely what the paper and Computer Services said it was going to look like, as this was so wrong. I suppose we were making something else, not too different, but literally not to the specification."
>
> (Barry Richards)

This was seen as the product of the original development work being performed in the absence of hardware:

> "We spent a year or more with the consultants, writing basic software without any hardware, so it was all being done from a very theoretical point of view."
>
> (Fred Jones)

By the spring of 1977 the development process had reached something of an impasse. Work was still going ahead, but the divisions within the group had not been resolved. The "project meeting nausea" continued and Ian Smith found his interest waning - he was interested in developing computer systems, not arguing about them. Consequently the involvement of Axis

Computers ceased:

> "After almost two years development changes were found necessary and this firm, Axis Computers, dropped off the job."
>
> (Al Green)

This confirmed the reservations that the Computer Services Department had had about employing consultants. Their other predictions too, appear to have been well founded:

> "Unfortunately they [the design engineers] were entering a high risk area. They were choosing new versions of everything; they were going to find themselves being the first user of a particular graphics screen, the first user of the software and the first user of a support computer. So it was a high risk situation and they did pay the price in their development. They were reaching into new areas and they had a lot of technical problems. This caused the project to slip."
>
> (Al Green)

A Phoenix from the Ashes?

From the time of the installation of the computer in 1976, Barry Richards was involved with writing applications code for the system. This was separate from the systems side of the development and he was able to carry on in relative peace:

> "Mine was an indirect contribution, I suppose. I could let all this [the wrangling] go on and stand back, because my work was fairly self-contained."
>
> (Barry Richards)

However, he needed to use the screen to test his software and in the Spring of 1977 turned to Terry Mason, who had become the graphics terminal expert:

> "I was working on some application code and I wanted data input to the terminal and output to the screen, so that I could more quickly test my software. So I got Terry to write me some routines, just simple graphics routines. Literally 'move to this point' and 'draw round that point' routines. He did this and I wrote some code to actually produce pictures on the screen."
>
> (Barry Richards)

The graphics routines were not contributions to the development system, merely tools that could be used to test other software. The work of these two, however, was the first success of the project, in terms of actually drawing on a video screen. Fred Jones, who was now head of the design team, saw what had been done and spoke to them about it:

> "The routines that had been generated for testing the application code were not that far away from a real system. Fred asked us how long it would take to make a real system and we said we would do a few tests. In fact we had a system of sorts operating within six weeks."
>
> (Barry Richards)

Initially this was intended as a test system, one which could be experimented with by the potential users to get their reaction. It was also seen as a test of the viability of the system as a whole, to see if "what they were being fed by Axis Computers was going to work."

The work on the 'real' system continued, though progress was slow. At the same time Barry Richards and Terry Mason continued to develop the test system. Reactions to the latter were favourable, the potential users becoming enthusiastic now that something could be seen to be working.

In April 1977 ideas about how to proceed began to change:

> "Fred [Jones] came to me one day and said that he didn't believe that what we'd been making for real would work. At this time we'd spent 20K in software, though I must admit I was rather fed up."
>
> (Barry Richards)

Soon after work on the 'real' system stopped, Fred Jones being a prime mover in this decision:

> "... it was a question of the right person at the right time. Fred Jones is considered one of our best engineers, is very able at solving problems. What he said carried a lot of weight and he was able to sell his ideas."
>
> (Al Green)

Instead the design team concentrated upon the facility that had been developed by Barry and Terry, turning it from a few simple graphics routines to a practical, though small scale, system. Actually working with a system caused a significant re-think of approach:

> "We had looked at systems and sat down and thought, as users, what it was we thought we wanted from a system and the facilities it ought to provide. It wasn't until we had a minimal facility, where we could sit down and try to do things that we realised that in a number of ways our thinking was quite wrong."
>
> (Fred Jones)

It also became clear that they had been working from a computer, rather than a user point of view:

> "We set off trying to do things that we rapidly came to realise, just did not satisfy the user. We took drawing board constructions and implemented them on the computer in an efficient way, each one efficient in its own right. While each of these processes were efficient, they were not compatible with each other, in user terms. The order in which

> data was demanded, was efficient for the computer, but not consistent to the user. He found himself having to stop and re-think - he couldn't get into any rhythm at all."
>
> (Fred Jones)

By the summer of 1977 Axis Computers had pulled out and the Computer Services Department had little involvement. The computer orientated designers were able to proceed without interference and had no regrets:

> "Quite honestly, if we'd carried on like that, we'd have screwed up the whole thing. We'd have spent lots of money and it would have been a white elephant. Purely because it was designed by a committee."
>
> (Barry Richards)

Management supported the development in the new form, allowing the designers to gradually improve facilities. In the autumn of 1977 a small scale production facility was made available; from here on the development proceeded with a strong reference to the users:

> "The system was used by a lot of the design people, they liked it and made suggestions. From then on the development was an inter-active process, the users being involved with the people who were producing the system."
>
> (Nigel Braine)

As both users and producers worked in the same department, under Fred Jones, such feedback was both informal and responsive. From here on, much of the development was suggested by the users, who asked for new facilities. The experience with the original, computer orientated, development suggested to the designers, that rather than make the system computer efficient, they should strive to make it easy for the user. Designers, as opposed to draftsmen, do not spend all or even most of their time at a drawing board, so the system had to be easy to use, easy to learn, and preferably self-tutoring. Even if this meant that the machine did not run efficiently:

> "We had a dedicated machine, all it had to do was satisfy our requirements. We decided that we didn't care how tough we made it for the computer, as long as it satisfies the user."
>
> (Fred Jones)

This philosophy became a 'corner-stone' of the development work.

Over the next eighteen months the system was improved and the facilities increased. In the autumn of 1978, for example, a new more powerful computer was delivered, offering 32-bit architecture, rather than the 16-bit of the old machine. This improved the operation of the system by doing away with over-laying - the bringing of parts of a large program into memory from disc when required, as the whole of it would not fit into memory. The change entailed modification of the programs and the development of newsoftware, but also allowed more screens to be driven and access and processing time to be reduced. However, by 1979 support for the development was waning.

A New Broom?

In 1979 ASL went through a major re-organisation and in the process took a serious look at all computer facilities. Whereas in the past something of a laissez-faire attitude to computer developments had been evident, things started to "tighten-up" and developing CAD systems was no longer considered a viable proposition:

> "We now have a lot of different top level boards, looking at facilities in terms of hardware and so on, right across the company. They looked at what we had been doing, looked at our estimates of man-

> years to complete it up to full specification. They declared that the company did not really have sufficient programming capability, manpower, to spare for that sort of activity. They thought we ought to look at buying-in."
>
> (Fred Jones)

The company now began to look at commercial CAD systems, for use by all relevant departments, not simply the Body Design area.

In the course of this evaluation the internally developed system fared badly, primarily because it was not fully matured. It lacked many of the facilities offered by other systems, for example the capacity for producing numerical control tapes. Because it was a company wide proposal, the corner-stone of the designers' system - ease of use - was not considered of vital importance, many other departments wanting CAD for draftsman usage. Computer Services, who had returned to the fray, preferred a system which would run on any machine, rather than one tailored to a particular computer and graphics screen. In the event a system was purchased, on a company wide basis, which was fully developed, transportable and supported by the suppliers. The system was installed during the Spring of 1981, though in some departments, including Body Design, it runs in tandem with the internally developed system. The latter, while not being improved, will continue to be maintained.

Discussion

The experiences of ASL in relation to Computer Aided Design provide a number of points of interest to the Diffusion of Innovation researcher. The first question that has to be raised is: "When did adoption take place?" As indicated by Gold (1981), the usual assumption of adoption being a discrete event (Rogers and Shoemaker, 1971) is unfounded:

> "....contrary to simplistic assumptions, major decisions seldom take the form of climactic once-for all commitments. Instead, they usually involve successive reviews of past estimates on the basis of developing information and experience and these lead to modifications of expectations and readjustments in still unimplemented commitments. Moreover, major innovations frequently require progressively widening sectors of readjustments in antecedent and later operations in order to regain effective integration of the entire network of processes. Hence, final results are seldom directly comparable with, much less attributable solely to, the initial decision."
>
> (Gold,1981)

This certainly proved to be the case with the adoption of CAD by ASL, progress being made by a gradual learning process. It could be argued that the initial stages, as outlined in "Background" should be classifiable as "Trial" and the decision to develop a CAD system taken as the actual adoption. However, given the nature of ASL's activities this plan could have been aborted at any time, indeed the nature of the plan did change over time.

If we take the decision to search for and later develop a CAD system as the adoption, there is evidence of the "Awareness" stage. Through their own activities with computer technology available to them, knowledge of the practices of competitors and the observations of their personnel (primarily by visits to the manufacturers)[1], ASL became aware of the kinds of technology available. Barry Richards, for example, recalled going to see a manufacturer in the USA and changing his mind about screen displays:

> "Until that time I had regarded the use of screens, video screens and refresh displays, as toys really."

1. This can be compared with the findings of Ryan and Gross (1943) which related innovative behaviour to travel to cities and towns.

Whether the introduction of CAD was the product of need pull or technology push (Langrish et al, 1972) is questionable. Although there was some need to improve the design process, it seems likely that the availability of the technology and the fear of being left behind were significant factors. Undoubtedly the experience with the digitiser and the mainframe design packages had created a climate conducive to the adoption of this innovation, which was "congruent" (Brandner and Kearl, 1964) with what had become accepted practices.

There was also evidence of a political process, as described by Pettigrew (1973). The various groups involved, particularly the design engineers and the computer personnel, appeared to have become locked into a political battle. Like Pettigrew (1973) we see evidence of the computer professionals using their specialism, their knowledge, as a power base. The activities of the engineers were an attack on the "norms that denied others competence" (Pettigrew, 1973). This may also explain why they were antagonistic to the employment of a consultant and why the engineers were for it, to weaken any dependency:

> "In this situation, Kenny chose to cut into the programmer's power base by bringing in an alternative source of programming expertise."
>
> (Pettigrew, 1973)

Obviously by having their "own expert" they could rebuff any attempts by the Computer Services Department to take control of the project, to "get their ball back".

A number of effects attributable to Differential Perception of Innovation could be identified in the case. We had, for example, the differences between Fred Jones and some of the other members of one of the early development teams. Many of the individuals lacked any experience of CAD or technical computing generally and thus their cognitive structure for evaluation of this technology would be necessarily sparse. The "Concept Attainment View" (Masterson and Hayward, 1979) suggested that conceptual tools must be available to make accurate assessments of technological innovation. This seems borne out by Fred Jones' emphasis on the "education process". Once this had been achieved and they had all attained the "same level of thinking", the difficulties diminished and they were able to produce a user specification and make decisions about likely forms of hardware.

The next and one of the most major influences of differential perception can be seen in the group which actually tried to fully specify and implement the system. In structural, and possibly emotional, terms we have three factions, with dimensions of similarity and difference. The design engineers and Computer Services personnel worked for the same company, which would suggest some cohesion in the face of the outsider - the computer consultant - but were split in terms of occupational speciality and role demarcation. The design engineers and the computer consultant had ties in as much as they were the people who wanted him there, were in effect his employers, but differed in terms of occupational speciality. Ian Smith, the computer consultant, had occupational similarity to the Computer Services personnel, but was separated from them by his links with the engineers; he was also an outsider. Thus this triad provided scope for analysis in terms of the Multidimensional Hypothesis.

In practice, Ian Smith became isolated from both sides. The Computer Services people attacked his methods, and used their knowledge of what he was doing against him, as witnessed by the debates about the best solution to a problem. His relationship with the engineers was better, but even here he felt that:

> "They wished to get involved themselves and have any collaboration with consultants on the side line."
>
> (Ian Smith)

Thus we have a triad which was highly differentiated; evidence suggests that triads of individuals are unstable (Caplow, 1968) and the same would appear true of groups. The difference in cognitive structures and the consequences of this for the members' perceptions, were undoubtedly a significant factor in its eventual failure. Take, for example, the way that the facilities it should contain were generated. Anybody who would eventually be involved was asked what functions they would like. As a consensus as to the nature of the eventual system had not been achieved, these were all incorporated, so that they "built in these great big things it ought to do". This suggests a lack of criteria for evaluating whether a particular function should be made available. In practice, in almost any design process, compromises must be made, decisions about what is essential and what is desirable, but not necessarily needed. However, in order to make such decisions, a consensus must be reached as to what exactly is being produced. If it had been possible to implement a characteristics of innovation measure at the time that this process occured it would seem likely that different characteristics were being utilised by the participants or, at least, that different weights were being applied.

The cognitive and conceptual differences within the development group were further illustrated by the differing perceptions of Ian Smith, the consultant, and the company members. According to Smith he wished to produce good, efficient and sophisticated software, whereas to the ASL personnel "he was interested in making things complex". In another frame of reference, valid arguments could be made as to who was right and who was wrong; in this context, like the debate about whether two events were simultaneous (Russell, 1969), we have to conclude that both were. To the experienced and highly competent computer consultant, what he was doing was not "complex", though it might be at the edge of what was feasible. To the less sophisticated (in graphical software terms) ASL personnel it was undoubtedly difficult to understand. This supported the notion that perceptions are "theory laden" (Hanson, 1958), and consequently was further evidence of differential perception of this technological innovation.

The differences between the engineers and the computer professionals can be highlighted by the search for a design specification. The computer personnel asked the designers "to tell them what they wanted, so that they could go away and make it". Leaving aside the fact that acquiescing to this request would have legitimated the programmers' role, there were the inherent differences between the two groups, as to how they perceived that the process should operate. There was an implicit assumption in the programmers' request that the designers were computer-literate, such that they could formalise their needs into a readily codable form. It was also clear that the potential users were unable to operate in this way, that they lacked sufficient knowledge/cognitive structures to treat the problem in an abstract way. Instead they wished to gain experience of the technology and become conceptually prepared to deal with the task. It is undoubtedly true that increasing knowledge and understanding of some topic allows the individual to operate in a more abstract way. If, as is believed, perception of innovation is conceptually determined, and conceptual expertise is the product of particular forms of experience, then the ability to deal with an innovation abstractly by one group, but not by another, may itself provide a measure of differential perception of innovation.

As suggested by Rogers and Shoemaker (1971) the group decision making was slow and in the result failed to produce a viable specification. When the time came to implement the software much of the specification was found to be impracticable and in effect was re-written by the programmers of the system. Differences in what was to be created, the idea of the innovation itself, coupled with the disagreements throughout the implementation process finally caused the project to cease. Explanations as to why this occured, themselves illustrate differing perceptions of the process, the engineer, Barry Richards, attributing the failure to the project meeting "nausea", whereas Al Green, of the Computer Department saw the whole project as "high risk", with the possibility of failure being ever-present. It is significant that the system developed by the design engineers had none of these problems, the individuals involved working in the same department and within the same cognitive structure. In contrast to the earlier "nausea", this development was described as a "fairly painless process". What CAD is, what facilities it should offer and how it should operate, as perceived by the engineers suggests obvious differences from the perceptions of the computer professionals. While the former valued ease of use, consistency for the user and generally "user-friendly" characteristics, the latter were interested in machine efficiency, and in the case of the computer consultant, providing sophisticated software.

The reader may have been surprised at how little reference was made to top management for the majority of the case. While it is possible that this may be a function of the respondents used in the case, none of whom were top managers, it is believed that the account is accurate. Generally top management were in favour of computer development and statements were made in the early 1970's of the need to move towards Computer Aided Engineering. Even now this is an ambitious proposition and may be more an indicator of how little they understood the technology, as was suggested about the Michaels Board in Pettigrew (1973):

> "... their dithering and inconsistent behaviour towards the computer department might have been a product, as Bell said, of their inability 'to understand what was going on'."

The brunt of the development work was left to those at a lower level, a significant individual being Fred Jones, who was highly respected within the company. He undoubtedly acted as an innovation champion:

> "It was very much a personal venture on his part. He [Fred Jones] decided that he could justify automating the design process and he took it so far before he needed backing."
>
> (Al Green)

Obviously, because they had to sanction expenditure, top management supported the venture, but they were generally favourable and lacking expertise could be convinced, without really understanding what it was about. A similar, though less extreme, process occured in the companies examined in Survey I, with top management suporting their subordinates judgement in certain cases. However, in contrast to ASL, these tended to be the less innovative and/or less expensive decisions, with consequently lower levels of risk. If one compares the involvement of ASL management at the different stages of events described by the case, then it is clear that they waited for things to settle down before entering the arena. One could speculate as to the political processe within ASL which caused top management to need to distance themselves from events with uncetain outcomes. The sending of Fred Jones into the CAD arena to "take over this development from a user point of view" is sugestive of a risk reduction exercise, with top management being uneasy about computer professionals, who operated in a way that they did not understand, preferring to put their trust in a known quantity - an engineer.

Over time this was to change, particularly as a result of the company re-organisation. It should also be remembered that during this period computer technology became less alien, particularly to a management group who were at least vicariously involved with it. This was witnessed by their wish to be more involved in the decision-making processes, the setting up of committees and control mechanisms:

> "It would be much more difficult now, it would be virtually impossible for Fred Jones to do now, what he did three years ago. Before he made his first move, before he employed a consultant, he would come into contact with the steering committees, watching committees, that would quickly pick up anything that was happening on the CAD front. It's taken us five years to get organised and control mechanisms are now very strong in the CAD area."
>
> (Al Green)

With the rise of managerial control came the return of the computer professionals to the CAD arena. These individuals and other potential users of the CAD system were not in sympathy with the aims of the designers. While the designers believed that "ease of use" (Characteristic 14: Ease in Operation) was highly important, this was not valued by other groups within the company. Other attributes, such as, "transportability" (Characteristic 20: Compatability with existing Equipment) and "technical support" (Characteristics 26 and 28: After-sales Service and Availability of Technical Advice respectively) were now seen as much more important, particularly by the computer profesionals. The Body Design people had produced a system which would satisfy their own requirements, but apparently not those of the rest of the company:

> "The CAD system Fred Jones and his people developed was produced in something of a vaccum as far as generating a company system was concerned. He was

> basically going his own way, producing something that would satisfy Body Design requirements. When it was exposed to the rest of the company, although it was liked by most people, it was found wanting in a number of ways."
>
> (Al Green)

The experiences of the engineers in Body Design, their relatively successful development of a CAD system and its subsequent rejection by other company members, can be directly attributed to their specific perceptions of what was important within such a system. It would be expected, however, that such 'perceptual biases' would not be the preserve of design engineers alone, but of all funtional groups within an organisation. The work performed within Surveys I and II was directed at comparisons of such groups and the way that perceptions of technological innovation varied across occupational and other groupings within organisations and allows more rigorous comparisons of perceptions, as are attempted in the next chapter.

CHAPTER TWELVE

FINDINGS II :
BASIC MEASURES OF PERCEPTION OF INNOVATION

If one wishes to examine perceptions of innovation through instruments which use the selection of certain characteristics and the importance ascribed to them, then basic comparisons of these data should prove useful. To this end the groupings defined by the Classifying Variables have been used to produce group importance means and percentage frequency of characteristic choice. If the different groups perceive innovation differently, this should be reflected in the frequency with which group members select characteristics and the mean importance given to them. This chapter therefore explores these basic measures, for support of the Differential Perception Hypotheses. In the case of Occupational Role this includes a test of the predictions generated under this hypothesis. The use of these basic measures is for an empirical, exploratory, study of differential perception. As yet examples of differential perception of innovation effects are limited, and consequently a priority objective is to discover evidence of the occurence of such an effect.

<u>Characteristic Choice</u>

The percentage frequencies of characteristics chosen were calculated for each relevant grouping, for each Occupational Role, Management Level and so on. The values were tabulated (see Table 5 and Appendix 4) and from these tables the most frequently and infrequently chosen characteristics were selected. A target of five of each (frequent and infrequent) was set, although because of ties in reality the number varied between 4 and 10. Whether less than five or more than five were chosen depended upon the percentage value of the characteristics which crossed over the

Table 5 - Occupational Role Percentages : Survey I

Characteristics	Org	Prod Eng	Prod	Eng	Fin	Comp
1	100.00	80.00	81.82	90.91	100.00	100.00
2	100.00	20.00	90.91	63.64	80.00	87.50
3	100.00	100.00	100.00	72.73	100.00	87.50
4	85.71	60.00	45.46	63.64	60.00	75.00
5	28.57	20.00	18.18	18.18	0.00	37.50
6	71.43	80.00	63.64	36.36	80.00	87.50
7	85.71	80.00	90.91	100.00	100.00	100.00
8	100.00	80.00	72.73	90.91	100.00	100.00
9	71.43	80.00	54.55	81.82	80.00	100.00
10	71.43	40.00	45.46	54.55	40.00	62.50
11	71.43	60.00	45.46	36.36	20.00	75.00
12	100.00	100.00	90.91	100.00	100.00	100.00
13	100.00	20.00	54.55	45.46	100.00	62.50
14	100.00	40.00	72.73	81.82	60.00	75.00
15	71.43	20.00	9.09	36.36	80.00	62.50
16	57.14	40.00	54.55	81.82	40.00	62.50
17	100.00	100.00	100.00	100.00	80.00	87.50
18	71.43	40.00	45.46	63.64	60.00	75.00
19	57.14	20.00	63.64	54.55	60.00	62.50
20	85.71	80.00	72.73	72.73	80.00	100.00
21	57.14	0.00	63.64	27.27	80.00	62.50
22	71.43	20.00	54.55	90.91	80.00	62.50
23	85.71	20.00	45.46	45.46	60.00	75.00
24	57.14	20.00	36.36	36.36	80.00	50.00
25	85.71	80.00	72.73	54.55	60.00	100.00
26	100.00	60.00	90.91	72.73	80.00	62.50
27	85.71	100.00	100.00	100.00	60.00	100.00
28	85.71	20.00	63.64	72.73	60.00	50.00
29	71.43	20.00	18.18	36.36	60.00	62.50
30	85.71	40.00	18.18	9.09	80.00	75.00
n	7	5	11	11	5	8

Org - Organisational
Prod Eng - Production Engineering
Prod - Production
Eng - Engineering
Fin - Finance

boundary. Where the percentage was somewhat lower than those already selected, these characteristics were ignored, though the occurrence was noted. In this account, primarily data referring to Occupational Role, as generated by Survey I, has been used. For the sake of brevity the other Classifying Variable results are referred to only briefly, a fuller account being available in Appendix 4 . A comparison of the results of Survey I and Survey II suggested that they are similar, the latter supporting those presented here.

As will become clear, certain characteristics were commonly chosen by the majority of respondents. A good example of this is Characteristic 8, "Reliability". Other characteristics were commonly infrequently chosen, the best example being Characteristic 5, "Re-sale Value". Exclusion of these characteristics and/or a standardisation procedure which would alleviate these effects was considered, but the simpler form was found more desirable. Exclusion, for example, of "Re-sale Value" would have distorted events where other characteristics were less frequently chosen, thus masking real effects. These characteristics could in effect be used as 'markers' against which others could be judged. The frequently/infrequently chosen characteristics, as indicated by the groupings derived from the Classifying Variables, particularly Occupational Role, will now be discussed.

OCCUPATIONAL ROLE (Survey I)

a) Role 1 - Organisational (n = 7)

Frequent

1.	Initial Cost	(100.00%)
2.	Running Cost	(100.00%)
3.	Rate of Return	(100.00%)
8.	Reliability	(100.00%)

12.	Effects on Quality	(100.00%)
13.	Variations in End Product	(100.00%)
14.	Ease in Operation	(100.00%)
17.	Effects on Labour Requirements	(100.00%)
26.	After-sales Service	(100.00%)

Infrequent

5.	Re-sale Value	(28.57%)
16.	Operator Comfort	(57.14%)
19.	Complexity	(57.14%)
21.	Trial on a Small Scale	(57.14%)
24.	Possibility of Modification	(57.14%)

One of the predictions of the Occupational Role Hypothesis applying to this grouping was supported. It was suggested that this group would select a high number of characteristics and this was borne out by the frequent choices all being 100% and the majority of 'infrequent' choices being higher than 50%.

b) Role 2 - Production Engineering (n = 5)

Frequent

3.	Rate of Return	(100.00%)
12.	Effects on Quality	(100.00%)
17.	Effects on Labour Requirement	(100.00%)
27.	Unit Costs	(100.00%)
1.	Initial Cost	(80.00%)
6.	Relative Advantage	(80.00%)
7.	Time Saving	(80.00%)
8.	Reliability	(80.00%)
9.	Ease of Maintenance	(80.00%)
20.	Compatability with Existing Equipment	(80.00%)
25.	Supplier's Reputation	(80.00%)

Infrequent

21.	Trial on a Small Scale	(0.00%)
2.	Running Cost	(20.00%)
5.	Re-sale Value	(20.00%)
13.	Variations in End Product	(20.00%)
15.	Need for Retraining	(20.00%)
19.	Complexity	(20.00%)
22.	Observability of Results	(20.00%)

23.	Perceived Risk of Adoption	(20.00%)
24.	Possibility of Modification	(20.00%)
28.	Availability of Technical Advice	(20.00%)
29.	Sophistication of Machine	(20.00%)

The frequently chosen characteristics provided some support for the predictions made under the Occupational Role Hypothesis. As expected "Relative Advantage", "Time Saving", "Reliability", "Ease of Maintenance" and "Compatability with Existing Equipment" were chosen by this group.

c) Role 3 - Production (n = 11)

Frequent

3.	Rate of Return	(100.00%)
17.	Effects on Labour Requirement	(100.00%)
27.	Unit Costs	(100.00%)
2.	Running Costs	(90.91%)
7.	Time Saving	(90.91%)
12.	Effects on Quality	(90.91%)
26.	After-sales Service	(90.91%)

Infrequent

15.	Need for Retraining	(9.09%)
5.	Re-sale Value	(18.18%)
29.	Sophistication of Machine	(18.18%)
30.	Effects on Safety	(18.18%)
24.	Possibility of Modification	(36.36%)

There was only a limited agreement between these findings and those suggested within the Occupational Role Hypothesis.

d) Role 4 - Engineering (n = 11)

Frequent

7.	Time Saving	(100.00%)
12.	Effects on Quality	(100.00%)
17.	Effects on Labour Requirement	(100.00%)
27.	Unit Costs	(100.00%)
1.	Initial Cost	(90.91%)
8.	Reliability	(90.91%)
22.	Observability of Results	(90.91%)

Infrequent

30.	Effects on Safety	(9.09%)
5.	Re-sale Value	(18.18%)
21.	Trial on a Small Scale	(27.27%)
6.	Relative Advantage	(36.36%)
11.	Space Requirement	(36.36%)
15.	Need for Retraining	(36.36%)
24.	Possibility of Modification	(36.36%)
29.	Sophistication of Machine	(36.36%)

While there was some agreement between the results and the predictions of the Occupational Role Hypothesis, there were some disagreements. Support was provided by the frequent choice of "Time Saving" and "Effects on Labour Requirement", but was outweighed by the infrequent choice of "Relative Advantage", "Possibility of Modification" and "Sophistication of Machine" and the Engineers' indifference to many of the other predicted characteristics.

e) Role 5 - Finance (n = 5)

Frequent

1.	Initial Cost	(100.00%)
3.	Rate of Return	(100.00%)
7.	Time Saving	(100.00%)
8.	Reliability	(100.00%)
12.	Effects on Quality	(100.00%)
13.	Variations in End Product	(100.00%)

Infrequent

5.	Re-sale Value	(0.00%)
11.	Space Requirements	(20.00%)
10.	Energy Requirements	(40.00%)
16.	Operator Comfort	(40.00%)

(This list has been truncated as the next percentage value is 60%, of which there are 9 occurrences).

The predictions of the Occupational Role Hypothesis could not be considered proven, as while "Initial Cost" and "Rate of Return" were frequently chosen, "Re-sale Value" and "Energy Requirements" were chosen only infrequently. However it should be pointed out that "Re-sale Value" was chosen only rarely by the respondents as a whole.

f) Role 6 - Computing (n = 8)

Frequent

1.	Initial Cost	(100.00%)
7.	Time Saving	(100.00%)
8.	Reliability	(100.00%)
9.	Ease of Maintenance	(100.00%)
12.	Effects on Quality	(100.00%)
20.	Compatability with Existing Equipment	(100.00%)
25.	Supplier's Reputation	(100.00%)
27.	Unit Costs	(100.00%)

Infrequent

5.	Re-sale Value	(37.50%)
24.	Possibility of Modification	(50.00%)
28.	Availability of Technical Advice	(50.00%)
10.	Energy Requirements	(62.50%)
13.	Variations in End Product	(62.50%)
15.	Need for Retraining	(62.50%)
16.	Operator Comfort	(62.50%)
19.	Complexity	(62.50%)
21.	Trial on a Small Scale	(62.50%)
22.	Observability of Results	(62.50%)
26.	After-sales Service	(62.50%)
29.	Sophistication of Machine	(62.50%)

One striking feature of this group was the high frequency of characteristics chosen, even those classified as "infrequent" were mostly at the 50% level or above. There was evidence of support for the predictions of the Occupational Role Hypothesis. Five characteristics, "Initial Cost", "Time Saving", "Reliability", "Compatability with Existing Equipment" and "Supplier's Reputation" were chosen by all these respondents. The only clear negation was "Re-sale Value", as others that were predicted as being likely to be chosen frequently, viz. "Complexity", "After-sales Service" and "Sophistication of Machine", while being classified as 'infrequent', were in fact chosen by 62.50% of respondents.

g) Relationships Between the Groups

If one accepts that Characteristic Choice is a valid measure of Differential Perception of Innovation, then the operation of this effect must be considered proven. Characteristics were not chosen with the same relative frequencies by all groups. For example, Production respondents chose the characteristics "Initial Cost" and "Reliability" far less frequently than any of the other groups. More specific examples were also found, such as Production Engineers choosing "Relative Advantage" frequently, while Engineers did not. This was a somewhat surprising finding, as it would be expected that these groups would be similar in outlook, particularly with respect to such a concept. This relationship was further illustrated in respect of "Observability of Results", when Engineers chose it frequently and Production Engineers (and Computer personnel) chose it infrequently. Consideration of "After-sales Service" produced expected and unexpected findings; the former being the frequent choice of this characteristic by Production and Organisational respondents. Computer personnel, on the other hand, chose "After-sales Service" infrequently, in spite of being involved in a technologically advanced area where after-sales and technical support would be expected to have a high priority. However, this may reflect the generally poor support given by computer manufacturers and the capacity of computer departments to solve their own problems.

Against these differences must be placed a level of commonality, with all groups acting in the same way towards "Re-sale Value" and "Effects on Quality" and most groups perceiving "Initial Cost", "Reliability" and

"Possibility of Modification" similarly. However, these must be considered a common 'core' on which differential perception effects modulated.

Characteristic Choice and the Other Classifying Variables

Similar patterns of difference could be discerned between the groupings suggested by the other Classifying Variables, giving further support for the Differential Perception Hypothesis. Examples of the same characteristic being chosen frequently by one group and infrequently by another were also found. Taking "Variations in End Product", it was found that this was chosen frequently by Management Levels 1 and 4, and infrequently by Management Level 3. Obviously such a relationship is difficult to explain, though it may suggest that in terms of perceptions Management Level is not a linear measure. Other examples are provided by "Raw Material Costs" being chosen infrequently by persons with no qualifications and chosen frequently by those with a degree, and "Ease of Maintenance" being chosen infrequently by those in the 21-30 age range and frequently by those aged between 51 and 60. The latter case may be something to do with increasing experience indicating the importance of maintenance, or it may be a product of the generally greater maintenance needs of machinery in the past than is now common.

For a full breakdown of the analysis of these Classifying Variables, see Appendix 4 .

Characteristic Importance

The mean importance rankings of the characteristics for each group, for example for each Occupational Role, Management Level and so on were calculated. These values were tabulated (see Table 6 and Appendix 5) and from those tables the relatively most and least important characteristics

Table 6 - Occupational Role Importance Means : Survey I

Characteristics	Org	Prod Eng	Prod	Eng	Fin	Comp
1	6.29	4.13	7.11	10.10	8.50	4.13
2	5.00	13.00	6.60	9.00	11.50	7.86
3	5.57	4.70	4.77	6.13	9.80	3.29
4	12.00	11.33	4.70	10.50	17.67	8.92
5	16.50	14.00	10.50	20.00	*	18.33
6	12.20	8.50	13.00	8.13	4.75	11.14
7	3.83	5.50	5.25	5.00	3.40	4.56
8	9.57	6.38	10.63	7.60	7.10	8.88
9	11.40	13.75	13.33	7.22	11.13	13.13
10	12.40	6.00	10.40	10.83	16.50	12.80
11	11.40	13.67	13.60	13.38	25.00	13.33
12	7.14	5.60	7.65	7.32	9.30	9.13
13	12.14	14.00	12.50	11.60	12.30	8.30
14	12.17	9.00	13.13	8.61	12.17	13.42
15	16.80	10.00	12.00	13.38	17.25	18.20
16	17.00	7.00	17.67	15.94	17.50	22.00
17	14.00	7.80	6.50	8.27	14.63	6.64
18	19.40	14.00	16.60	13.64	19.33	19.92
19	20.00	16.00	17.43	10.83	10.50	23.40
20	18.00	7.75	13.75	11.13	8.13	14.13
21	14.00	*	13.14	14.33	13.63	16.50
22	14.20	8.00	12.67	12.90	18.13	12.70
23	15.67	20.00	10.60	12.60	13.67	19.00
24	14.57	17.00	16.25	15.50	14.63	25.38
25	16.17	10.13	13.50	14.83	11.33	14.88
26	16.71	13.33	13.20	13.00	11.38	17.40
27	7.67	6.60	4.68	7.46	5.50	6.63
28	15.56	11.00	14.00	12.38	12.67	5.25
29	16.60	19.00	16.50	10.00	14.33	18.80
30	18.83	6.50	12.00	9.00	14.25	19.58
n	7	5	11	11	5	8

Org - Organisational
Prod Eng - Production Engineering
Prod - Production
Eng - Engineering
Fin - Finance

were selected. A target of five for each (important and unimportant) was set, though because of ties this could not always be adhered to. Like the previous section, this account is primarily concerned with the Occupational Role data generated by Survey I (Survey II did not take importance rankings). The tables and selected characteristics for the Classifying Variables, other than Occupational Role, can be found in Appendix 5 .

As for Characteristic Choice, certain characteristics were valued more highly by the majority of respondents, the principal example being "Time Saving", with "Effects on Noise" being seen as unimportant by the majority. The important characteristics, as indicated by groupings derived from the Classifying Variables, particularly Occupational Role, will now be discussed.

OCCUPATIONAL ROLE (Survey I)

a) Role 1 - Organisational (n = 7)

Important

7.	Time Saving	(3.83)
2.	Running Cost	(5.00)
3.	Rate of Return	(5.57)
1.	Initial Cost	(6.29)
12.	Effects on Quality	(7.14)

Unimportant

19.	Complexity	(20.00)
18.	Effects on Noise	(19.40)
30.	Effects on Safety	(18.83)
20.	Compatibility with Existing Equipment	(18.00)
16.	Operator Comfort	(17.00)

No predictions about this role were made under the Occupational Role

Hypothesis, as it was found difficult to operationalise the role attributes in these terms.

b) Role 2 - Production Engineering (n = 5)

Important

1.	Initial Cost	(4.13)
3.	Rate of Return	(4.70)
7.	Time Saving	(5.50)
12.	Effects on Quality	(5.60)
10.	Energy Requirements	(6.00)

Unimportant

23.	Perceived Risk of Adoption	(20.00)
29.	Sophistication of Machine	(19.00)
24.	Possibility of Modification	(17.00)
19.	Complexity	(16.00)
5.	Re-sale Value	(14.00)
13.	Variations in End Product	(14.00)
8.	Effects on Noise	(14.00)

The predictions of the Occupational Role Hypothesis were supported in terms of two characteristics: "Time Saving" and "Energy Requirements".

c) Role 3 - Production (n = 11)

Important

27.	Unit Costs	(4.68)
4.	Raw Material Costs	(4.70)
3.	Rate of Return	(4.77)
7.	Time Saving	(5.25)
17.	Effects on Labour Requirement	(6.50)

Unimportant

16.	Operator Comfort	(17.67)
19.	Complexity	(17.43)
18.	Effects on Noise	(16.60)
29.	Sophistication of Machine	(16.50)
24.	Possibility of Modification	(16.25)

The predictions of the Occupational Role Hypothesis were unproven. On the one hand the predictions for "Time Saving" and "Effects on Labour Requirement" were supported and on the other, "Operator Comfort" and "Effects on Noise" were found to be unimportant, contrary to the predictions.

d) Role 4 - Engineering (n = 11)

Important

7.	Time Saving	(5.00)
3.	Rate of Return	(6.13)
9.	Ease of Maintenance	(7.22)
12.	Effects on Quality	(7.32)
27.	Unit Costs	(7.46)

Unimportant

5.	Re-sale Value	(20.00)
16.	Operator Comfort	(15.94)
24.	Possibility of Modification	(15.50)
25.	Supplier's Reputation	(14.83)
21.	Trial on a Small Scale	(14.33)

The predictions of the Occupational Role Hypothesis were supported to the extent that "Time Saving" and "Ease of Maintenance" were selected, but disproved in respect of "Possibility of Modification", which was considered unimportant.

e) Role 5 - Finance (n = 5)

Important

7.	Time Saving	(3.40)
6.	Relative Advantage	(4.75)
27.	Unit Costs	(5.50)
8.	Reliability	(7.10)
20.	Compatibility with Existing Equipment	(8.13)

Unimportant

11.	Space Requirements	(25.00)
18.	Effects on Noise	(19.33)
22.	Observability of Results	(18.13)
4.	Raw Material Costs	(17.67)
16.	Operator Comfort	(17.50)

The predictions of the Occupational Role Hypothesis must be considered unproven. On the one had we have the support of the importance of "Unit Costs" and on the other the finding that "Raw Material Costs" was unimportant.

f) Role 6 - Computing (n = 8)

Important

3.	Rate of Return	(3.29)
1.	Initial Cost	(4.13)
7.	Time Saving	(4.56)
28.	Availability of Technical Advice	(5.25)
27.	Unit Costs	(6.63)

Unimportant

24.	Possibility of Modification	(25.38)
19.	Complexity	(23.40)
16.	Operator Comfort	(22.00)
18.	Effects on Noise	(19.92)
30.	Effects on Safety	(19.58)

The predictions of the Occupational Role Hypothesis were supported to a degree. While "Complexity" was actually found unimportant, "Initial Cost", "Time Saving" and "Availability of Technical Advice" were found important as predicted.

g) Relationships Between the Groups

Like Characteristic Choice, the Importance Means undoubtedly indicated differential perception effects. The value of the characteristics as perceived by the respondents varied across the groups, some being seen as important or unimportant by some and indifferently by others. A clear difference in perceptions between Production and Finance personnel was indicated by "Raw Material Costs", while the former considered this highly important, the latter considered it unimportant. It would appear that being directly concerned with the production process makes these persons more aware of material costs and their implications for overall costings. It is interesting that the only truly financial characteristic considered important by the Finance personnel was "Unit Costs". This may reflect a synthesis of all other monetary considerations into this one unifying concept.

The meaningfulness of the variability observed was enhanced by the presence of characteristics treated in the same way by at least the majority of groups. These included "Time Saving", "Operator Comfort" and "Effects on Noise". Again this suggested a commonality of viewpoint against which differential perception of innovation effects modulated.

Mean Importance and the Other Classifying Variables

Similar variability could be observed within the groupings defined by the other Classifying Variables and provided further support for the Differential Perception Hypothesis. Differences between groups as to the importance ascribed to specific characteristics were again illustrated. For example, while Management Levels 2 and 5 considered "Perceived Risk of Adoption" as unimportant, Management level 3 considered it important. This may indicate a greater concern for advancement within this group, wherein risk is a greater consideration; these being 'Middle Managers', mostly in the 30-40 age range.

For a full breakdown of the characteristics considered important/unimportant by these groupings see Appendix 5.

The Perceived Value of the Characteristics

The two measures discussed attempt to gauge the differing perceptions of innovation by the selection and importance of the characteristics respectively. Examination of the results of these two measures suggested that the findings of each, while similar, were not correlated. It would be expected that a characteristic which was considered 'valuable' by the respondents would be indicated as such by being selected frequently and ranked as important, but such is not the case. It would seem likely, as argued by Cattell (1966), in relation to different forms of personality measure, that the different approaches were sampling data at different levels of generality. Moreover, the effect may indicate perceptual differences within groups, such that a characteristic which was chosen infrequently was perceived as important by those who did choose it. An example of this was provided by the reaction of Management Level 3 to "Perceived Risk of Adoption", referred to previously. Comparison of the frequency percentages and the mean importance data indicated that while this characteristic was not that frequently chosen (71.63%) it was seen as highly important (6.60) by those who did select it. This pattern was reflected in relationships with other characteristics. For example, "Initial Cost", "Reliability" and "Effects on Quality", while being selected by the majority of respondents were considered important by far fewer, when considered in relation to Occupational Role.

Discussion

The first objective of the research, that of establishing the presence of differential perception of innovation within the organisational context, has undoubtedly been achieved. Examination of the basic measures of differential perception of innovation, as indicated by the 'value' the groups of respondents placed upon them, indicated the presence of these effects. Occupational Role was chosen as a representative example of the operation of differential perception, with the added benefit that this variable offered the only real possibility of predictions, generated under any of the hypotheses. While these predictions were only supported in a limited number of cases, they were never considered as more than rough guidelines, necessitating empirical evidence for validation. That this has not generally been forthcoming suggests a review of the operationalisation of the perceptions associated with each Occupational Role and clearly confirms the need for exploratory ventures such as the present research.

Even the use of aggregate data, which would generate measures of group specific perceptions, could not fail to highlight a central problem of differential perception of innovation research. The findings outlined, while clearly illustrating the presence of perceptual differences, did not do so in a way which provided meaningful distinctions in the majority of cases. Examples of explainable differential perception effects were found and documented, which would suggest that a true picture of events had been established. However one must turn to the Multidimensional Hypothesis for clarificaton of the results. The lack of discernable patterns suggested that the properties of the specific individual determined perception of innovation, the union of personal attributes making for a particular perceptual outlook. If commonality of perception of innovation could not be established through grouping individuals in an apparently meaningful way, by occupation and so on, a different approach was obviously necessary. The combination of 'group' members, while statistically valid and possibly an indicator of perceptual trends within groups, provides the 'lowest common denominator' of perceptions, rather than a meaningful picture. However, perceptual expectations can only be generated by observation of examples of perceptions of technological innovation, by which group trends can be distinguished from the effects of other variables. The only viable way to proceed from this point was to group individuals in terms of their perceptions of innovations and to try to establish cause in terms of the Classifying Variables, either singly or in combination.

CHAPTER THIRTEEN

FINDINGS III :
A FINE-LEVEL ANALYSIS OF PERCEPTIONS OF INNOVATION

The perception of innovation data available in the study consisted of three parts for Survey I and one for Survey II. These measures of perception of innovation, being in a numerical form, were amenable to a number of statistical treatments. Of these, Cluster Analysis was the most appropriate for the grouping of individual perceptions. The technique, in common with a number of other multivariate analysis procedures, such as Factor Analysis, was routinely applied to the data as it was gathered during Survey I. In this way possible trends within the data could be monitored as the sample size increased. It became clear as Survey I drew to a close that clusters attributable to a single classifying variable were not in evidence and that the underlying logic of differential perception of innovation was undoubtedly complex. However, a more detailed examination of perceptual groupings demonstrated that relationships could be established, although they were not the product of general trends.

A form of Hierarchical Cluster Analysis was applied to the data according to various data groupings. Both the choice of characteristics and the importance assigned to them were subjected to this technique. Differences in the data types (nominal and ordinal respectively) were allowed for in specifying the analysis procedure, thus ensuring statistical validity. The technique, which is computer based,[1] produces a similarity matrix, in which each analysis unit (respondent) is compared with each other unit, in terms of each variable (characteristic). If desired the matrix can be displayed, giving a form similar to a correlation matrix, except that the values are in terms of percentage similarity. From the

1. Using the statistical analysis package, GENSTAT.

similarity matrix, further data representations can be generated, particularly the clusters themselves. The matrix is scanned first for units which are 100% similar and any occurrences displayed. From this point the criterion level is gradually reduced, with clusters identified at any particular criterion level being printed. The procedure continues until all units have been clustered. The great advantages of the technique were that it required no assumptions in its use and that the relationships between individuals were clearly displayed, by their being grouped within a cluster. Also, because it is a hierarchical procedure, relationships between clusters could be perceived, as a result of their being merged in response to a lower similarity criterion. The products of this technique for both Characteristic Choice and Characteristic Importance for the Survey I data can be found in Appendices 6 and 7 .

The computational procedure which generated the clusters also offered an alternative data representation, the "Neighbours Table". Essentially, a specified number (in this case four) of the units who were most similar to each respondent were selected and printed out in the form of a table. These relationships were chosen from the similarity matrix and the percentage similarity between respondents was printed within the table. This form of representation of perceptual similarity proved particularly suitable for the exploration of differential perception of innovation effects which forms the substance of this chapter.

The Neighbours Table

From the Neighbours Table, relationships between respondents demonstrating 80%[2] or greater similarity were selected for further study. The neighbour grouping for each respondent was explored in detail to establish if relationships explicable in terms of the Classifying Variables

2. 80% proved a convenient cut-off point.

could be found. For this chapter the Neighbours Table of Characteristic Choice and Characteristic Importance data from Survey I was used, the results being found in Tables 7 and 8 respectively. In some cases explanations were made in terms of one Classifying Variable[3] and in others several appeared to determine the relationship established between individuals by the cluster analysis technique; some relationships required a phenomenological interpretation. Although a parsimonious approach was taken to this data analysis, the treating of each perceptual relationship as a 'case study' found a multitude of complex relationships. Because of the 80% cut-off, the number of neighbours varied between four and zero; in the latter case the nearest neighbour and the percentage similarity was included.

The neighbour relationships for the Characteristic Choice data (Table 7) were subjected to a content analysis procedure which sought to group them in terms of Classifying Variable and other explanations. Thirteen groupings were produced in this way, ranging from 'Multidimensional Relationships' to 'Perceptual Isolates' and these were used as a coding frame for the categorisation of the Characteristic Importance data (Table 8). Each neighbour relationship was classified with the letters a-m[4], in line with the following description of each group. The coding of each relationship was by means of a primary criterion, for example "Occupational Role", however, in certain cases supplementary causes of perceptual similarity were also found. The nature of the relationships were treated in a hierarchical manner, with the simplest and most 'powerful' cause being

3. In line with the findings of the previous chapter Occupational Role, Management Level and Company were concentrated upon, with the addition of membership particular adoption teams.

4. These can be found in the column marked "Cl" (class) in Tables 7 and 8.

used for coding purposes. The nature of each grouping was determined by the manipulation of the data through the content analysis, rather than some a priori reasons, to produce meaningful, reasonably sized combinations of similarly determined perceptual pairs. The number of relationships included in each grouping, for both Characteristic Choice and Characteristic Importance data, ranged from 9 to 32 distinct pairs - reciprocal relationships being ignored. The definition of the relationship between neighbours for each grouping being as follows:

a) Multidimensional Relationships

n = 22

The primary definition for this group was that the perceptually similar individuals were the same in terms of Company, Occupational Role, Management Level and were involved in the adoption of particular innovations. In some cases, this relationship was supplemented by other factors, for example, the pairing of Production Engineerings (6) and (7) who work in the same department of Company Y.

This grouping undoubtedly provides support for the Multidimensional Hypothesis, commonality of perception being generated by a combination of a number of Classifying Variables.

b) Occupational Role and Management Level Relationships

n = 13

All members of this group have the same Occupational Role and Management Level, providing support for the relevant hypotheses, as well as some multidimensional effects. Certain of the members of this group are also the same in terms of such variables as Company and the adoption of particular innovations.

c) Same/Similar Management Level and Occupational Role Relationships

n =13

All members of this group are either the same or similar in terms of Occupational Role and Management Level; some being the same in terms of one of these variables and similar in terms of the other, some being similar in terms of both. This grouping can be seen as a weaker form of the previous grouping (Section b) and provides support for the same hypothesis. Supplementary contributions to the similarity of perception included Company and involvement in the adoption of particular innovations.

d) Same Occupational Role Relationships

n = 9

The primary determinant of this grouping was that the individuals had the same Occupational Role and is primarily a support for the Occupational Role Hypothesis, although other variables, such as Company contribute to the perceptual similarities.

e) Same Management Level Relationships

n = 15

The primary determinant of this grouping was that the individuals had the same Management Level and is primarily support for the Management Level Hypothesis, although other variables, such as Company, contribute to the perceptual similarities.

f) Company/Similar Management Level Relationships

n = 24

The perceptual similarities occuring within this grouping were primarily determined by the individuals belonging to the same company and having a similar Management Level. Some perceptual similarities also featured involvement in the adoption of particular innovations. This grouping provides support for the Organisational and Management Level Hypotheses.

g) Similar Occupational Role Relationships

n = 10

All the perceptual similarities belonging to this grouping have similar Occupational Roles, providing support for that hypothesis. Some perceptual pairings also involved Company effects.

h) Similar Management Level Relationships

n = 9

All the perceptual similarities belonging to this group have similar Management Level, providing support for that hypothesis.

i) Company Relationships

n = 13

All members of this group belong to the same company and consequently provide support for the Organisational Hypothesis.

j) Superior/Subordinate and Involvement in Adoption Relationships

n = 10

All perceptual pairs belonging to this grouping were closely linked in organisational terms. Essentially one of the pair was the subordinate of the other, generally were situated in the same department and obviously belonged to the same company. As might be expected, all pairs were involved in the adoption of one or more innovations.

This grouping provides support for a particular facet of the Organisational Hypothesis. The individuals perceptually linked here were close in organisational terms, with consequent effects upon their cognitive structuring - reflected in their perceptual similarity. It should be noted, however, that none of the member pairs belong to the same Occupational Role, highlighting the complexity of organisational structure and the difficulty of defining occupational function.

k) Involvement in Adoption Relationships

n = 20

All perceptual pairs in this grouping were involved in the adoption of one or more innovations and demonstrated the effects of similar experiences upon perception of innovation. It is likely that those who contribute to a collective adoption decision will be involved in other collective activities which will affect their structuring of experience. Moreover, a number of these perceptual pairings were of individuals who were involved in the adoption of CAD - computing, like accounting, proving a powerful determinant of perceptual similarity.

l) Phenomenological Relationships

n = 32

These relationships were ones beyond any definition that could be provided by the Classifying Variables. Moreover, many of the relationships were determined by the individual's identification with groups other than those by which they were classified. Three primary forms of explanation were encompassed within this grouping:

(i) 'Upward Looking' Individuals.
(ii) 'Downward Looking' Individuals.
(iii) Production/Production Engineering Orientation.

The first two of these explanations refer to individuals who identify strongly with groups at a higher or lower Management Level than that which they occupy. 'Upward Looking' individuals are probably ambitious and consequently identify strongly with higher management groups. 'Downward Looking' individuals, on the other hand, appear to be persons who have not been signicantly affected by their career progression, psychologically remaining at an earlier 'occupational development' stage. Both these phenomena being aspects of an occupational socialisation process.

The 'Production/Production Engineering Orientation' was a description of a common interest in the production process. Within manufacturing industry there is a close cooperation5 between those in the production, production engineering and engineering functions, with a likelihood of an integration of perceptual outlook. Some individuals, such as Works Manager (13) retain their engineering outlook, as witnessed by his being grouped with Design Engineer (46) - Works Manager (13) was also seen as being 'downward looking'.

This grouping also contains relationships between Director (29) and those fulfilling an accounting function - Controller Capital Investment (39), Materials Costing Officer (45) and Works Accountant (44). It appears, therefore, that Director (29) through the demands of his current function must take great account of finacial matters and consequently thinks somewhat as accountants do.

Overall, the relationships featured within this grouping were the product of phenomenological processes, rather than factors which could be 'objectively' ascribed.

m) Perceptual Isolates

n = 14

Within the neighbours table were individuals who had no neighbours, these being referred to as perceptual isolates. This must be considered as relative isolation, as the range of similarity displayed between these individuals and their 'nearest neighbour' was 66.7 - 79.1% and consequently

5. While not wishing to ignore the friction that may occur between these functions, they will often be working towards the same aims and are closer to each other than other functional areas.

some were only a little below the cut-off point. However, this arbitrary decision process was found convenient within the study as a whole and is no different to other statistical practices, such a statistical significance levels being set at 5%.

Beyond the neighbour pairs were considerations of the neighbour groupings as a whole. Some clusters of neighbours could be explained by reference to a wider similarity of background which acted as a determinant of perception of innovation. For Characteristic Choice data (Table 7), for example, we had the neighbours of Technical Director (24), who were all involved in the adoption and operation of CAD by Company Y; a similar causation applying to the neighbours of Drawing Office Manager (26). Indeed the latter was one of the members of the group around Technical Director (24); Manager (27) also being common to both groups. This CAD orientation could be extended to include the neighbours of Technical Director (25) where, again, commonality of function could be perceived.

Other neighbour groupings, such as those around Project Engineer (35) (Table 7) and Production Engineer (2), Chief of Engineering Computing (19), Production Engineering Manager (43) and Works Accountant (44) (all Table 8) were attributable to Company effects. Management Level clusters were also in evidence, such as that around Production Engineer (9) (Table 7) - all of his neighbours were at Management Level 2 (Upper Middle Management), Production Engineer (9) being seen as 'upward looking'. The means of identifying such individuals was through their being connected to a number of higher level people; the same being true of the identification of 'downward looking' individuals - for example, Technical Director (24) (Table 8).

The analysis of differential perception was also complicated by the occurrence of 'step-wise linkage'. For example, Production Resources Manager (3) was linked by company effects to CAD Manager (22) and by Management Level and company effects to Production Engineering Services Manager (16); the third neighbour was Production Engineering Manager (43) who was related through Management Level alone. If one looked at the degree of similarity, the first relationship showing Management Level and Company effects was strongest, the second, showing a Company effect, was weaker, and the third, Management Level alone, weaker still. This suggested that company climate was a strong determinant of perception of innovation. The neighbours of Production Manager (42) (Table 8) were linked to Manufacturing Manager (17) through having the same Occupational Role and Management Level and to Accountant (37) through Company and involvement in the adoption of Hot Ball Rolling. In this case Occupational Role and Management Level proved stronger determinants than Company and the collective adoption decision.

A further example of 'step-wise linkage' was provided by Production Engineers (2), (6) and (7). Although highly similar, these individuals demonstrated a lack of reciprocal relationship. The Neighbours of Production Engineer (2) (see Fig 7) included Production Engineer (7). The only neighbour of Production Engineer (6) was Production Engineer (7) (see Fig 8). However the two neighbours of Production Engineer (7) were Production Engineers (2) and (6) (see Fig 9). From this it was concluded that there was a gradation of perception of innovation across these engineers, with Production Engineer (7) holding the middle position.

Fig 7 - Production Engineer (2) and His Neighbours

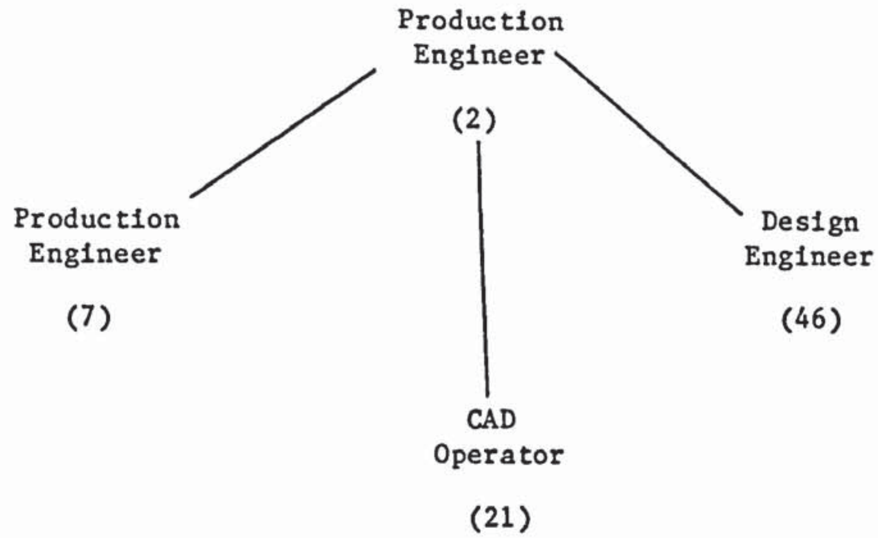


Fig 8 - Production Engineer (6) and His Neighbour

Fig 9 - Production Engineer (7) and His Neighbour

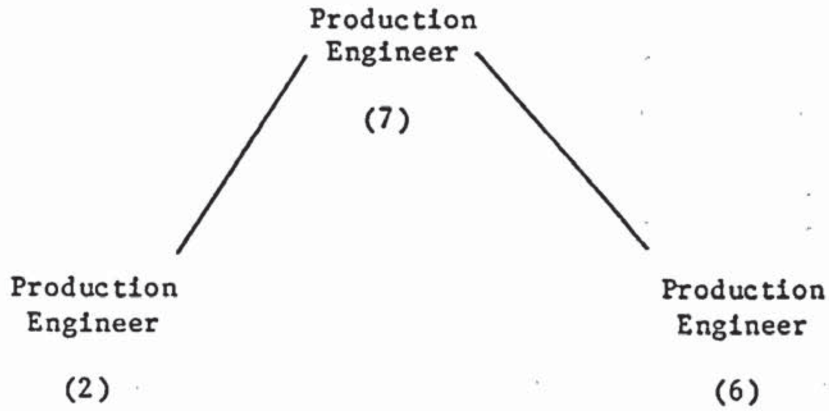


Table 7: Characteristic Choice Neighbours Table

Unit	Neighbours	Relationships	Cl
(1) Chief of Production Engineering Services	(11) Manufacturing Manager	Company; Adoption of Hardinge Lathe.	k
	(4) Production Manager	Company; Adoption of Wadkin, Marden Wire Wrapper and Hardinge Lathe.	k
	(27) Manager	Company.	i
	(10) Production Engineering Services Manager	Company; Adoption of Hardinge Lathe.	k
(2) Production Engineer	(7) Production Engineer	Company; Same Occupational Role and Management Level; Adoption of Hardinge Lathe and Wadkin.	a
	(21) CAD Operator	Company; Similar Management Level.	f
	(46) Design Engineer	Same Occupational Role and Management Level.	b

Table 7: Characteristic Choice Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(3) Production Resources Manager	(16) Production Engineering Services Manager	Company; Same Occupational Role and Management Level; Adoption of Hardinge Lathe and Wadkin.	a
	(22) CAD Manager	Company; Similar Management Level.	f
	(43) Production Engineering Manager	Same Occupational Role and Management Level.	b
(4) Production Manager	(10) Production Engineering Services Manager	Company; Same Management Level and Similar Occupational Role; Adoption of Hardinge Lathe.	c
	(14) Works Manager	Company, Same Management Level and Similar Occupational Role; Adoption of Hardinge Lathe and Wadkin.	c
	(9) Production Engineer	Company; Adoption of Hardinge Lathe.	k
	(11) Manufacturing Manager	Company; Same Management Level and Occupational Role; Adoption of Hardinge Lathe.	a

Table 7: Characteristic Choice Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(5) Works Manager		Nearest Neighbour - Production Engineer (2): 76.7%	m
(6) Production Engineer	(7) Production Engineer	Company (same department); Same Occupational Role and Management Level; Adoption of Hardinge Lathe and Wadkin.	a
(7) Production Engineer	(6) Production Engineer	Company (same department); Same Occupational Role and Management Level; Adoption of Hardinge Lathe and Wadkin.	a
	(2) Production Engineer	Company; Same Occupational Role and Management Level; Adoption of Hardinge Lathe and Wadkin.	a
(8) Technical Director		Nearest Neighbour- Chief of Production Engineering Services (1): 73.3%	m

Table 7: Characteristic Choice Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(9) Production Engineer	(14) Works Manager	Company.	i
	(4) Production Manager	Company; Adoption of Hardinge Lathe.	k
	(10) Production Engineering Services Manager	Company (same department); Adoption of Hardinge Lathe.	j
	(12) Works Accountant	Company.	i
(10) Production Engineering Services Manager	(4) Production Manager	Company; Same Management Level and Similar Occupational Role; Adoption of Hardinge Lathe.	c
	(14) Works Manager	Company; Same Management Level and Similar Occupational Role; Adoption of Hardinge Lathe.	c
	(42) Production Manager	Same Management Level and Similar Occupational Role.	c
	(9) Production Engineer	Company (same department); Adoption of Hardinge Lathe.	j

Table 7: Characteristic Choice Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(11) Manufacturing Manager	(1) Chief of Production Engineering Services	Company; Similar Management Level; Adoption of Hardinge Lathe.	f
	(4) Production Manager	Company; Same Management Level and Occupational Role; Adoption of Hardinge Lathe.	a
	(10) Production Engineering Services Manager	Company (both subordinates of Works Manager (13) ; Same Management Level and Occupational Role; Adoption of Hardinge Lathe.	a
	(14) Works Manager	Company; Same Management Level and Occupational Role; Adoption of Hardinge Lathe.	a
(12) Works Accountant	(14) Works Manager	Company; Same Management Level; Adoption of Hardinge Lathe.	e
	(4) Production Manager	Company; Same Management Level; Adoption of Hardinge Lathe.	e
	(9) Production Engineer	Company (subordinates of Works Manager (13)); Adoption of Hardinge Lathe.	j
	(10) Production Engineering Services Manager	Company (subordinates of Works Manager (13)); Same Management Level; Adoption of Hardinge Lathe.	e

Table 7: Characteristic Choice Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(13) Works Manager	(46) Design Engineer	Production/Production Engineering Orientation - 13 has an engineering orientation, his original means of employment.	1
(14) Works Manager	(4) Production Manager	Company; Same Management Level and Occupational Role; Adoption of Hardinge Lathe and Wadkin.	a
	(9) Production Engineer	Company; Adoption of Hardinge Lathe.	k
	(10) Production Engineering Services Manager	Company; Same Management Level and Similar Occupational Role; Adoption of Hardinge Lathe.	c
	(12) Works Accountant	Company; Same Management Level; Adoption of Hardinge Lathe.	e
(15) Works Accountant	(44) Works Accountant	Same Occupational Role and Management Level.	b
	(37) Accountant	Same Occupational Role.	d

Table 7: Characteristic Choice Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(16) Production Engineering Services Manager	(35) Project Engineer	Production/Production Engineering Orientation.	1
	(3) Production Resources Manager	Company; Same Occupational Role and Management Level; Adoption of Hardinge Lathe and Wadkin.	a
	(4) Production Manager	Company; Same Occupational Role and Management Level; Adoption of Hardinge Lathe and Marden Wire Wrapper.	a
	(11) Manufacturing Manager	Company; Same Management Level and Occupational Role; Adoption of Hardinge Lathe.	a
(17) Manufacturing Manager	(11) Manufacturing Manager	Company; Same Management Level and Occupational Role; Adoption of Hardinge Lathe.	a
	(12) Works Accountant	Company; Same Management Level; Adoption of Hardinge Lathe.	e
	(14) Works Manager	Company; Same Management Level and Occupational Role; Adoption of Hardinge Lathe and Wadkin.	a
	(16) Production Engineering Services Manager	Company; Same Management Level and Occupational Role; Adoption of Hardinge Lathe and Wadkin.	a

Table 7: Characteristic Choice Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(18) Assistant Production Director	(26) Drawing Office Manager	Company; Adoption of CAD.	k
(19) Chief of Engineering Computing	(25) Technical Director	Company; Adoption of CAD.	k
	(23) CAD Operator	Company; Same Occupational Role; Adoption of CAD.	d
(20) Section Leader	(32) Quality Control Manager	Production/Production Engineering Orientation.	h
(21) CAD Operator	(2) Production Engineer	Company; Similar Management Level.	f
(22) CAD Manager	(4) Production Manager	Company; Similar Management Level.	f
	(9) Production Engineer	Company; Production/Production Engineering Orientation.	i
	(10) Production Engineering Services Manager	Company; Similar Management Level.	f
	(14) Works Manager	Company; Similar Management Level.	f

Table 7: Characteristic Choice Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(23) CAD Operator	(27) Manager	Company; Same Occupational Role; Adoption of CAD.	d
	(19) Chief of Engineering Computing	Company; Same Occupational Role; Adoption of CAD.	d
	(22) CAD Manager	Company; Same Occupational Role; 22 is a superior of 23; Adoption of CAD.	d
	(25) Technical Director	Company; Adoption of CAD.	k
(24) Technical Director		Nearest Neighbour - Chief of Production Engineering Services (1) : 66.7%.	m
(25) Technical Director	(26) Drawing Office Manager	Company; 25 is a superior of 26; Adoption of CAD.	j
	(19) Chief of Engineering Computing	Company; Adoption of CAD.	k
	(27) Manager	Company; 25 is a superior of 27; Adoption of CAD.	j
	(22) CAD Manager	Company; Adoption of CAD.	k

Table 7: Characteristic Choice Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(26) Drawing Office Manager	(25) Technical Director	Company; 25 is a superior of 26; Adoption of CAD.	j
	(1) Chief of Production Engineering Services	Company; Similar Management Level.	f
	(18) Assistant Production Director	Company; Adoption of CAD.	k
	(27) Manager	Company; Same Management Level and Occupational Role; Adoption of CAD.	a
(27) Manager	(23) CAD Operator	Company; Same Occupational Role; Adoption of CAD.	d
	(1) Chief of Production Engineering Services	Company; Similar Management Level.	f
	(25) Technical Director	Company; 25 is a superior of 27; Adoption of CAD.	j
	(4) Production Manager	Company.	i

Table 7: Characteristic Choice Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(28) System Manager	(4) Production Manager	Company.	i
	(9) Production Engineer	Company; Same Management Level.	e
	(11) Manufacturing Manager	Company.	i
	(10) Production Engineering Services Manager	Company. Company.	i
(29) Director	(44) Works Accountant	29 appears to operate as an accountant.	1
(30) Technical Director	(43) Production Engineering Manager	Similar Management Level; Production /Production Engineering Orientation	h
(31) Production Engineering Manager	(35) Project Engineer	Company; 31 is a superior of 35; Adoption of Autoball Dispenser and Autowrapping Machine.	j
	(36) Manager Special Products Unit	Company; Similar Management Level and Occupational Role.	c

Table 7: Characteristic Choice Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(32) Quality Control Manager	(20) Section Leader	Similar Management Level.	h
	(36) Manager Special Products Unit	Company; Same Occupational Role and Similar Management Level.	c
(33) Production Manager		Nearest Neighbour - Project Engineer (35): 76.7%	m
(34) Chief Development Engineer	(36) Manager Special Products Unit	Company; Same Management Level and Similar Occupational Role.	c
(35) Project Engineer	(36) Manager Special Products Unit	Company; Similar Occupational Role.	g
	(31) Production Engineering Manager	Company; 31 is a superior of 35; Adoption of Autoball Dispenser and Autowrapping Machine.	j
	(16) Production Engineering Services Manager	Production/Production Engineering Orientation.	1.
	(37) Accountant	Company; Similar Management Level.	f

Table 7: Characteristic Choice Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(36) Manager Special Products Unit	(35) Project Engineer	Company; Similar Occupational Role.	g
	(31) Production Engineering Manager	Company; Similar Management Level and Occupational Role.	c
	(16) Production Engineering Services Manager	Similar Management Level, and Occupational Role.	c
	(32) Quality Control Manager	Company; Same Occupational Role and Management Level.	b
(37) Accountant	(15) Works Accountant	Same Occupational Role.	d
	(35) Project Engineer	Company; Similar Management Level.	f
	(44) Works Accountant	Company; 44 is a superior of 37; Same Occupational Role; Adoption of Fluid Fire.	d
(38) Chief Development Engineer	(10) Production Engineering Services Manager	Similar Occupational Role. Similar Occupational Role.	g
	(40) Area Manager	Company; Adoption of Hot Ball Rolling.	k

Table 7: Characteristic Choice Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(39) Controller Capital Investment		Nearest Neighbour - Production Engineering Manager (43): 76.7%.	m
(40) Area Manager	(4) Production Manager	Similar Management Level.	h
	(10) Production Engineering Services Manager	Similar Management Level.	h
	(14) Works Manager	Similar Management Level.	h
	(1) Chief of Production Engineering Services	1 is seen as being 'upward looking'.	1
(41) Chief Production Engineer	(4) Production Manager	Similar Occupational Role and Management Level.	c

Table 7: Characteristic Choice Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(42) Production Manager	(10) Production Engineering Services Manager	Same Management Level and Similar Occupational Role.	c
	(4) Production Manager	Same Management Level and Occupational Role.	b
	(14) Works Manager	Same Management Level and Occupational Role.	b
	(9) Production Engineer	Similar Occupational Roles.	g
(43) Production Engineering Manager	(3) Production Resources Manager	Same Occupational Role and Management Level.	b
	(10) Production Engineering Services Manager	Same Occupational Role and Management Level.	b
	(16) Production Engineering Services Manager	Same Occupational Role and Management Level.	b
	(30) Technical Director	Similar Management Level.	h

Table 7: Characteristic Choice Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(44) Works Accountant	(15) Works Accountant	Same Management Level and Occupational Role.	b
	(45) Materials Costing Officer	Company; 44 is a superior of 45; Same Occupational Role; Adoption of Fluid Fire and Form Flo.	d
	(29) Director	Similar Management Level; 29 appears to act as an accountant.	h
	(37) Accountant	Company; 44 is a superior of 37; Same Occupational Role; Adoption of Fluid Fire.	d
(45) Materials Costing Officer	(44) Works Accountant	Company; 44 is a Superior of 45; Same Occupational Role; Adoption of Fluid Fire and Form Flo.	d
(46) Design Engineer	(2) Production Engineer	Same Occupational Role and Management Level.	b
	(13) Works Manager	13 appears to be a 'downward looking' individual.	1

Table 7: Characteristic Choice Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(47) Design Engineer		Nearest Neighbour - Production Engineering Manager (31): 66.7%.	m

Table 8: Characteristic Importance Neighbours Table

Unit	Neighbours	Relationships	Cl
(1) Chief of Production Engineering Services		Nearest Neighbour - Works Manager (13): 73.1%	m
(2) Production Engineer	(19) Chief of Engineering Computing	Company; Adoption of Transdata Terminal.	k
	(6) Production Engineer	Company; Same Occupational Role and Management Level; Adoption of Hardinge Lathe and Wadkin.	a
	(24) Technical Director	Company; Adoption of Transdata Terminal.	k
	(7) Production Engineer	Company; Same Occupational Role and Management Level; Adoption of Hardinge Lathe and Wadkin.	a

Table 8: Characteristic Importance Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(3) Production Resources Manager	(46) Design Engineer	Production/Production Engineering Orientation.	1
	(29) Director	Company; Adoption of Max-E-Trace.	k
	(44) Works Accountant	Company; Same Management Level; Adoption of Hardinge Lathe and Wadkin.	e
	(15) Works Accountant	Company; Same Management Level; Adoption of Hardinge Lathe and Wadkin.	e
(4) Production Manager		Nearest Neighbour - Works Manager (13): 75.1%	m
(5) Works Manager	(47) Design Engineer	Production/Production Engineering Orientation.	1
	(13) Works Manager	Company; Same Occupational Role and Management Level; Adoption of Hardinge Lathe.	a
	(33) Production Manager	Same Occupational Role and Management Level.	b
	(7) Production Engineer	Company; 5 is a superior of 7; Adoption of Hardinge Lathe.	j

Table 8: Characteristic Importance Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(6) Production Engineer	(26) Drawing Office Manager	Company; Similar Management Level.	f
	(2) Production Engineer	Company; Same Occupational Role and Management Level; Adoption of Hardinge Lathe and Wadkin.	a
(7) Production Engineer	(13) Works Manager	Company; Production/Production Engineering Orientation; Adoption of Hardinge Lathe.	k
	(8) Technical Director	Company; 8 is a superior of 7; Adoption of Max-E-Trace, Hardinge Lathe and Wadkin.	j
	(39) Controller Capital Investment	Similar Management Level.	h
	(5) Works Manager	Company; 5 is a superior of 7; Adoption of Hardinge Lathe.	j

Table 8: Characteristic Importance Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(8) Technical Director	(30) Technical Director	Company; Same Occupational Role and Management Level; Adoption of Transdata Terminal.	a
	(45) Materials Costing Officer	45 appears to be an 'upward looking' individual.	1
	(35) Project Engineer	Production/Production Engineering Orientation.	1
	(46) Design Engineer	Production/Production Engineering Orientation.	1
(9) Production Engineer	(40) Area Manager	Production/Production Engineering Orientation.	1
(10) Production Engineering Services Manager	(45) Materials Costing Officer	45 appears to be an 'upward looking' individual.	1
	(44) Works Accountant	Same Management Level.	e
	(3) Production Resources Manager	Company; Same Occupational Role and Management Level; Adoption of Hardinge Lathe.	a
	(8) Technical Director	Company; Similar Management Level; Adoption of Hardinge Lathe.	f

Table 8: Characteristic Importance Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(11) Manufacturing Manager		Nearest Neighbour - Manufacturing Manager (17): 78.4%.	m
(12) Works Accountant	(45) Materials Costing Officer	Same Occupational Role.	d
	(31) Production Engineering Manager	Same Management Level.	e
	(35) Project Engineer	35 appears to be an 'upward looking' individual.	1
	(44) Works Accountant	Same Occupational Role and Management Level.	b
(13) Works Manager	(37) Accountant	37 has 'upward looking' tendancies and 13 has 'downward looking' ones.	1
	(7) Production Engineer	Company; Production/Production Engineering Orientation; Adoption of Hardinge Lathe.	k
	(5) Works Manager	Company; Same Occupational Role and Management Level; Adoption of Hardinge Lathe.	a
	(45) Materials Costing Officer	45 has 'upward looking' tendancies and 13 has 'downward looking' ones.	1

Table 8: Characteristic Importance Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(14) Works Manager	(45) Materials Costing Officer	45 appears to be an 'upward looking' individual.	1
	(12) Works Accountant	Company; Same Management Level; Adoption of Hardinge Lathe.	e
	(29) Director	Company; 29 direct superior of 14; Similar Management Level.	h
	(44) Works Accountant	Same Management Level.	e
(15) Works Accountant	(34) Chief Development Engineer	Similar Management Level.	h
	(3) Production Resources Manager	Company; Same Management Level; Adoption of Hardinge Lathe and Wadkin.	e
	(46) Design Engineer	46 appears to have 'upward looking' tendancies.	1
	(29) Director	Company; Similar Management Level.	f

Table 8: Characteristic Importance Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(16) Production Engineering Services Manager		Nearest Neighbour - Technical Director (24): 76.9%.	m
(17) Manufacturing Manager	(42) Production Manager	Same Occupational Role and Management Level.	b
	(31) Production Engineering Manager	Same Management Level and Similar Occupational Role.	c
	(41) Chief Production Engineer	Similar Management and Occupational Role.	c
(18) Assistant Production Director	(33) Production Manager	Similar Management Level.	h
	(47) Design Engineer	Production/Production Engineering Orientation.	l
	(39) Controller Capital Investment	39 appears to have 'upward looking' tendancies.	l
(19) Chief of Engineering Computing	(8) Technical Director	Company; Adoption of Transdata Terminal.	k
	(2) Production Engineer	Company; Adoption of Transdata Terminal.	k

Table 8: Characteristic Importance Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(20) Section Leader		Nearest Neighbour - Technical Director (24): 78.9%.	m
(21) CAD Operator		Nearest Neighbour - CAD Manager (22): 73.3%.	m
(22) CAD Manager		Nearest Neighbour - Production Engineer (2): 79.1%.	m
(23) CAD Operator	(34) Chief Development Engineer	Production/Production Engineering Orientation.	1
(24) Technical Director	(46) Design Engineer	Production/Production Engineering Orientation.	1
	(47) Design Engineer	Production/Production Engineering Orientation.	1
	(2) Production Engineer	Company; Adoption of Transdata Terminal.	k

Table 8: Characteristic Importance Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(25) Technical Director	(15) Works Accountant	Company; Similar Management Level.	f
	(27) Manager	Company; 25 is a superior of 27; Adoption of CAD.	j
	(32) Quality Control Manager	Production/Production Engineering Orientation.	l
(26) Drawing Office Manager	(6) Production Engineer	Company; Similar.Management Level.	f
	(7) Production Engineer	Company; Similar Management Level.	f
(27) Manager	(25) Technical Director	Company; 25 is a superior of 27; Adoption of CAD.	j
(28) System Manager		Nearest Neighbour - CAD Operator (23): 78.2%.	m

Table 8: Characteristic Importance Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(29) Director	(3) Production Resources Manager	Company: Similar Management Level; Adoption of Max-E-Trace.	f
	(34) Chief Development Engineer	Production/Production Engineering Orientation.	1
	(45) Materials Costing Officer	29 appears to act as an accountant; 45 appears to be 'upward looking'.	1
	(35) Project Engineer	Production/Production Engineering Orientation.	1
(30) Technical Director	(8) Technical Director	Company; Same Occupational Role and Management Level.	b
	(45) Materials Costing Officer	45 appears to be an 'upward looking' individual.	1
	(44) Works Accountant	Similar Management Level.	h
	(29) Director	Company; 29 is a direct superior of 30; Same Occupational Role and Management Level; Adoption of CAD and Transdata Terminal.	a

Table 8: Characteristic Importance Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(31) Production Engineering Manager	(12) Works Accountant	Same Management Level.	e
	(45) Materials Costing Officer	Company.	i
	(44) Works Accountant	Company; Same Management Level.	e
	(46) Design Engineer	Company; 31 is a superior of 46.	i
(32) Quality Control Manager	(3) Production Resources Manager	Similar Occupational Role.	g
	(5) Works Manager	Same Occupational Role.	d
	(34) Chief Development Engineer	Company; both subordinates of 31; Adoption of Autoball Dispenser and Autowrapping Machine.	j
	(15) Works Accountant	Similar Management Level.	h

Table 8: Characteristic Importance Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(33) Production Manager	(45) Materials Costing Officer	Company.	i
	(44) Works Accountant	Company; Same Management Level.	e
	(46) Design Engineer	Company; Similar Occupational Role.	g
	(47) Design Engineer	Company; Similar Occupational Role.	g
(34) Chief Development Engineer	(45) Materials Costing Officer	Company; Similar Management Level.	f
	(15) Works Accountant	Similar Management Level.	h
	(29) Director	Production/Production Engineering Orientation.	l
	(12) Works Accountant	Similar Management Level.	h

Table 8: Characteristic Importance Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(35) Project Engineer	(45) Materials Costing Officer	Company; Similar Management Level.	f
	(44) Works Accountant	Company.	i
	(29) Director	Production/Production Engineering Orientation; 35 appears to be an 'upward looking' individual.	1
	(12) Works Accountant	35 appears to be an 'upward looking' individual.	1
(36) Manager Special Products Unit	(29) Director	36 appears to be 'upward looking', young for his level of responsibility.	1
	(45) Materials Costing Officer	Company; Similar Management Level; Adoption of Fluid Fire.	f

Table 8: Characteristic Importance Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(37) Accountant	(39) Controller Capital Investment	Company; Same Occupational Role and Management Level.	b
	(13) Works Manager	13 has 'downward looking' tendancies and 37 has 'upward looking' ones.	1
	(34) Chief Development Engineer	Company; Similar Management Level.	f
	(5) Works Manager	5 has 'downward looking' tendancies and 37 has 'upward looking ones.	1
(38) Chief Development Engineer	(8) Technical Director	Production/Production Engineering Orientation.	1
	(5) Works Manager	Similar Occupational Role.	g
(39) Controller Capital Investment	(37) Accountant	Company; Same Occupational Role and Management Level.	b
	(29) Director	29 appears to act as an accountant.	1
	(35) Project Engineer	Company; Similar Management Level.	f
	(45) Materials Costing Officer	Company; Same Occupational Role and Management Level; Adoption of Form Flo.	a

Table 8: Characteristic Importance Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(40) Area Manager	(12) Works Accountant	Similar Management Level.	h
	(45) Materials Costing Officer	Company; Adoption of Form Flo.	k
	(41) Chief Production Engineer	Company; Adoption of Form Flo.	k
	(10) Production Engineering Services Manager	Similar Management Level.	h
(41) Chief Production Engineer	(31) Production Engineering Manager	Company; Similar Occupational Role and Management Level.	c
	(44) Works Accountant	Company; Similar Management Level; Adoption of Form Flo.	f
	(45) Materials Costing Officer	Company; Similar Management Level; Adoption of Form Flo.	f
	(8) Technical Director	Production/Production Engineering Orientation.	1
(42) Production Manager	(17) Manufacturing Manager	Same Occupational Role and Management Level.	b
	(37) Accountant	Company; Adoption of Hot Ball Rolling.	k

Table 8: Characteristic Importance Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(43) Production Engineering Manager	(44) Works Accountant	Company; Same Management Level; Adoption of Form Flo.	e
	(46) Design Engineer	Company; Adoption of Ball and Half-Cage Unit.	k
	(34) Chief Development Engineer	Company; Adoption of Autowrap, Autoball Dispenser, Ball and Half-Cage Unit and the Ring Storage Device.	k
	(31) Production Engineering Manager	Company; Same Management Level and Occupational Role; Adoption of Autowrapping Machine.	a
(44) Works Accountant	(45) Materials Costing Officer	Company; 44 is the superior of 45; Same Occupational Role; Adoption of Form Flo and Fluid Fire.	d
	(33) Production Manager	Company; Same Management Level.	e
	(46) Design Engineer	Company.	i
	(35) Project Engineer	Company.	i

Table 8: Characteristic Importance Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(45) Materials Costing Officer	(34) Chief Development Engineer	Company; Similar Management Level.	f
	(12) Works Accountant	Same Occupational Role.	d
	(44) Works Accountant	Company; 44 is the superior of 45; Same Occupational Role; Adoption of Fluid Fire and Form Flo.	d
	(47) Design Engineer	Company; Similar Management Level.	f
(46) Design Engineer	(3) Production Resources Manager	Similar Occupational Role.	g
	(44) Works Accountant	Company.	i
	(33) Production Manager	Company; Similar Occupational Role.	g
	(45) Materials Costing Officer	Company; Similar Management Level.	f

Table 8: Characteristic Importance Neighbours Table (cont.)

Unit	Neighbours	Relationships	Cl
(47) Design Engineer	(45) Materials Costing Officer	Company; Similar Management Level.	f
	(33) Production Manager	Company; Similar Occupational Role.	g
	(24) Technical Director	Production/Production Engineering Orientation.	1
	(5) Works Manager	Similar Occupational Role.	g

Discussion

The theoretical development of differential perception of innovation, through the products of the cultural climate which generated it, suggested that the perceptions of the individual would be the product of their phenomenological field, and further, that the "social world is comprised of active, thinking individuals who behave in terms of ideas, in terms of their own theories about how their social world operates" (Tilley, 1980). To a great extent this was confirmed by the results presented in this chapter. Analysis at a fine level, which sought to establish how the person structured his evaluation of innovation, through a comparison with the perceptions of others and the search for explanatory concepts, revealed a number of aspects of the differential perception of innovation process. While it was possible to identify perceptions explicable in terms of social, group related concepts, others proved more a function of personal characteristics, or at least of identification with a group other than that expected.

Examination of the neighbours suggested that a number of relationships attributable to Occupational Role and Management Level (Sections b and c) were established. The other Classifying Variables, except Organisation (Sections f and i) as might be expected, proved less powerful in determining perceptions of innovation. In many cases the individuals concerned identified strongly with their occupational or management group and therefore perceived innovation in a common way. Organisational effects, suggesting the presence of company and departmental climate, also proved strong. There were undoubtedly more 'within-company' relationships than those 'between-company'. In some instances, also, the membership of a particular adoption team (Sections j and k) acted as a powerful determinant. As suggested by the Multidimensional Hypothesis, the strongest and tightest neighbour groups were of individuals who had commonality in terms of a number of Classifying Variables (Section a). Take for example the neighbours of Production Engineer (7) (Table 7), who were both production engineers, and who worked for the same company, two of the group belonging to the same department.

Looking at Occupational Role (principally Section d) for its power to determine perceptions of innovation, indicated differences between the roles. Computing and Accountancy proved much stronger than did the other four roles (as applied to the Survey I data). Thus Works Accountant (15) (Table 7) had two neighbours - both accountants - and CAD Operator (23) had three computing neighbours and one who was a Technical Director responsible for a CAD installation. By comparison the other four roles acted as lesser determinants, but this may be a function of their nature. Take Occupational Role 1, as exemplified by the Technical Director referred to above. The members of this role group were seen as being involved in a general management function. Obviously this is ill-defined, but a valid functional distinction. It could be expected that such individuals would associate themselves, in terms of perception of innovation, with people around them. Thus Technical Director (25), through association with computer personnel, took on their evaluation standards. This was further reinforced by the experience with such personnel during the data collection. As referred to in an earlier chapter, some top management personnel felt unable to comment on specific innovations which they had been responsible for adopting. Although they had sanctioned the expenditure, they had used the recommendations of their subordinates to make their decision and had not got personally involved. Under such conditions it would seem highly likely that their perceptions of innovation would be strongly 'coloured' by these subordinates.

In Tables 7 and 8 a fairly common description of the relationship between individuals was in terms of a 'production/production-engineering orientation' (Section 1). It became clear that Production, Production Engineering and Engineering groups were not distinct in terms of perceptions of innovation. Examination of the career structure of such personnel suggests that they are not separate:

> "A second recurrent theme of the literature has been the problems typically faced by scientists [those involved in R and D] because of the career structure of industry. In particular, concern was, and still is, expressed that scientists, in order to ascend the corporate career structure, have to switch from being actively engaged in science to management."
>
> (Griffiths, 1979)

Thus it would seem likely that many of the production personnel were previously in an engineering role and may have maintained engineering perceptions; while production engineers may be 'production orientated' with an eye to the future. In all, therefore, we had a complex inter-related grouping across these Occupational Roles, as was indicated by the findings. If one attempted to construct a 'perceptual network', in which the similarities existing between individuals were used to provide the basis of groupings of individuals, a complex pattern developed before many people were included. The presence of phenomenological explanations, stepwise linkage, the multidimensional nature of many relationships and the number of different types of relationship encountered, aggravated this situation, such that a coherent description of which individuals were related to which, and why, was not forthcoming. Hence the 'case study' approach that was advocated for this chapter. The results of the cluster analysis technique were, however, able to clarify the nature of relationships within and between groups, even if many were not attributable to the Classifying

Variables but rather a more complex pattern. If there are many cases of perceptual similarity which traverse the constructed boundaries, then the definition of such boundaries are obviously inappropriate; even though in some cases they do operate successfully. The presence within groupings, such as that provided by a particular Occupational Role, of individuals who maintain perceptions consonant with a different Occupational Role, undoubtedly weakens any simplistic statistical comparison. Instead one must recognise the complexity of the causation of differential perception of innovation and adapt research methods to this reality and in the final analysis view all relationships phenomenologically.

If we take the person and his phenomenological field as the basis of our expectations about perception of technological innovation, then we should look at the totality of his life experience. To Kelly (1955) the relationships between people were the product of a similar construction of events:

> "Commonality Corollary : To the extent that one person employs a construction of experiences which is similar to that employed by another, his psychological processes are similar to those of the other person."

Given that the development of a person's construction is the product of experience - "the replication of events" (Kelly, 1955) - then it is the degree of commonality of constructed experience which determines the similarity of perception of technological innovation. Phenomenologically, however, simple reference to life events is not necessarily sufficient. For example, two people may have occupied the same job at a certain time in their lives. To one it might have been an important, highly rewarding event; to the other just a job, a way to earn a living. The effect of experience in determining behaviour will differ from person to person depending upon the way it was constructed at the time and subsequently.

Organisational roles cannot be considered as fixed and immutable, independent of the reactions of the individuals who occupy them:

> "Even in formal organisations, however, people respond affectively to support and approval, as they do to punishment and restriction. Their behaviour in role therefore is always a mix of role-determined and other-determined characteristics."
>
> (Katz and Kahn, 1978)

The task specialisation and constraints imposed by a bureaucratic model of organisational life may well be inappropriate for most, or indeed all, organisations. Certainly the typology of organisations, such as "mechanistic-organic" (Burns and Stalker, 1961), recognises variability within organisations in respect of the parameters of particular roles, there being greater freedom within an organic environment.

The way that the individual responds to the requirements of a role may vary:

> "One dimension that served to order the data of this study was called 'role readiness'. Role readiness was defined by the newcomer's evaluation of the relevance of the job to his future work plans. If the job was seen as having little or no relevance to the work the newcomer intended to perform in the future, the newcomer was categorized as a 'role rejector.' On the other hand, if the job was seen as possessing a fair degree of relevance to his future work, the newcomer was categorized as a 'role acceptor.' Somewhat suprisingly, close to 40 percent of the monitored group fell into the role-rejecting category........... suprisingly, an analysis of the demographic characteristics of accepters and rejectors failed to reveal any differences in age,sex, education, marital status, previous work experience, occupation of spouse, or the like. In short, role readiness was not related to any of the reasonable demographic characteristics........"
>
> (Graen, 1976)

One must also recognise the operation of projection and identification:

> "Executives not only follow the norms of the organizational family they are also affected by outside groups with which they identify. Such groups tend to be at the executives own level of power and status, or somewhat above it. The information and values of these outside groups are given more weight than similar inputs from groups of lower status and power........Reciprocal to the process of identification is that of projection. In the former case, people see themselves as similar to those of greater prestige and power, in the latter, they see others as similar to themselves. Projection is the attribution to others of our own feelings and beliefs."
>
> (Katz and Kahn, 1978)

Identification with other groups could undoubtedly be perceived in the cluster analysis results, as a cause of perceptual similarities, with cases of 'upward looking' individuals, for example.

The findings presented in this chapter demonstrated a continuum of perception of technological innovation, rather than discrete 'packets' that might be expected within a differential perception of innovation approach. The continuum was, moreover, disjointed in form as to the relationships which linked the individuals within it, as demonstrated by the thirteen perceptual groupings found necessary to take account of all perceptual relationships encountered. It was significant, however, that Company effects and the membership of innovation adoption groups were important factors in establishing perceptual similarity. If one accepts that role definition is not as precise as could be expected from the bureaucratic model and that interaction leads to cognitive similarity, as can safely be assumed from work on, for example, attitudes (Newcomb, 1952), then the causes of these findings are clear. While it appeared reasonable to assume that individuals with the 'same' Occupational Role or

Management Level would have had sufficient common experiences such that they would have developed a comparable outlook in relation to technological innovation, this proved not to be verified in practice. Organisational titles are clearly only approximations to actual functions, the reality of their operation being partly due to organisational demands and partly due to the individual himself. While there were exceptions to this, such as the Accounting Occupational Role, the overall trend was towards 'role breakdown'. This process being further aggravated by the merging of role paradigms in response to the search for the 'shared reality' necessary for the achievement of collective adoption decisions.

CHAPTER FOURTEEN

DISCUSSION OF FINDINGS

The findings of this study clearly indicated that differential perception of innovation was the product of a complex process. Phenomenological propositions have been supported and it can be concluded that perceptions of innovation are determined less by who a person is, than who he thinks he is; though in many cases the two will coincide. The presence of variability attributable to differential perception of innovation cannot be denied, though at times the causation may be somewhat obscure. If one were to accept empirical relationships alone, then the case was undoubtedly proven. However, the ultimate aims of this study were rather more ambitious, and through the combination of the three approaches: the "Case Study", the "Basic Measures" and the "Fine Level Analysis", understanding was sought.

Many questions were raised by the findings documented in the previous three chapters and this discussion seeks to combine all the results presented into a coherent whole, to try to answer them. First, however, it is necessary to marshall the information.

The Case Study

The difficulties encountered during the introduction of CAD into Body Design demonstrated the effects of differential perception of innovation. At various stages of the process, individuals became involved who had different ideas about how things should be done and what should be made. The early development team, led by Fred Jones, had to attain the "same level of thinking" before they could proceed in the creation of a system specification. Later there were many problems in the relations between the Computer Services Department and the Body Design engineers. The programmers wanted a straightforward, codable specification at a level of detail the engineers were unable to give, and they also wanted things "left to the professionals", being unable to grasp that the potential users were not sophisticated enough to give them what they wanted.[1] By way of contrast, the engineers wanted to take a "hands-on" approach in order to gain experience.

The computer consultant, Ian Smith, might have been able to resolve these difficulties, being the only individual involved who had prior experience of developing such a system. However, he only seemed to complicate matters by bringing a further and apparently incomprehensible (to the ASL team) approach to the software development. The product of these disagreements, the project meeting "nausea", caused the "project to slip". In contrast, when one group, the design engineers, took complete control progress was made. The activities of the design engineers, in Body Design, demonstrated a gradual improvement in knowledge about Computer Aided Design, through contact with the technology and experimentation. As one of them, Barry Richards, described it, they were "learning and learning the hard way". This had also applied to the computer professionals who had previously been involved - although familiar with the technology and software development, they had little real knowledge of CAD. Thus we had an introduction of a technological innovation for which there was no complete "conceptual repertoire" (Masterson and Hayward, 1979) or applicable paradigm (Kuhn, 1970). A workable paradigm could have been developed if the theories (Hanson, 1958) of both had been combined.

1. The programmers demonstrated a form of "double think". On the one hand the engineers were seen as too ignorant to be directly involved and on the other as sophisticated enough to generate a clear specification.

In practice there was no one who could arbitrate, decide what should be done, what should be aimed for. The technical expertise of Ian Smith proved insufficiently strong or comprehensible[2] to the two factions. Top management, who might have forced the two groups to settle their differences and get on with the job, proved too weak to do so. Whether this was lack of interest or of technical expertise (Pettigrew, 1973) is unclear. The system specification was consequently unworkable, everybody had made their contribution with no control over the process to decide what should have priority. They included all "these great big things it ought to do", as without a clear picture of the innovation, a consensus as to its nature, decisions could not be taken as to what was important.

A recurrent theme through the case was the need for learning to occur before individuals could deal with the CAD innovation. The expertise of top management, for example, improved over time, culminating in a change from a laissez-faire attitude to tight control of computer developments. The Body Design engineers became more competent in relation to CAD, by actively experimenting with the technology and their success in developing a system can be seen as the product of this learning, generating a "CAD paradigm". It can be argued that the adoption of such an innovation requires a suitable paradigm, which was lacking for the wider adoption group (the Body Design engineers and the computer professionals). For heterophilous groups (Lazarsfeld and Merton, 1964) the very existence of a "collective" adoption decision can be brought into question, unless those involved are committed to making a decision and, therefore, make an effort to communicate and establish an appropriate paradigm.

2. Possibly if Ian Smith had been less sophisticated he might have been more successful in dealing with ASL personnel. The evidence on "Opinion Leadership" (Rogers and Shoemaker, 1971) suggests that the leader must not be too different from the other group members.

Basic Measures

The findings of the measures of value of the characteristics - frequency of choice and mean importance - provided evidence of differential perception of innovation (see Tables 9 and 10). While there was evidence of commonality of viewpoint, there were also indications of differences, for example, the perceptions of different Management Levels in relation to certain characteristics, and the differing importance ascribed to "Raw

Table 9 : Frequently Chosen Characteristics

	Occupational Role					
Characteristic	O	PE	P	E	F	C
12 Effects on Quality	X	X	X	X	X	X
1 Initial Cost	X	X		X	X	X
7 Time Saving		X	X	X	X	X
3 Rate of Return	X	X	X		X	
8 Reliability	X	X			X	X
17 Effects on Labour Requirement	X	X	X	X		
27 Unit Costs		X	X	X		X
2 Running Costs	X		X			
13 Variations in End Product	X				X	
20 Compatibility with Existing Equipment		X				X
25 Supplier's Reputation		X				X
26 After-sales Service	X		X			

O - Organisational E - Engineering

PE - Production Engineering F - Finance

P - Production C - Computing

Material Costs" by Finance and Production personnel. When the two measures of 'value' were compared, a complex relationship could be perceived. While choice of characteristic sampled the universe of things to be considered, this did not imply that only important items were dealt with in the evaluation of manufacturing innovation.

Table 10 : Important Characteristics

	Occupational Role					
Characteristic	O	PE	P	E	F	C
7 Time Saving	X	X	X	X	X	X
3 Rate of Return	X	X	X	X		X
27 Unit Costs			X	X	X	X
1 Initial Cost	X	X				X
12 Effects on Quality	X	X		X		
2 Running Cost	X					
8 Reliability					X	
10 Energy Requirements		X				
17 Effects on Labour Requirement			X			
20 Compatibility with Existing Equipment					X	
28 Possibility of Modification						X

Fine Level Analysis

By analysing the perceptions of innovation in detail, the effects of the process were clarified at the individual level, the logical conclusion of the phenomenological approach. Although this was an individual analysis, certain trends could be perceived within the clusters. The first of these indicated the great importance of organisational factors. Of the

117[3] neighbour relations for Characteristic Choice, at the 80% similarity level or above, 84 were within the company and only 33 between, thus demonstrating the importance of company climate. This was reinforced by a reasonable number of relationships which were explained by departmental links or the membership of innovation adoption teams. Another broad explanatory concept concerned the production/production-engineering dimension – a number of the neighbour linkages were attributable to this factor. It was also clear that Engineers, Production Engineers and Production personnel formed a mixed group, with perceptual similarities crossing the role boundaries. This was confirmed by the career patterns of individuals occupying these roles, as identified by Griffiths (1979). By way of contrast those occupying Financial or Computing roles provided reasonably distinct perceptual groupings. Computing and Finance personnel have more developed and distinctive occupational paradigms (Kuhn, 1970), than those occupying production/production-engineering roles and this was reflected in their perceptions of technological innovation.

The Differential Perception hypotheses received support from many of the neighbour relationships. A number of these linkages were obviously related to Management Level, Occupational Role, Age and Education although the latter two proved less important. The Multidimensional Hypothesis also received strong support. As predicted, the greater the similarity of the individuals, in terms of the Classifying Variables, the more often their perceptions of innovation were grouped. Thus we had a grouping of three Production Engineers, another of two Manufacturing Managers and so on; the relationship of the Production Engineers being further reinforced by two of them being members of the same department.

The operation of specific Classifying Variables, each contributing one relationship within a grouping of neighbours could also be perceived.

3. Out of a possible 188.

These 'step-wise linkages' could even be recognised in otherwise tight groupings, such as that of the three Production Engineers (2), (6) and (7), wherein a gradation of perception was found, with Production Engineer (7) holding the middle position. Another form of relationship concerned individuals whose perceptions were determined by factors other than the Classifying Variables. Thus we had the case of Technical Director (25) who was perceptually similar to those holding a computing role, though he was classified as "Organisational". Reference to the organisation chart shows him to be in charge of a computer installation and thus he can be considered a token computer person. There was also the case of Works Manager (13) whose only near neighbour was a Design Engineer; however, the Works Manager was originally an engineer and appears to have retained this engineering paradigm. Finally we had the cases of individuals such as Production Engineer (9) who were commonly associated with respondents who were of a different Management Level and whose perceptions could only be interpreted phenomenologically, in terms of identification with these groups.

Lawrence and Lorsch (1967) suggested that the holders of particular roles must concentrate upon areas which are related to that role. Thus manufacturing managers would concentrate upon process aspects, sales personnel on the needs of the market place, and research personnel on knowledge acquisition. However, this assumes clear differentiation, rather than a more fluid operationalisation of the roles. Guetskow (1968) performed an experimental study of the relationship between role and task, but found that the "task characteristics did not determine just how the components should be assembled into differentiated roles - nor whether these roles need be continuously played by one set of individuals or interchanged among them." If we apply such analysis to the production process then the discussions of tasks related to production, production engineering and engineering work may not be clearly defined, particularly when the career structure of these roles is taken into account. Thus the engineer or production engineer may, through circumstance, become directly involved in the production process, while the production man may have to operate as an engineer to solve production problems.

Other roles, such as Finance and Computing were more clearly defined, but even here some association, some dilution of function, was possible. The accountant, through association with the production/production-engineering personnel will learn of their ways and their language, and consequently think a little as they do. This will be reinforced by contacts in the assessment of technological innovation, where technical attributes will be seen as highly important and some awareness of these factors will be part of any assessment of an innovative development. In simple terms the accountant must learn when reference to technical advantages, suggested by production/production-engineering personnel, are valid and when they are not. Further, production/production-engineering personnel are likely to learn how to "sell ideas" to accountants, to talk in the appropriate language and make reference to financial matters to strengthen their case.[4]

Rosenberg et al (1960) demonstrated that if an individual presents material supporting a particular position, their own attitudes become more similar to those of that position. Thus we can conclude that there will be a convergence of roles where collective decision-making is common. The results make it seem likely that such a process does occur, there being evidence of a continuum of perception of innovation. From this it can be concluded that role paridigms merge in response to repeated interaction and the search for a 'shared reality' necessary for the accomplishment of a collective adoption decision.

4. Informal communication with Company Y personnel suggests that many of their engineers act as "accountants" for this purpose.

Discussion

The findings presented in this section are undoubtedly complex and the expectations of clearly defined perceptions of innovation, particularly within the organisational context, must surely now be considered premature. That Kivlin and Fliegel (1967) were able to establish perceptual groupings within agriculture, would suggest that the organisational context was an extremely difficult milieu for the study of differential perception of innovation. However, it should be stressed that the present study was more ambitious than that of Kivlin and Fliegel (1967) in that it sought not only to identify perceptual differences, but also to discover the nature of the processes and the causes of perceptual difference. The lack of straightforward explanation may be disappointing, but as Braun (1981) indicated in his presentation of "Constellation Theory", expectations of simple analysis of social phenomena, particularly manufacturing innovation, are somewhat naive:

> "It may be a truism to say that all complex phenomena - and manufacturing innovation is nothing if not a complex phenomenon - require a constellation of various circumstances to be propitious for the event to occur. The truism becomes useful when it helps us to turn our backs on the attractions of simple cause and effect relationships which are utterly inadequate to cope with the complexity of the real world, yet provide such comforting illusions of understanding. Constellation theory can never provide the simple comforts of delusion, but it can provide a framework for a deeper understanding of reality in a way which can prove useful in terms of policy actions."
>
> (Braun, 1981)

When individual perceptions were grouped in terms of variables, such as Occupational Role and Management Level, differences could indeed be discerned, as documented in the section on "Basic Measures." Such information could be of use to the practioner (eg the Marketeer) who could tailor his communication in an appropriate way. If one wishes to influence those involved in the adoption of manufacturing innovation, then the results of the Characteristic Choice and Characteristic Importance data would suggest that the majority of Occupational Roles would be interested in the "Rate of Return", "Time Saving" and "Unit Costs"; with specific roles also being concerned with other innovation characteristics. However:

> "When faced with a choice among several alternatives, people often experience uncertainty and exhibit inconsistency. That is people are often unsure which alternative they should select, nor do they always make the same choice under seemingly identical conditions. In order to account for the observed inconsistency and the reported uncertainty, choice behaviour has been viewed as a probabalistic process."
>
> (Tversky, 1972)

The practioner, therefore, would not be able to guarantee that his approach to manufacturing innovation would always be successful, as individuals may modify their cognitions over time[5]. However, the main difficulty with such aggregate data is that it only represents the perceptions shared by the majority of individuals, without reference to the importance ascribed to them by each individual. Characteristics highlighted by such a procedure may, therfore, represent the perceptual 'lowest common denominator' of the group, rather than a meaningful indication of how members of, for example, a particular Occupational Role perceive technological innovation.

There remains a question, moreover, as to whether techniques such

5. It should be pointed out here that a limited retest of respondents using the Characteristic Checklist did generate similar results, indicating that approaches to technological innovation are relatively stable over time - at least for the period between test and retest of one year.

as the checklist truly represent the cognitive structuring of the individuals who complete them, such methods being "opaque" (Harre, 1979). It would seem likely that when an individual considers technological innovation he utilises a complex procedure with trade-offs between attributes. Wallsten and Barton (1982) performed an experimental study in which subjects made decisions involving a small number of evaluative dimensions and concluded:

> "... any model that assumes that dimensions were processed independently in this experiment is wrong. This includes independent parallel models, models that assume that dimensions are sampled probabilistically according to salience, and the deterministic serial model we used."

This rejection of simplistic approaches to decision-making and the use of attributes suggests that more complex, dynamic models of these processes are required, before worthwhile analysis can be made of perceptions of technological innovation.

The final difficulty for our practioner concerns immediate needs within the manufacturing process, which affect the cognitions of those he would wish to influence. Braun (1981) suggested that the adoption of manufacturing innovation can be viewed as going through a number of phases, with the "zeroth phase of a constellation for innovation" being "the cluster of circumstances in which and under which the firm operates" and adoption, if it occurs, proceeding from the "first phase":

> "The first phase in any manufacturing innovation consists of the identification of a weak link in the existing manufacturing system. To identify such a link requires an actor (or group of actors) whose task it is to keep the production machinery as efficient as possible. The weak link may consist of a variety of individual circumstances, such as a shortage of skills, inefficient flow of production, waste of energy, waste of materials, quality of product, unreliability of machinery, high

maintenance costs, inadequate output, low productivity (capital or labour), low yield in production, contravention of safety regulations, unpleasant working conditions. The list is not exhaustive, but indicates the many flaws which may occur in a production system and which we have encountered in our case studies. It must be emphasised that weaknesses in a system are only relative to the best available practices and technologies. Weak links develop, they are not static."

(Braun, 1981)

Without knowledge of the client needs, the practioner may not pick up on what has been perceived as a "weak link" and is therfore salient at that time. Obviously in reality the practioner is likely to have good knowledge of the industry and companies with which he deals, allowing him to tailor his approach to satisfy current needs. Moreover, he may himself be a factor in the identification of a "weak link", by making the potential adopter of manufacturing innovation aware of a "new technology which had become available" (Braun, 1981).

The difficulties encountered in grouping individuals and comparing their perceptions led to the cluster analysis approach, in which similar perception itself was the primary criterion. The use of the 80% cut-off point meant that only perceptual pairings demonstrating a reasonably high level of similarity were used for further analysis. However, it was found that many of the pairings were not explicable in terms of the Classifying Variables, suggesting that dimensions other than those which seemed initially reasonable were responsible. As documented in the previous chapter, a large number of causes of perceptual similarity were encountered. The presence of stepwise linkage effects further complicated the overall pattern, suggesting that perceptions collectively formed a wide network, in which 'strange bedfellows' were found. A primary cause of this, 'role breakdown' has been discussed elswhere, as has the question of the applicability of the bureaucratic model to most organisations.

The failure of the bureaucratic model does still cause some concern, as organisational roles with similar titles and apparently similar functions should give a greater degree of consonance than has been found in this study. However, the importance of organisational factors does mitigate this concern to a great extent. While the individual's occupational and/or hierarchical paradigm may prove weaker than expected, with the exception of certain groups; the strength of company, departmental or adoption team culture proves strong, as is quite reasonable. Such a factor, although intangible, obviously has wide reaching implications. For example, company success being dependant upon how successful the company members perceive it to be (Cyert and March, 1963). Company climate, while not impinging in an overt way is a continual and evolving part of the individuals experience and clearly a large part of the "secondary socialisation" (Berger and Luckmann, 1966) is governed more by the immediate organisational environment than the occupational paradigm itself. One can obviously identify conflicts between, say, an occupational speciality, such as engineering which values technical sophistication and a company policy and climate which is stongly committed to incurring minimal costs. Such modulations upon the technical skills of such an individual are almost certain to have a cognitive effect, given the pressure towards conformity that can be brought to bear by social groups (Asch, 1956).

Such effects within organisations are commonly facets of political processes, the importance of which were indicated within the ASL case study. The prime movers in the CAD development were not technically or hierarchically positioned for the successful completion of such a project. However, under conditions of uncertainty and in a clear power vacuum, they made significant progress in their aims. The engineers, in Body Design, had a commitment and a sense of purpose that was lacking elsewhere in the organisation. Senior management, being unable to make 'rational' decisions about the development, gave general support, particularly finance. The Computer Services Department had only a political aim - that of retaining their professional status (Pettigrew, 1973). Clearly, under conditions of uncertainty an individual or group which has direction can have a significant impact upon a collective decision-making process. Although, as indicated by the third part of the case study, the organisational paradigm will re-establish itself as it assimilates the new conditions.

The power struggle at ASL, to determine who controlled the CAD, system should not, however, let us lose sight of the importance of differential perceptions within such a process. Certainly Pettigrew (1973) recognised the operation of factors which contribute to such differences and generate conflict:

> "Given the uncertain nature of the task facing the computer technologists and managers here studied, the making of a large scale computer-investment decision, and allowing for the hypothesised differences in interests, attitudes, and values between the two groups, we can expect their decision-making deliberations to be characterised by tension, conflict and misunderstanding."

That "conflict and misunderstanding" ensue within decision-making processes involving different occupational groups was supported by Pettigrew's work, as it was by the ASL case study; clearly as a product of the differing value systems being applied. In the case of ASL, it is apparent that many of the disagreements were attributable to the differing perceptions of the CAD innovation. If the two main protagonists - the Body Design engineers and the Computer Services personnel - had had a uniform perception of the development, then it would have mattered little whose power-base had been responsible for the introduction of CAD. On the contrary, the nature of the innovation, the way that it was implemented, was very much in dispute. For example, the engineers required a system that was easy to use, whereas the computer professionals were inclined towards machine efficiency - a characteristic prized within their occupational value system.

The activities of the engineers in Body Design also tends to underline the findings of the Hierarchical Cluster Analysis, being a clear example of 'role breakdown' in their attempt to 'annexe' the occupational speciality of another group - the computer professionals. Through their interest and experience, individuals, such as Barry Richards6, can move beyond the limitations of the 'legal definition' of their function; or may be forced to through circumstance. The cluster analysis results would tend to support the view that such movements are relatively common, particularly under conditions of uncertainty, such as innovative decision-making. The formal rules and practices of an organisation are orientated towards the 'steady state' and will prove weaker in more unusual areas of organisational life. Role definitions will be subject to the same loss of focus and a more "organic" (Burns and Stalker,1961) structure will ensue. Obviously, this will represent only a movement from the 'steady state' and for a highly "mechanistic" organisation the structure may remain comparitively rigid.

The individual encountering uncertainty, under conditions in which organisational roles are themselves unclear, is likely to develop 'perceptual disorientation'. When an individual is unsure of how to evaluate some event, such as technological innovation, he is likely to turn to an opinion leader (Rogers and Shoemaker, 1971) for guidance, whether or not this be in the form of an overt act. Under 'steady state' conditions organisational opinion leaders will be those who have known status through hierarchical position or professional competence. Indeed, such guidance as to the conceptualisation of organisational events are major components of the organ-

6. The Body Design engineer who carried out much of the CAD development.

isational paradigm. Most or all of these opinion leaders and the paradigm they generate will, by definition, prove unequal to the analysis of uncertainty and the organisation must modify the paradigm to take account of the new conditions.

One mechanism that has been identified in such a process is that of the adaption-innovation dimension by Kirton (1976,1980). The adaptor is the mainstay of the organisation and operates wholly within its paradigm; the innovator, on the other hand, rejects the paradigm and wishes to establish new ideas and practices. The importance of these types very much depends upon environmental conditions. Under 'steady state' the innovator operates on the periphery of organisational life, leaving the adaptors to interact and get on with the business. When faced with an innovative decision, the adaptors cannot cope, as the organisational paradigm itself is threatened. The innovator has no such reservations and will be brought in by the adaptors to deal with this 'crisis'. When the necessary changes have been made to the paradigm, to allow for new conditions, the innovator is again excluded. The adaptors move forward with the new paradigm as though it had always existed in that form, seemingly unaware that the 'rules' had ever let them down.

The paradigm switch (Kuhn, 1970) described by Kirton (1980) and in personal communication, can be seen as a learning process engaged in by the organisation members. Indeed, a central theme of this analysis of differential perception of innovation must be the way that individuals learn and the importance of experience in determining such perceptions. Examples of the 'experience factor' within this research are many, from the "education process" necessary for the initial development team at ASL, through the increasing ability of the Body Design engineers to deal with computer technology, to the importance of departmental and company climate in the analysis of the survey data, particularly the cluster analysis. Many of the neighbour relations established were attributed to departmental links, in the absence of facilating factors, such as Occupational Role. A clear example was Technical Director (25) (Table 7) who was grouped with computer personnel as a result of being currently in charge of a CAD installation. Life experience could also be seen as causal, as in the case of Works Manager (13) (Table 7), whose early engineering background has remained with him in spite of the professional changes that he has been subjected to. The latter case, however, indicates the problems involved in the identification of those life experiences which are significant from those which are not; for Works Manager (13) the important events lie in the past, whereas for 'upward looking' individuals, such as Project Engineer (35) they lie in the present anticipation of the future.

The importance of experience in determining perception of innovation and the acceptance that cognitive processes are phenomenologically determined, suggests that the possibilities for simplistic research methodologies are limited. If one adds to this the difficulties inherent in the organisational context, where an individual's role may be partly defined by himself and partly by others, the possibilities for simple research diminishes further. If, as has been established, it is the received experience which determines the individual's perceptions of technological innovation, one must seek to determine the nature of that experience and establish, at least a proportion of, the causation of that perception. But how is the researcher to identify the significant experience?

Clearly a number of factors will influence whether an individual will change as the result of any experience, including that of a group decision-making process:

> "Changes in group member cognition in fact can occur as a result of changes in available information and changes in personal wants (both interdependent). While this may suggest to management that orientation of, say, sales personnel to a problem may be changed to a more desirable orientation by the provision of appropriate information, it must be remembered that new information does not always bring about cognitive change in recipients. Any change will also be mediated by the number and variety of cognitions incorporated in one person's cognitive system, by the extent to which the elements of his cognitive system coexist, and by the extent to which this one cognitive system is interconnected with his other cognitive systems. Convincing an accountant that his view of the corporate budget as a mere cost minimising device is rather too narow and potentially dysfunctional for the whole company may not be a simple matter of changing that cognition. It may require a change in a number of his related cognitions about the scope of the accountant's task, the role of management and the goals of the company. Group member's personalities also influence their susceptibility to cognitive change through intellectual ability for reorganising beliefs, ability to tolerate ambiguities and inconsistencies and the extent of their closed mindedness.
>
> (Parker, 1980)

Such a view reinforces the phenomenological analysis of Kelly (1955), amongst others, in which it must be recognised that it is the current cognitive structure and the individual's degree of commitment to that structure, which controls, to a significant extent, the response to a particular event. Thus an innovation which is consonant with the cognitive structure (a "traditional" innovation; Hayward, Allen and Masterson, 1976) is more likely to be adopted.

To establish how favourably an individual or group of individuals will respond to an innovation it is necessary to identify the judgemental dimensions used by the individuals considered. A central issue in the evaluation of perceptual findings, as to their meaningfulness, concerns the way individuals utilise the dimensions they possess. The evidence of perception of innovation research suggests that adopters of technological innovation may be less favourable, in some respects, than the non-adopters. The present research has also highlighted the presence of innovation characteristics which, although not commonly used, are considered important by those who do use them. As has previously been noted, simplistic approaches to the use of attributes in decision-making are inadequate, causing a two-stage model to be proposed:

> "In the first stage, the entire stimulus is noted, perhaps as a 'blob', as Lockhead (1972) suggested in a different context, or perhaps in terms of the seperate dimension values. This prior encoding results in a partitioning of the dimensions according to the population each favours, and a tentative binary choice is made between the populations. During the second stage of processing, the dimensions are attended to individually for the purposes of modifying quantitative opinion."
>
> and:
>
> "... dimensions are considered configurally rather than independently, such that the subjective impact of a dimension is a positive function of opinion held when the dimension is considered. Thus second-stage processing begins with a bias toward the tentatively selected population, and the order in which likelihood ratios are considered becomes crucial."
>
> (Wallsten and Barton, 1982)

This two-stage approach, with its recognition of the interactions of the dimensions and the hypothesis testing nature of the process, has a great deal of appeal as the embryo of a model of differential perception of innovation. However, such models will have to be significantly improved before they offer a realistic basis for modelling matters as complex as perception of technological innovation. Certainly the work of Wallsten and Barton (1982) is somewhat consoling to the innovation researcher who may be examining ten, twenty or thirty dimensions, as in this study, for they experienced complex results in an experiment using between three and five dimensions.

The study of differential perception of innovation in the organisational context has, left a number of problems. Knowledge of thinking and decision-making processes is extremely limited, as is that applying to organisations. Phenomenological analysis, while having the power of explanation of the findings that have been generated, presents a number of difficulties. Those who wish to examine perception and differential perception of innovation may be left with no alternative but to observe and collate perceptions, without reference to determination. Certainly techniques exist to measure perceptions and the literature is full of examples of differences between adopters and non-adopters of innovation, producers and users of innovation and so on. However, as outlined at the outset of this document a common finding of such studies concerns the variability within groups, such as adopters and non-adopters of innovation. Leaving aside the work of Kivlin and Fliegel (1967), no researchers have yet clearly identified the sub-groups within potential adoption populations that would explain such variability. This fact is significant given that it is a long-standing problem within the field and that the possibility of sub-groups being the cause of the variability was expounded by Rogers and Shoemaker (1971), an important source in the field of diffusion of innovation.

The present research would suggest that such sub-groupings do not exist. While there are clearly confounding factors, such as that of 'role breakdown' and the complexity of the use of attributes in decision-making (Wallsten and Barton, 1982), organisational roles should have some impact on cognitive functioning, which should be reflected in the individual's perception of technological innovation. Many researchers, for example Child and Ellis (1974), Choffray and Lillien (1978), and Lawrence and Lorsch (1967) would undoubtedly support this position. If groupings applied within this research were reasonable ones and variablity attributable to these groupings were not forthcoming, then 'perceptual quanta' do not exist and we must leave the 'discrete lifestyle' to the electron. From a humanist point of view, such a conclusion is clearly optimistic, emphasing as it does the uniqueness of human beings and the difficulty of placing people into neat categories. For the innovation researcher, however, it prohibits one of the mechanisms for information reduction, that of typing. The evidence of this research suggests that perceptual groupings, where they exist, are the product of multidimensional factors, with 'stepwise linkages' being causal in many cases. Clearly such a 'complex web' of perceptions makes it difficult to conceptualise the overall network to generate understanding of the process and eliminate such things as "communication hangups" (Rogers and Shoemaker, 1971).

For the future a number of research areas present themselves as worthwhile avenues to explore towards the clarification of this research area. Some of these are for other researchers, such as the cognitive psychologists and the organisational workers, and some for those who research in the general area of technological innovation. What is clearly needed is an understanding of the way that the individual structures his approach to technological innovation, the trade-offs he applies and so forth. A particular need is for techniques which allow a dynamic approach to data gathering, at the same time offering the possibility of readily available quantitative analysis. Currently we are stuck between the questionaire-type technique which constrains the individual to make compromises to fit the pre-selected pattern of variability and the non-directed interview-type approach, with all the consequent comparabilty problems, possibility of interview bias and so on. The use of interactive computer techniques may offer the possibility of solving this problem. Consider the current work on "Expert Systems" where the computer program incorporates the decision-rules employed by one or more practioners in a given field, such that in some cases the program has proved superior to a man. If one can take decision-rules utilised by doctors, horticulturalists, geologists and mathematicians, as has been done, and incorporate them into a computer program, then the same should be true of the 'rules' used to evaluate technological innovation. Work currently underway (Young, 1984) is using the programs for the development of "Expert Systems", known as "Production Systems", to research the development of cognitive skills in children and similar kinds of uses may prove worthwhile for those wishing to evaluate innovative decision-making and perceptions of innovation, especially for the clarification of differential perception effects.

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APPENDICES

Introductory Note

This appendix provides a brief description of the innovations referred to in the body of the text. It is not intended as a full description, the innovations themselves being mainly peripheral to the focus of the research and the data presented. The description has four parts: the purpose of the innovation; an innovativeness rating - an estimate of how novel the innovation was perceived to be by the potential adoption population; the need which the innovation was to satisfy; and a brief description of the essentials of the innovation itself.

The Form Flo Cold Roll Forming Machine

The Purpose: The production of inner races for bearings.

Innovativeness Rating: Fairly High.

The Perceived Need

This machine provides a means of cold forming the inner races of bearings[1] in contrast to the hot forming done previously. The main impetus for this change was to reduce production time, reduce material waste, and improve quality. The great disadvantage of hot forming was that the shaping was only approximate and a great deal of finishing work was necessary. Coupled with this were problems with quality, particularly unwanted stress characteristics. The company were keen to adopt this innovation and to a great extent acted as product champions for it. For a number of years they acted as 'underwriters' for the producers in their dealings with N.R.D.C., by guaranteeing that they would purchase the first production model.

1. Although machines have been developed which will produce outer races, the company does not consider them reliable enough, as yet.

The Machine

To produce an inner bearing race, a metal blank (an undersized ring of steel) is introduced between a pair of large (relative to the blank) dies. One of these is fixed and the other powered hydraulicallyis brought to bear on the blank, at high pressure. As the blank is rolled between the dies the ball track and recesses are formed. At right angles to the dies (but in the same plane) are two planet rolls (small shaped wheels) which are also brought to bear on the blank, to prevent deformation of the race. Once the rolling is completed the race is ejected into an oil bath2 and can be subsequently heat treated and ground.

Hot Ball Rolling

The Purpose: The production of balls for bearings.

Innovativeness Rating: Fairly High.

The Perceived Need

The adoption of this innovation is an example of technology push. Previously balls had been shaped by cold forming and subsequently heat treated, ground, flashed and lapped. Although hot forming had been attempted, it could not achieve production rates as good as those for cold forming machines (e.g. roughly 300 balls/min. for 0.5 inch diameter balls) and generally gave a low quality product. However the problems associated with cold forming, such as the need for highly skilled operators, a lot of down time and high noise levels - all as a result of the fact that the machine works by sheer power (crushing the metal to shape) - made a change in production methods desirable.

2. At this point the race is hot to the touch and the bath allows it to cool before it is moved on.

The Machine

This innovation is the result of incremental improvements which finally led to a viable machine. A critical development was the design of a tool which produced suitable grain characteristics. As in cold forming, the raw material comes as a metal bar. The steel is heated by induction and rolled between two rotating rolls, to the required shape and size. This results in much higher production speeds than cold forming and has the added advantage of requiring less finishing. One other aspect of hot forming that bears mention is that it is more suitable for continuous use than cold forming, and in fact it is better if it is not cooled down.

The Fluidised Furnace

The Purpose: The heat treating of balls.

Innovativeness Rating: Moderate.

The Perceived Need

This innovation was adopted for the simple reason that it speeded up production and reduced costs. Originally balls were heat treated in Shaker Hearths and later in Scroll Hearths - the difference being that the former moved the balls by shaking them through the furnace and the latter by using a circular motion. In both cases the balls are heated to a given temperature, kept there for a time, quenched and finally tempered. A hot gas and air mixture (gas-rich to avoid oxidation) passes through the hearth, and the heat transfers from the atmosphere to the balls. Both the shaker and the scroll were used to ensure that the balls were heated for the correct time, by moving them forward at intervals.

The Machine

The Fluidised Furnace uses silica sand into which the balls are introduced for their travel through the furnace. The travel is again achieved by a scroll. The balls sit in the fluidised sand, which allows greater heat transfer, the basic heat source still being a gas/air mixture. As a consequence the throughput is far greater, being of the order of 400 Kg/hr., in comparison with 100 Kg/hr. for a scroll hearth. As an added benefit the better heat transfer requires lower energy input, the efficency being further enhanced by the use of the exhaust gases in tempering furnaces. While the labour requirements are about the same in the area, there is a need to improve quality-control methods, to cope with the higher production speed.

The Radyne Auto-wrapping Machine

The Purpose: The wrapping of medium-sized bearings.

Innovativeness Rating: Moderate.

The Perceived Need

The adoption of this innovation was mainly to reduce labour costs but also to complete a fairly automated production line in which it was installed. Prior to the introduction of this machine the finished bearings were taken from the assembly area to a packing station. Packers would then wrap the bearing in paper and place it into a box. The company were keen to reduce the labour costs involved in this process, but a suitable packer was unavailable. Consequently they contacted a number of companies specialising in polythene welding, and of these only Radyne felt able to provide a proposal for a machine. The company paid half of Radyne's development costs and subsequently purchased a usable machine.

The machine constitutes the final part of a semi-automated production line. The parts which constitute the ball bearing are brought to the assembly area (see Auto-Ball Dispenser) and when completed are conveyed to the Auto-wrapper. The bearings are fed into the machine at a controlled speed and each is brought to a halt so that it lies between two layers of polythene. A welder is brought to bear, so that the bearing is sealed into a polythene bag. The operator removes the packaged bearing from the waste film whilst the edges are still warm and stacks it with others ready to be removed to final store and eventual despatch.

The Auto-Ball Dispenser

The Purpose: The assembly of bearings.

Innovativeness Rating: Moderate.

The Perceived Need

This piece of equipment was developed by the company in-house[3] and initially, at least, was seen as a project for a young engineer to "cut his teeth on", soon after he joined the company. In common with others, this company was attempting to automate its production methods as much as possible and this machine was a result of that philosophy. Prior to the installation of this machine, ball bearings were assembled totally by hand. Inner and outer races were measured and organised into matched pairs, which were labelled to indicate the size of ball necessary[4]. The bearings were assembled by the operator placing the inner race into the outer (with the inner race to one side) on the bench and introducing the correct number of balls into the gap. By drawing the inner race towards the centre, it can be snapped into position.

3. A machine of this type could not be purchased as it is too specialised for equipment manufacturers.

4. For a particular bearing size there is a range of balls that can be used, these being indicated by: +3,+2,+1, Standard, -1,-2,-3.

The Machine

Essentially this machine mimics the actions that were performed manually, but more quickly at one station. Its main components are seven bins (in which the balls are stored), a measuring device (essentially a pair of electronic micrometers), an electronic control device and a distortion jig. In operation, the inner and outer races are introduced (without prior selection) to the measuring device. These measurements are passed to the control unit which selects the ball size appropriate. The operator removes the races from the measuring device and places them in the distortion jig, which is under a ball dispensing point (with the inner race offset as for manual assembly). The bins are connected to this point by pipework, via a 'filter' under the direction of the control unit. When the races are in position the operator pushes a button which operates the dispenser, causing the correct number of balls to be selected from the appropriate bin. The outer race is now distorted slightly, which makes the centring of the inner race relatively easy (quite a bit of effort was required to do this manually).

The Ball and Half-Cage Unit

The Purpose: The assembly of bearings.

Innovativeness Rating: Moderate.

The Perceived Need

This machine was being developed by the company for use in its production area - development work was still being undertaken at the time of the data collection, making it an interesting innovation. The complexity of the task it was needed to perform, coupled with a relatively small development cost, prompted the Production Engineering Department to finance the project from its own budget. The aim was to produce a prototype which could be used to demonstrate its viability to higher management and gain funding for further machines. In line with many other innovations purchased or developed by the company, a principal aim was to reduce labour requirements.

The Machine

The operations to assemble a ball-bearing (manually) were as follows:

1. An inner ring is placed into an outer ring (both having been previously matched for size).
2. The correct number of balls is introduced between the rings.
3. The rings are positioned (the inner ring centred within the outer) and the balls evenly spaced around them.
4. A cage is placed over the balls to maintain their positions.
5. A plate is introduced onto the other side of the bearing to the cage an the plate and cage spot welded together.

This machine was intended to perform operations 2 to 4, taking the inner and outer rings, introducing the balls, spacing them and placing the cage over them. The part assembled bearing was then passed to a welder for completion.

It was decided to use a totally mechanical approach to achieve these ends, pneumatic and other methods being thought too unreliable (experience with other machines contributed to this view). The timing and sequencing of the operations was consequently achieved by a cam drive system, the settings of the cams controlling the operations. The rings are positioned by plates in the bed, balls having been introduced between them. A staggered tooth device is brought to bear on the balls and succesively positions each until the required configuration is achieved. The cage is introduced to fix this positioning and the bearing moved from the bed and another introduced.

The Ring Storage Device

The Purpose: Grading bearing rings as to size and temporarily storing them.

Innovativeness Rating: Fairly Low.

The Perceived Need

This machine was developed by the company's Production Engineering Department, to replace existing, externally purchased equipment which had been found unsatisfactory. The latter was a carousel machine, which utilised gravity feed. The problems involved with this machine, not least of which was that sorted rings often ended up deposited on the floor, made it essential that an alternative be found. The unreliablility of the carousel machines imposed a high labour requirement, which was felt undesirable. Funding for the project was obtained from the company's central finance, following a proposal for the machine, detailing the necessary expenditure.

The Machine

Gravity feed was rejected in favour of a powered delivery, which allowed a more stable, horizontal racking configuration. Bearing rings are passed through electronic measuring devices, connected to a sizing decision point, which passes the rings to one of seventeen racks (these being eight sizes below 'Standard' and eight above, as well as 'Standard' itself). As each ring enters the rack (a piece of steel angle suffices for this), the row of rings is moved forward. This continues until one of the grooves becomes full, when a bar at the end is pushed over. This bar operates a switch which stops the machine and turns on a light to attract the operator's attention (each operator minds several machines). The operator removes the completed set of rings and resets the bar, thus restarting the machine. The rings are placed in a storage rack (which is marked as to size) ready to be removed to the final assembly area.

The KTM Max-E-Trace

The Purpose: The milling of large metal components.

Innovativeness Rating: Fairly High.

The Perceived Need

In the case of this innovation, its arrival made possible design work, which would not have been fruitful previously. The company used the Max-E-Trace to manufacture large metal components (fifteen feet or more in length) which "could not have been produced any other way". The shaping of these components must be performed extremely accurately[5], which, coupled with the need for a good surface finish, ruled out casting. Consequently they are machined from aluminium alloy; this metal as well as being light (an advantage in the use of the product) is also relatively easily worked. Difficulties of production centre on the size of work-piece and accuracy.

The Machine

The Max-E-Trace achieved this potential simply by being a large numerically controlled machine[6]. In essence it consists of a work bed

5. Tolerances of two thousandths of an inch.

6. The innovation here is really the introduction of a large numerically controlled machine, of which the Max-E-Trace is a particular example.

over which a gantry moves, the cutting heads being mounted on the gantry. Integral with the gantry is the control unit and a power pack for the gantry and the hydraulic system - the cutters being self-powered. The bed itself is made of cast iron sections, the basic length being twelve feet, with six foot extensions available to any length. Width is also variable on most models, up to a maximum of twenty feet. The gantry locates onto the bed via hardened tool steel slideways. Between one and four cutting heads can be mounted on the gantry, depending upon model and width[7].

In operation, the gantry moves along the bed with the cutting heads positioned across the width for the appropriate cut. This movement, and its angle and depth of cut, are controlled hydraulically through mechanical servo systems. Overall control of the machine is by paper tape, although some manual controls are also used.

The Hardinge HNC Lathe

The Purpose: General purpose turning work.

Innovativeness Rating: Low.

The Perceived Need

This machine was purchased as part of a programme to automate as much of the production process as possible. The company makes specialist equipment, over long time periods, and consequently a major advantage of n.c. machines is that once a part has been programmed, it can be manufactured at a later date with no lead time. The adoption of this innovation was as a replacement for a manual lathe.

7. The company uses the machine with two heads to produce two components simultaneously.

The Machine

The Hardinge HNC is a relatively small n.c. lathe, bought mainly for precision turning work. It has an eight-station turret and can be run at speeds between 150 and 3000 rpm. The machine is totally enclosed with a plastic canopy, so that the operator is protected from oil and chips - the canopy can of course be removed for re-tooling, setting-up, loading, etc. The control system is extremely flexible, allowing for program modification to compensate for tool wear, programming errors or to allow design changes, without having to alter the paper tape. It can also produce an up-dated tape incorporating these changes if required. Obviously, being numerically controlled it only requires a semi-skilled operator as opposed to the skilled operator needed for a manual machine.

The Wadkin SCD 50T

The Purpose: General milling/drilling work.

Innovativeness Rating: Low.

The Perceived Need

The adoption of this innovation resulted from the company's wish to introduce numerically controlled machines wherever possible and consequently it was an advanced replacement for a manual machine.

The Machine

The Wadkin is a vertical drilling/milling machine. It has an eight spindle turret, powered by a 7 h.p. motor. Power is delivered through an automatic gearbox, providing 37 spindle speeds between 50 and 3250 rpm. It was designed to give rapid tool changes and is controlled by a Plessey 1130 control unit. The company uses the Wadkin to produce small metal casings and component mountings.

The Marden NC20-36

The Purpose: Production of circuit boards requiring many wired connections.

Innovativeness Rating: Moderate.

The Perceived Need

Some of the complex electronic equipment manufactured by the company requires that a number of wires are connected between various parts of the circuit[8]. The wires are fixed to pins in the circuit board, the joints being achieved by tightly wrapping the wire around the pins with a special tool (a wrapping gun) and not by solder as was previously done[9]. The main problem, with the large number of wires and fixing points, is to ensure that the correct connections are made. Because of this, quality problems were encountered as a result of operator errors, these being expensive and time consuming to correct. The company's need, therefore, was for a means of ensuring that the correct connections were made and also that appropriate wire colours were used, to ease any repair work necessary while the equipment was in service.

The Machine

The Marden NC20-36 solves these problems by guiding the operator to the correct fixing point and supplying a length of wire to make the connection. Essentially the machine consists of an upright frame in which the circuit board is positioned. To the right of the frame is a numerical

8. The only possible alternative to this would be multi-layer printed circuit boards, which are expensive to make and virtually impossible to repair.

9. This method is quick, easy and extremely efficient; many of the problems such as dry joints are not experienced, nor is there a need to protect against heat damage of components.

control unit and beneath it a number of small bins, which contain pre-cut lengths of wire. In operation a guide moves over the circuit board, each movement being instigated by the operator using a hand or foot control. The guide stops at the pin to be wired and the operator locates the wire with it, places the wrapping tool in the guide, presses the trigger and makes a joint. When a wire is to be selected, a digital display indicates which bin is appropriate; the guide can also be used to indicate the route a particular wire should take between pins.

The control unit acts upon instructions fed in on a paper tape which is produced by part programmers, although computerised production is also possible. The control unit itself is of modular construction, the circuitry being on "cards", which can be exchanged easily if they become faulty, so reducing down time. Of its type the Marden must be considered a basic machine, as it does not contain advanced features such as a testing capacity in addition to production facilities. However, it is rather cheaper than such competitors.

The Computervision Computer Aided Design System

The Purpose: The production of drawings, with eventual direct connection to numerically controlled machines.

Innovativeness Rating: High.

The Perceived Need

The company decided to adopt this innovation as a response to a national shortage of draughtsmen, which meant that it, in common with many others, had difficulty in attracting sufficient trained manpower. Although it did occur to them to offer premium rates to satisfy this need, they felt that in the longer term it would only contribute to widespread wage increases, leaving their rates uncompetitive again. Fortunately the recent development of computer aids, which significantly increase productivity, provided an alternative. Higher management decided that "if they could not get men they would get machines".

The Machine/System

Computer Aided Design is a system whereby a draughtsman does his work at a visual display unit, rather than a drawing board. Drawings are formed by the use of an electrically sensitive instruction board, called a menu. The menu contains instructions for the drawing of straight lines, curves, etc, along with directives which indicate starting and finishing points, length, and so on[10]. Each design console contains both a graphics terminal (a large Textonics screen) and an ordinary VDU - the latter being for control, filing, and also the display of any data needed for a particular drawing.

Each system has up to eight design stations connected to a mini-computer (often a DEC PDP-11/70). As well as being the source of the graphics software, the computer has disc storage for in-progress or completed drawings. It is also possible for the draughtsman to file incomplete drawings to be worked on later. There are two other useful features that should be mentioned. The first is the ability to work on parts of a drawing and combine them for the finished article; the second is that any particular component which is commonly used can be filed and included in a drawing by specifying its code number and where it is to be placed.

The ability to utilise and alter existing drawing work is of particular use to the company, as many of their products are modified to suit customer requirements. At a drawing board even minor modifications

10. A Variety of menus are available or can be produced to specification and once programmed can be selected at will, allowing the operator to choose menus in a matter of moments.

would necessitate starting from scratch, whereas a CAD drawing only requires the appropriate alterations. When a drawing is completed or a copy needed from file the output is sent to a plotter. It is possible to specify scale, dimensions, titles, etc and have them incorporated by the software. One development that can be made from this system is to connect it directly to the manufacturing area. Numerical control data can be fed directly to a lathe or other machine and produce parts without the need for drawings and part programmers. The company was researching the potential of this kind of development at the time of the data collection.

The Transdata Terminal

The Purpose: Production of numerical control tapes.

Innovativeness Rating: Moderate.

The Perceived Need

The company has many numerically controlled machines in its production area and was concerned about the time spent in part programming. Because of the specialised nature of their products they do not have long production runs and so programming costs were relatively high. The adoption of this innovation was seen as a way of reducing the part programming time involved and virtually eliminating errors.

The Machine/System

This innovation is a system with associated hardware which uses the power of a mainframe computer to produce numerical control tapes. Essentially it consists of an input terminal, an associated memory module, a mainframe interface and a tape punch and/or printer. Data are entered by the keyboard (or a tape reader) and either passed to memory[11] or

11. This can be used as a temporary store until mainframe time is available, or as a small permanent store.

direct to the mainframe. When the computer has processed the data into a suitable n.c. format, they are passed to the tape punch, possibly with associated messages on the printer. Although this system was still in use, it had to a great extent been overshadowed by the potential for Computer Aided Manufacture which existed within the company.

App 2

CHARACTERISTIC SCORE SHEET

Name: Company: No.

CHAR	INNOVATIONS												
1													INITIAL COST
2													RUNNING COST
3													RETURN
4													MATERIALS
5													RE-SALE
6													ADVANTAGE
6													TIME
8													RELIABILITY
9													MAINTENANCE
10													ENERGY
11													SPACE
12													QUALITY
13													VARIATIONS
14													OPERATION
15													RE-TRAINING
16													COMFORT
17													LABOUR
18													NOISE
19													COMPEXITY
20													COMPATIBILITY
21													TRIAL
22													OBSERVABILITY
23													RISK
24													MODIFICATION
25													SUPPLIER
26													AFTER SALES
27													UNIT COSTS
28													ADVICE
29													SOPHISTICATION
30													SAFETY
31													
32													
33													
34													
35													

App 2

PERSONAL ATTRIBUTES QUESTIONNAIRE

PRIOR EXPERIENCE

We would be grateful if you could give us some or all of the information indicated on this sheet. While it will be treated in complete confidence and all responses will be coded, we quite understand if you would rather not. However any information, no matter if incomplete, would be most useful to us.

NAME:

AGE:

PRESENT JOB TITLE:

QUALIFICATIONS/PROFESSIONAL MEMBERSHIP:

PREVIOUS JOB TITLES (possibly with time spent at each):

App 2

SURVEY II QUESTIONNAIRE

Innovation Questionnaire

(1-3)

This questionnaire is part of a follow-up to a survey we have been conducting, concerning Technological Innovation. We would be very grateful if you could complete it, so that we may check our findings on a different sample. As the context of the method on which this questionnaire was based is somewhat different to that which you may find yourself, we hope you will bear with us and complete it as best you can. You are being asked to complete it as you are engaged in part-time management education and consequently are likely to be or have been a practising manager.

The concern of the survey as a whole is to examine the views of individuals who have been involved in the purchase of new technology. Please fill it in even if you have not been involved in such an exercise. The first question deals with this matter and even if you have not been involved in such an exercise, your views are important to us.

Name: Age: (4,5)

1) Have you been involved with the purchase of any equipment that you consider innovative?

Yes( )
No ( ) (6)

If so, what?

2) What is your present (or most recent) job title? (7)

(8)

3) What qualifications have you?

(9)

4) Are you a member of any professional bodies?

Yes( )
No ( ) (10)

If you are which one(s)?

5) How many people are employed by your present (or most recent) company (or division, if it is a large company).

--- (11)

App 2

Part Two:

This part of the questionnaire is concerned with a list of Innovation Characteristics which have been found useful in our earlier survey. The purpose of this section is to discover which of these characteristics you feel are important when judging Technological Innovation. What we would like you to do, is read the list and tick the characteristics that are important to you. Remember it is your views we are interested in and by doing this you are making an important contribution.

You may find this section difficult as you are not being asked about a particular innovation. However please be assured that this is a valid method and that we can make sense of it. To further assist us could you please indicate at the bottom an innovation which you feel the characteristics you have chosen could be judged. This does not have to be something extremely novel, as an indication, the definition of innovation that we use is - "That which is new to the firm."

Now please tick the characteristics you feel are those you would use to evaluate Technological Innovation.

01 Inital Cost................................( )	☐	(21)
02 Running Cost...............................( )	☐	(22)
03 Rate of Return.............................( )	☐	(23)
04 Raw Material Cost..........................( )	☐	(24)
05 Re-sale Value..............................( )	☐	(25)
06 Relative Advantage.........................( )	☐	(26)
07 Time Saving................................( )	☐	(27)
08 Reliability................................( )	☐	(28)
09 Ease of Maintenance........................( )	☐	(29)
10 Energy Requirements........................( )	☐	(30)
11 Space Requirements.........................( )	☐	(31)
12 Effects on Quality.........................( )	☐	(32)
13 Variations in End Product..................( )	☐	(33)
14 Ease in Operation..........................( )	☐	(34)
15 Need for Retraining........................( )	☐	(35)
16 Operator Comfort...........................( )	☐	(36)

17 Effects on Labour Requirements............( ) ☐ (37)

18 Effects on Noise.........................( ) ☐ (38)

19 Complexity...............................( ) ☐ (39)

20 Compatibility with Existing Equipment......( ) ☐ (40)

21 Trial on a Small Scale...................( ) ☐ (41)

22 Observability of Results..................( ) ☐ (42)

23 Percieved Risk of Adoption................( ) ☐ (43)

24 Possibility of Modification...............( ) ☐ (44)

25 Supplier's Reputation.....................( ) ☐ (45)

26 After-sales Service.......................( ) ☐ (46)

27 Unit Costs................................( ) ☐ (47)

28 Availability of Technical Advice..........( ) ☐ (48)

29 Sophistication of Machine.................( ) ☐ (49)

30 Effects on Safety.........................( ) ☐ (50)

Please indicate an innovation you think the characteristics you have chosen would apply to:

Thank you very much.

APPENDIX 3: ORGANISATION CHARTS

FIG 1 COMPANY X ORGANISATION CHART

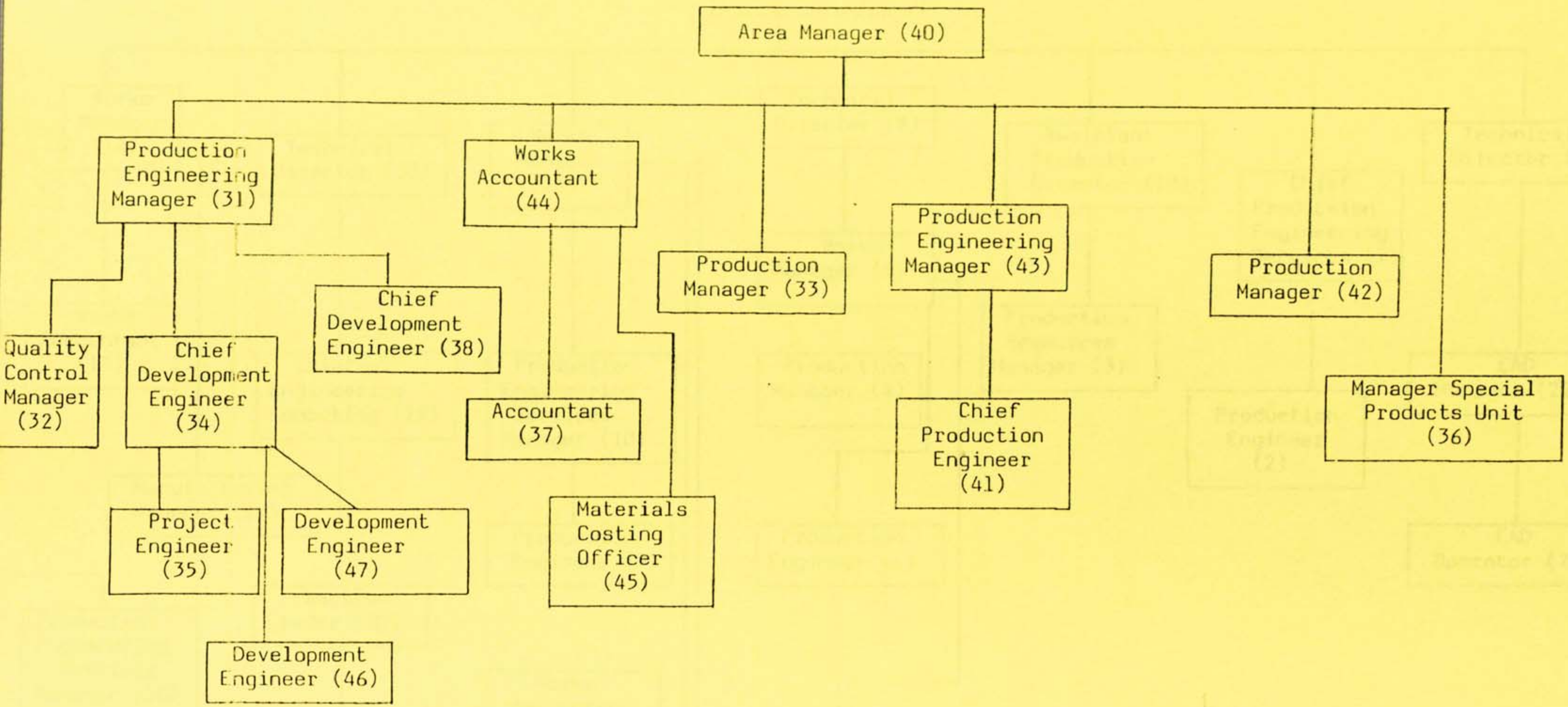


FIG 2 COMPANY Y ORGANISATION CHART (i)

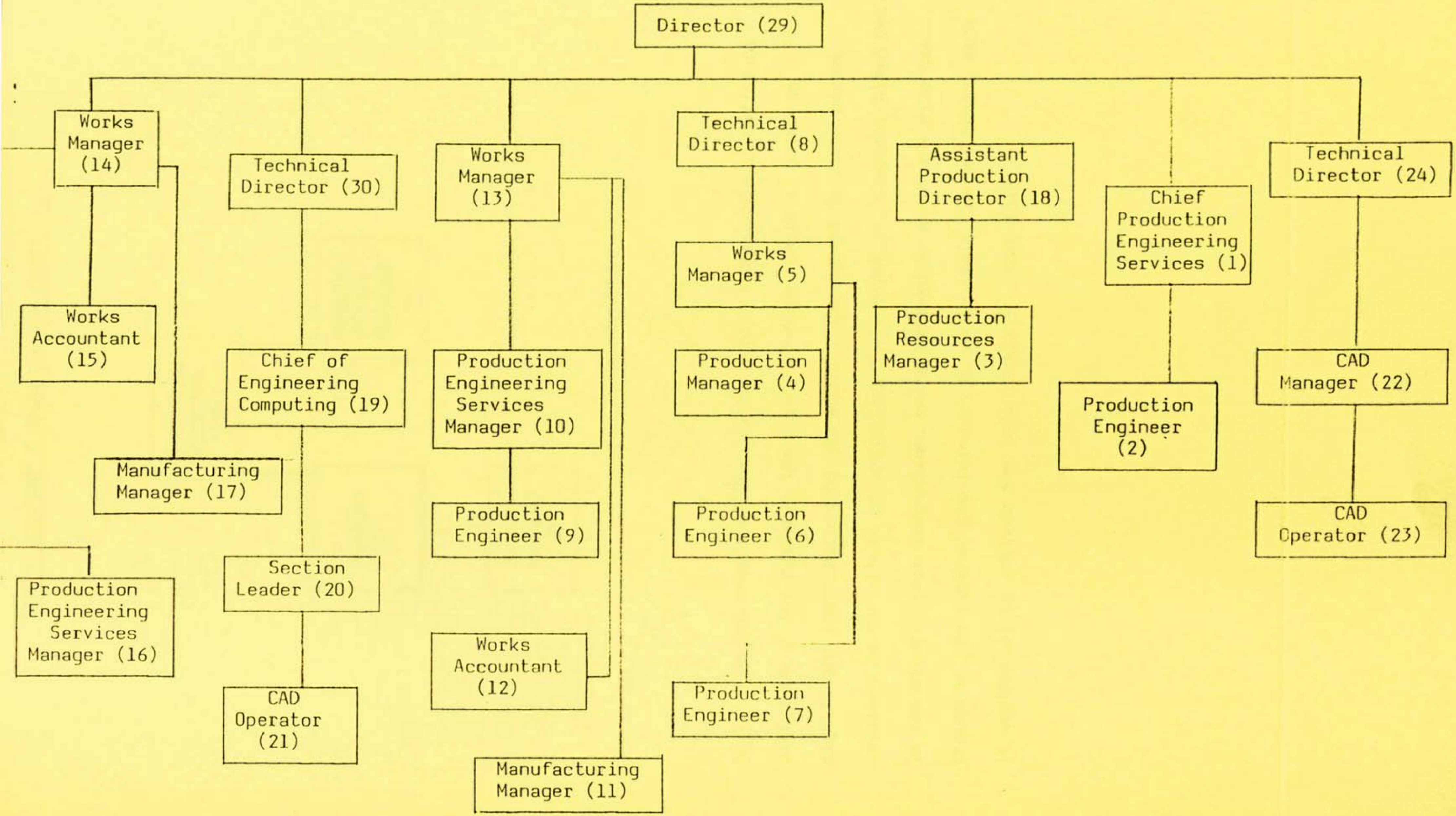
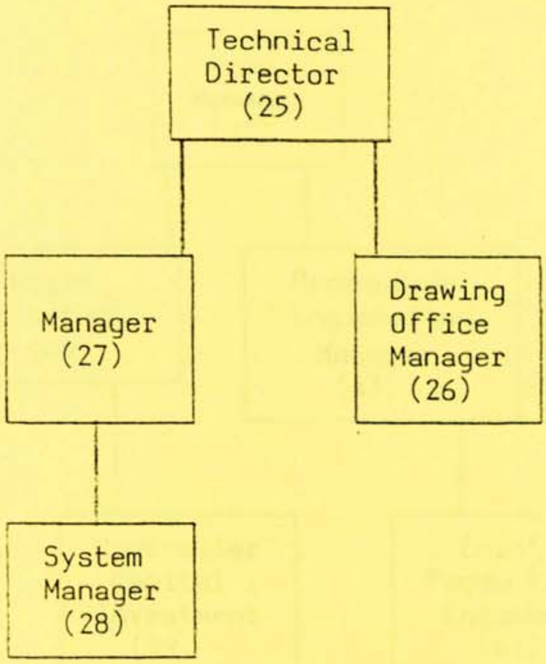


FIG 3 COMPANY Y ORGANISATION CHART (ii)



NOTE: The two charts of Company Y present individuals in different divisions of the company, the first of which (Chart i) acted as significant contributors to the study. The second division became involved as the result of including the innovation, Computer Aided Design in the study. This innovation, being adopted on a company wide basis, though at the time of the research on an initial, limited scale, made it worthwhile to include the individuals in Chart (ii).

FIG 4 FORM FLO

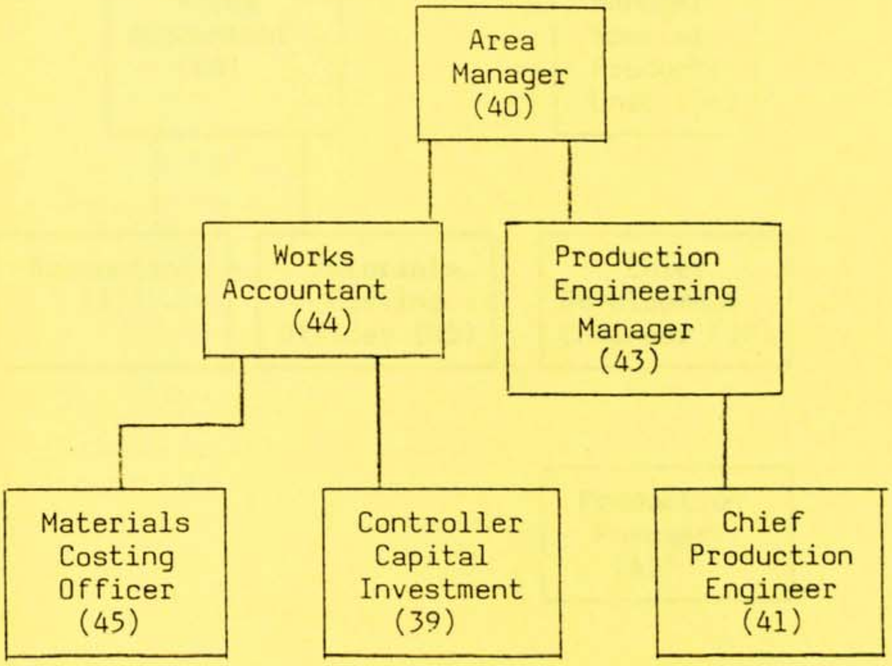


FIG 5 HOT BALL ROLLING

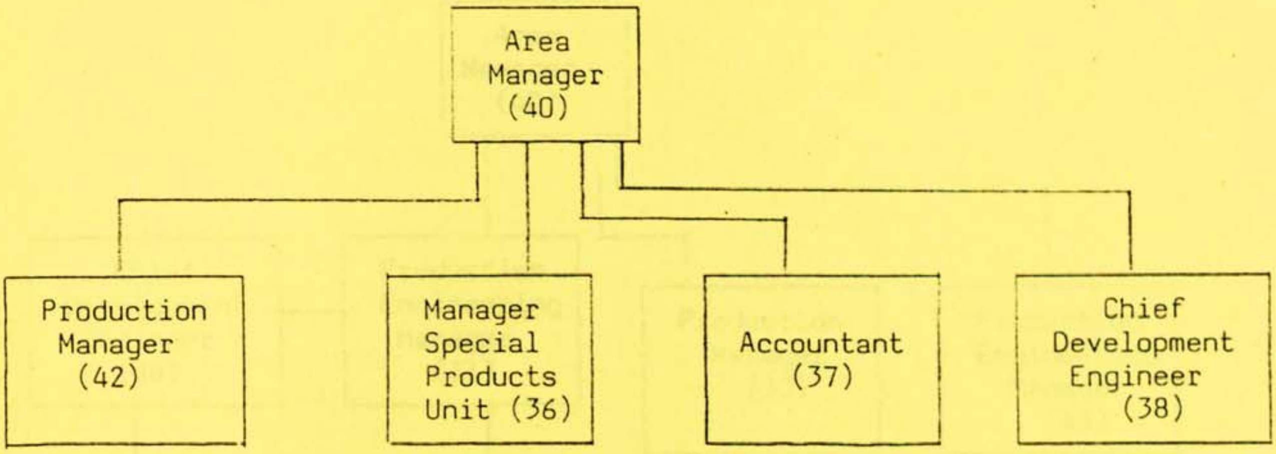


FIG 6 FLUID FIRE

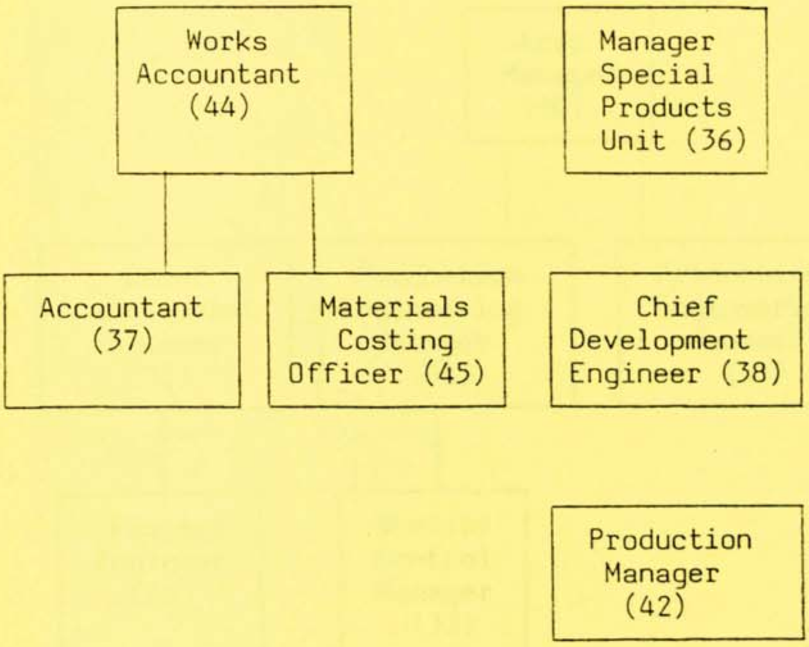


FIG 7 AUTOWRAPPING MACHINE

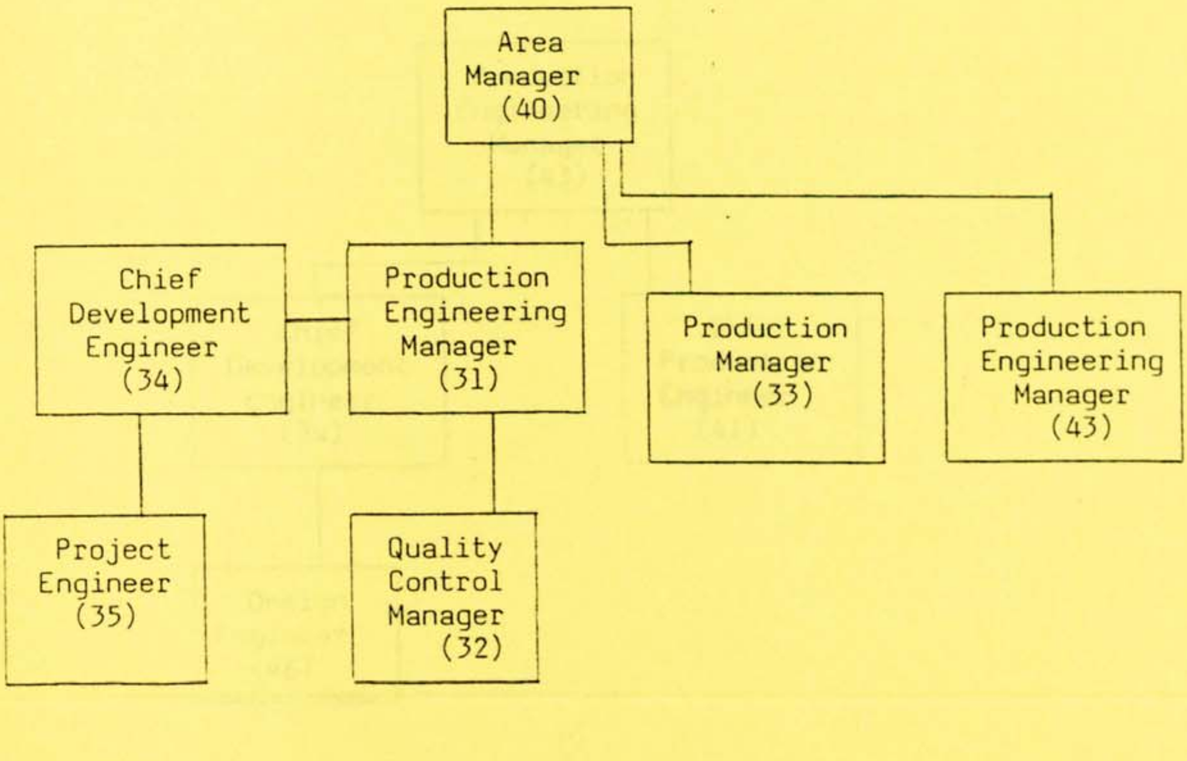


FIG 8 AUTO-BALL DISPENSER

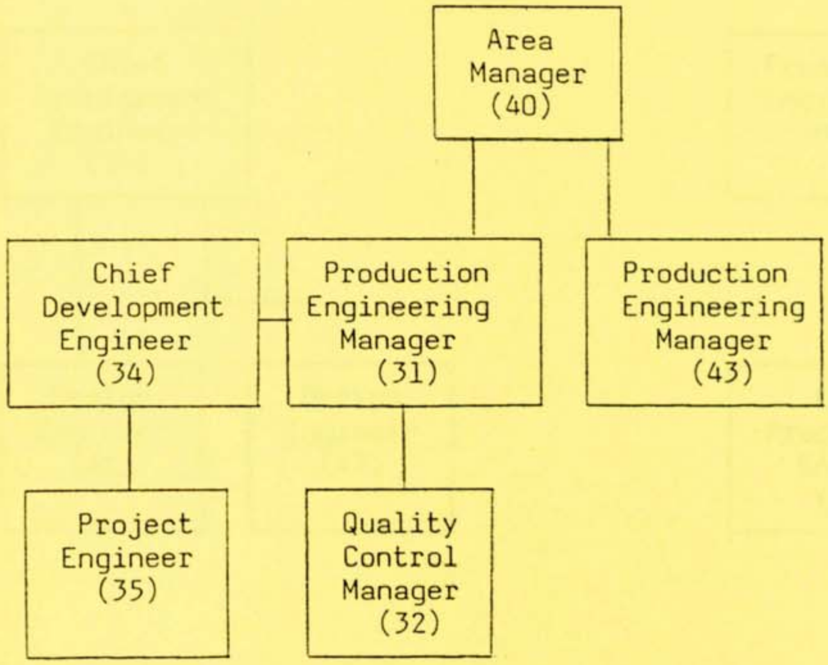


FIG 9 BALL AND HALF-CAGE UNIT

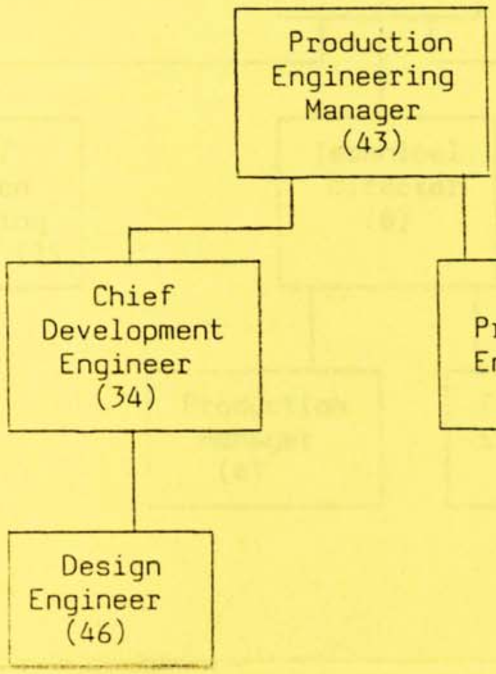


FIG 10 RING STORAGE DEVICE

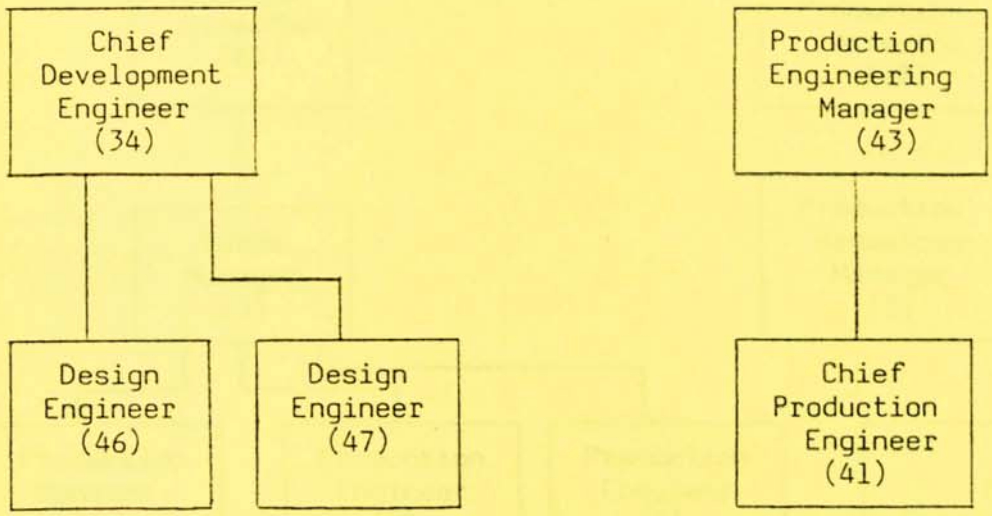


FIG 11 MAX-E-TRACE

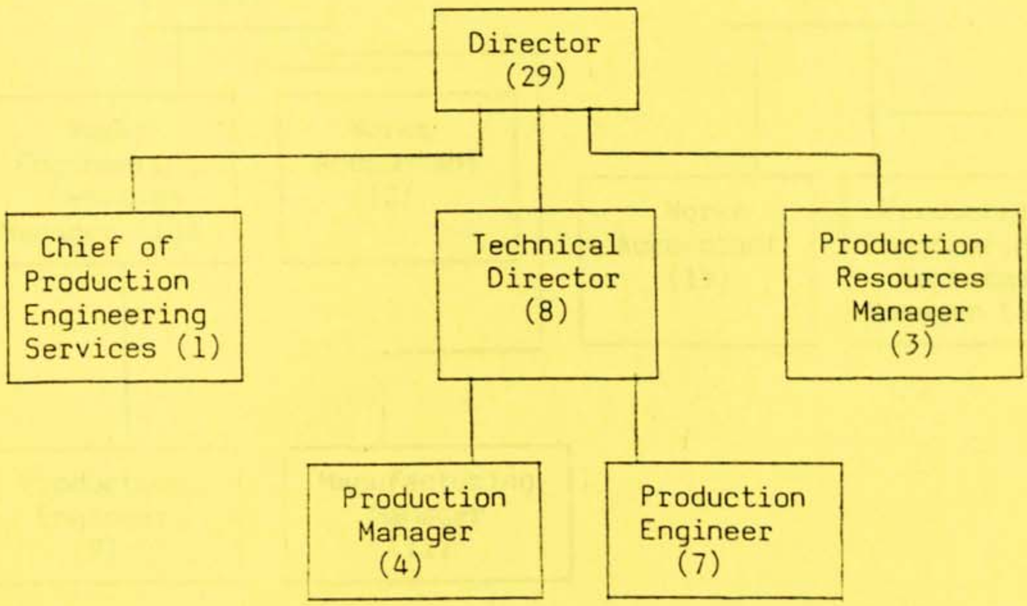


FIG 12 HARDINGE HNC LATHE

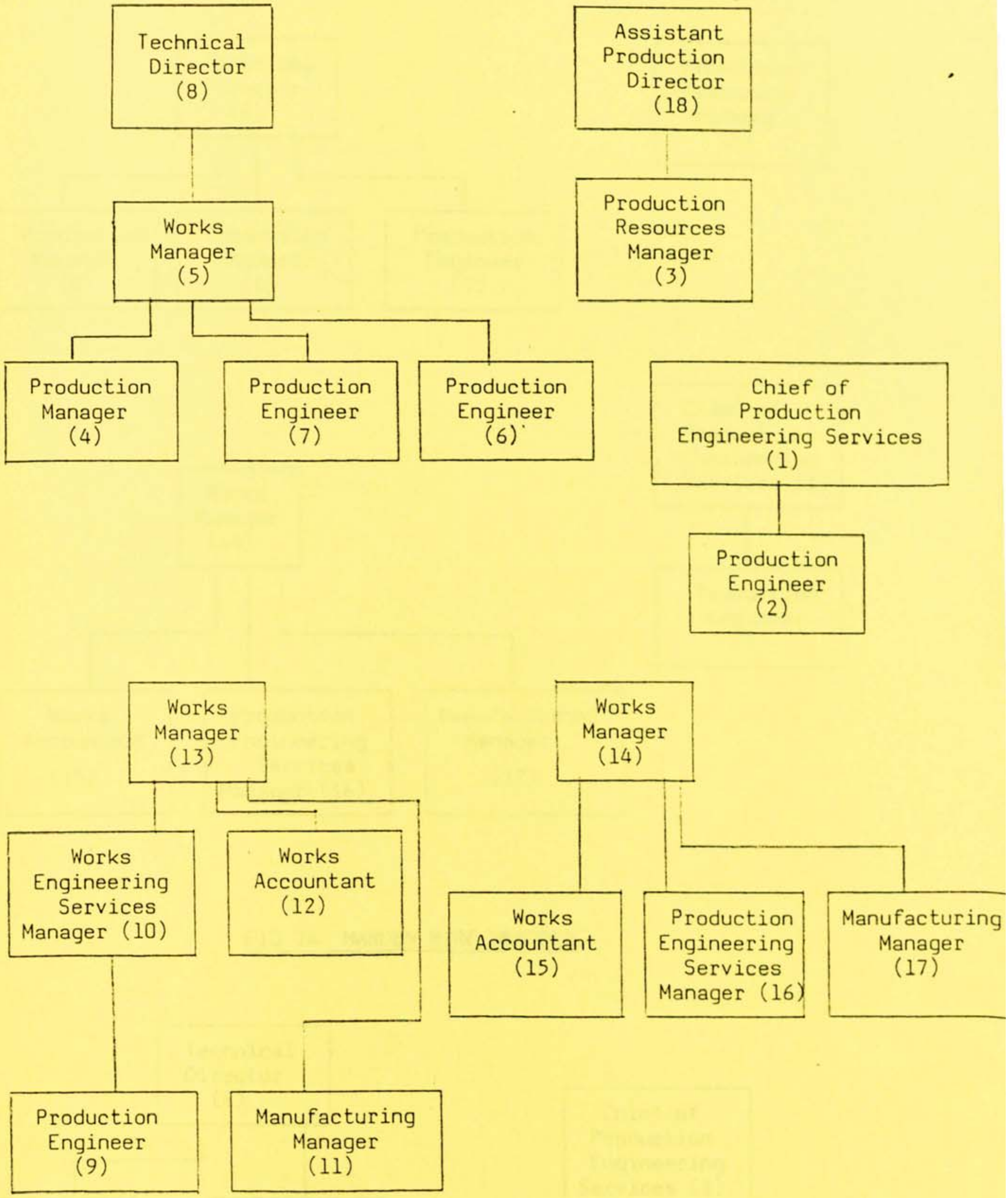


FIG 13 WADKIN SCD 50T

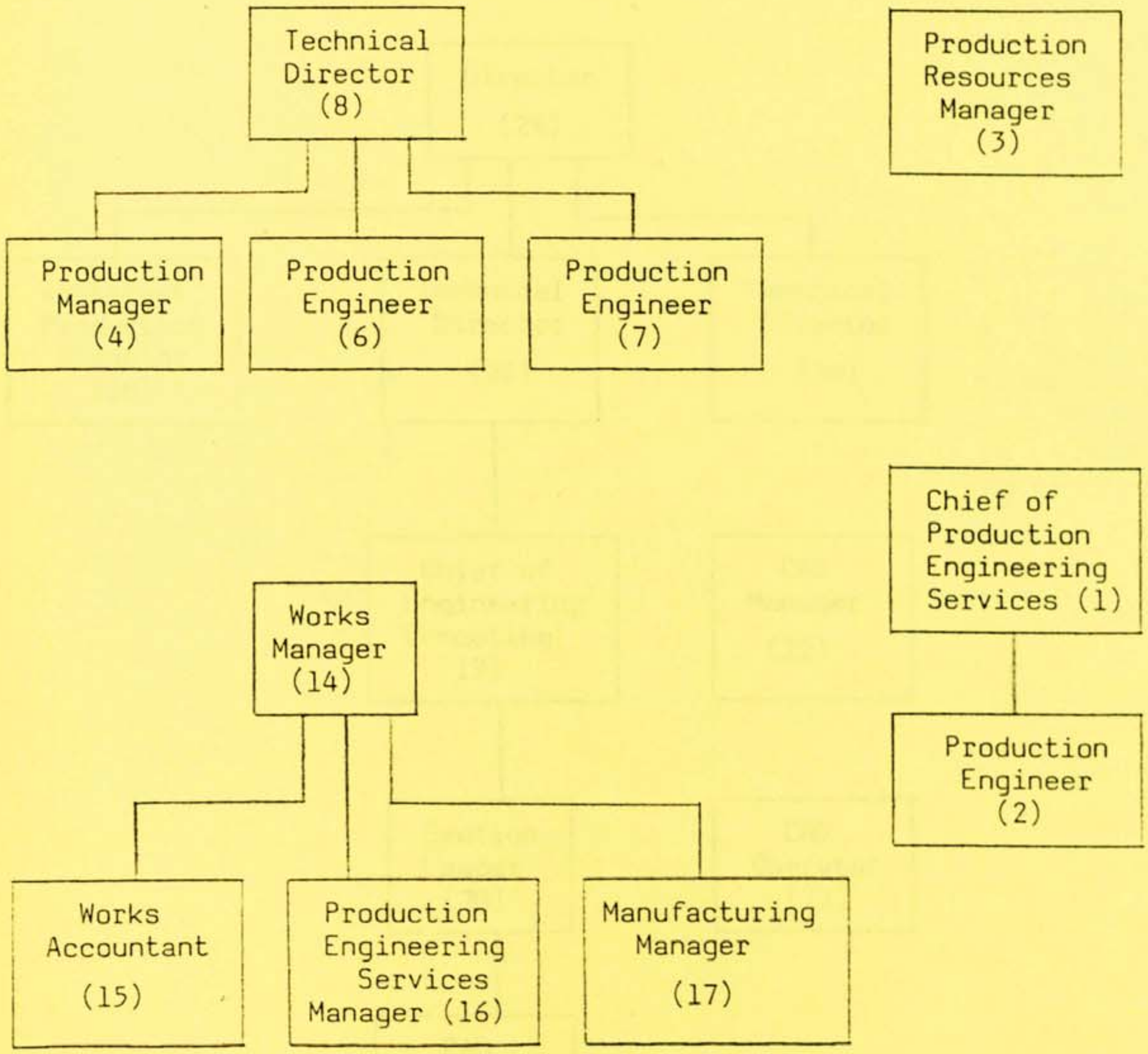


FIG 14 MARDEN WIRE WRAPPER

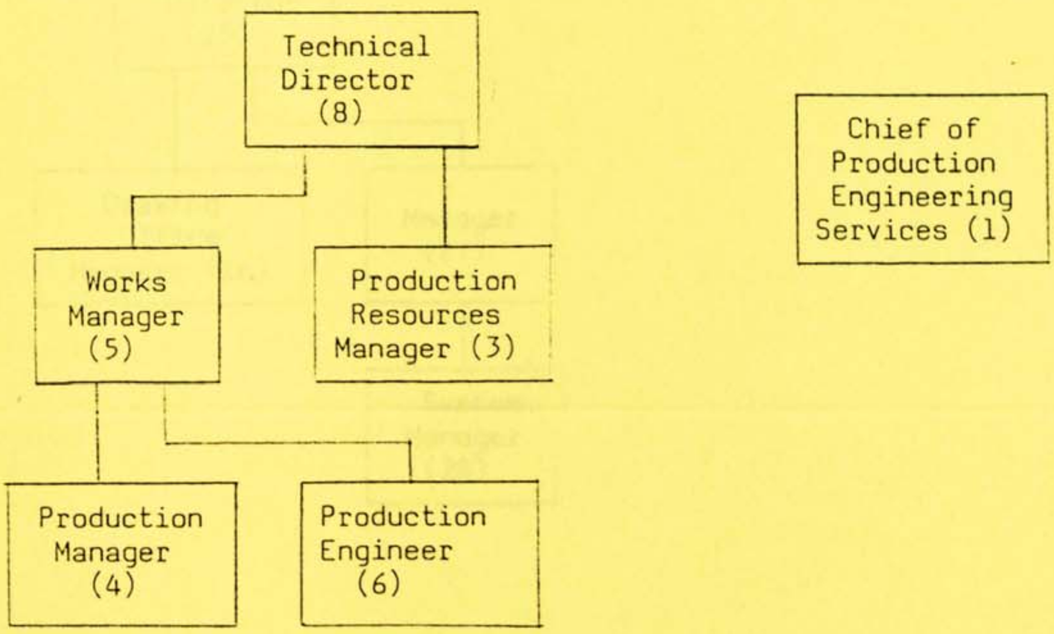


FIG 15 COMPUTER AIDED DESIGN

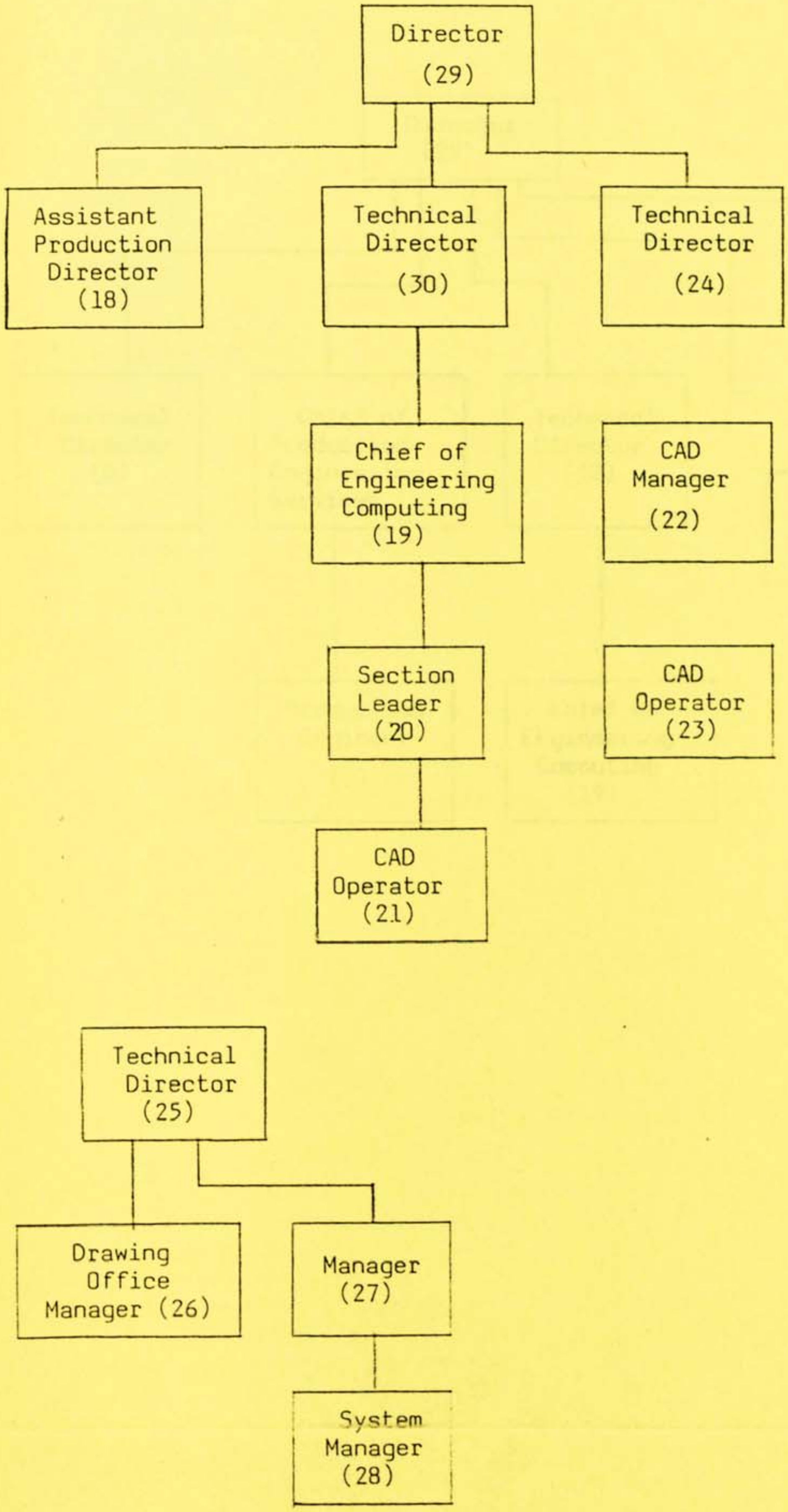
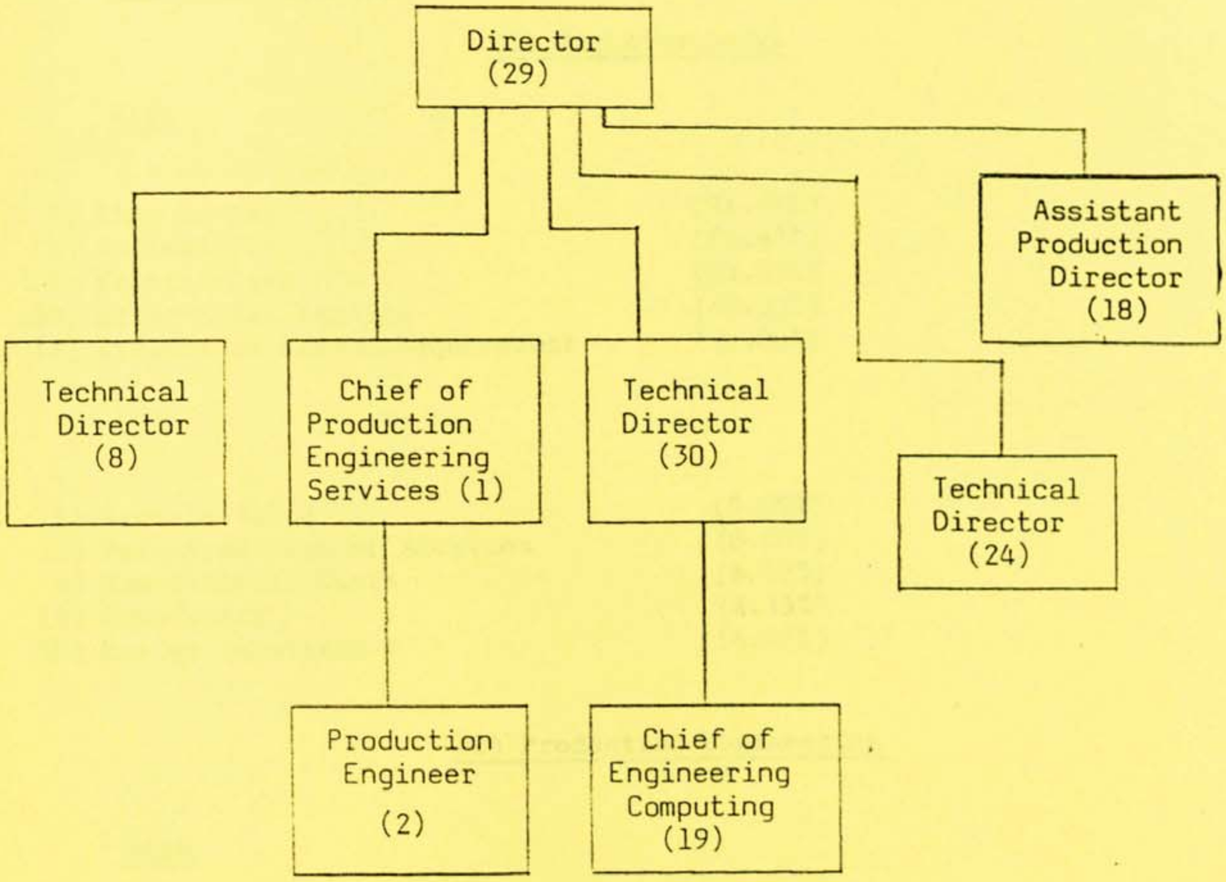


FIG 16 TRANSDATA TERMINAL



App 4

FREQUENTLY CHOSEN CHARACTERISTICS: SURVEY II

Occupational Role

(1) Organisational

High

7)	Time Saving	(91.67%)
8)	Reliability	(91.67%)
1)	Initial Cost	(83.33%)
26)	After-sales Service	(83.33%)
17)	Effects on Labour Requirement	(75.00%)

Low

5)	Re-sale Value	(0.00%)
23)	Perceived Risk of Adoption	(0.00%)
4)	Raw Material Costs	(8.33%)
19)	Complexity	(8.33%)
10)	Energy Requirement	(16.67%)

(2) Production Engineering

High

8)	Reliability	(89.47%)
1)	Initial Cost	(84.21%)
14)	Ease in Operation	(84.21%)
28)	Availability of Technical Advice	(73.68%)
6)	Relative Advantage	(68.42%)
7)	Time Saving	(68.42%)
12)	Effects on Quality	(68.42%)
17)	Effects on Labour Requirement	(68.42%)

Low

5)	Re-sale Value	(10.53%)
4)	Raw Material Costs	(26.32%)
23)	Percieved Risk of Adoption	(26.32%)
10)	Energy Requirement	(31.58%)
29)	Sophistication of Machine	(36.84%)

App 4

(3) Production

High

8) Reliability	(96.77%)
12) Effects on Quality	(96.77%)
7) Time Saving	(87.77%)
14) Ease in Operation	(83.87%)
26) After-sales Service	(83.87%)

Low

5) Re-sale Value	(6.45%)
23) Perceived Risk of Adoption	(16.13%)
29) Sophistication of Machine	(25.81%)
24) Possibility of Modification	(35.48%)
4) Raw Material Costs	(38.71%)

(4) Engineering

High

8) Reliability	(88.57%)
7) Time Saving	(82.57%)
14) Ease in Operation	(71.43%)
20) Compatibility with Existing Equipment	(71.43%)
28) Availability of Technical Advice	(68.57%)

Low

5) Re-sale Value	(5.71%)
4) Raw Material Costs	(17.14%)
13) Variations in End Product	(25.71%)
11) Space Requirements	(28.57%)
18) Effects on Noise	(28.57%)
21) Trial on a Small Scale	(28.57%)
27) Unit Costs	(28.57%)

(5) Finance

Sample too small for meaningful comparison.

(6) Computing

High

1) Initial Cost	(100.00%)
8) Reliability	(100.00%)
6) Relative Advantage	(80.00%)
7) Time Saving	(80.00%)
9) Ease of Maintenance	(80.00%)
14) Ease in Operation	(80.00%)
17) Effects on Labour Requirement	(80.00%)
20) Compatibility with Existing Equipment	(80.00%)
25) Supplier's Reputation	(80.00%)
26) After-sales Service	(80.00%)

Low

5) Resale Value	(0.00%)
3) Rate of Return	(20.00%)
4) Raw Material Costs	(20.00%)
10) Energy Requirements	(20.00%)
13) Variations in End Product	(20.00%)
19) Complexity	(20.00%)
27) Unit Costs	(20.00%)
30) Effects on Safety	(20.00%)

(7) Administrative

High

1) Initial Cost	(80.00%)
8) Reliability	(80.00%)
14) Ease in Operation	(75.00%)
2) Running Costs	(70.00%)
9) Ease of Maintenance	(65.00%)
26) After-sales Service	(65.00%)
30) Effects on Safety	(65.00%)

App 4

Low

4) Raw Material Costs	(5.00%)
5) Re-sale Value	(5.00%)
13) Variations in End Product	(20.00%)
29) Sophistication of Machine	(20.00%)
10) Energy Requirements	(30.00%)
23) Perceived Risk of Adoption	(30.00%)
24) Possibility of Modification	(30.00%)
25) Supplier's Reputation	(30.00%)

App 4

OCCUPATIONAL ROLE PERCENTAGES: SURVEY II

Chars	Org.	Prod. Eng.	Prod.	Eng.	Fin.	Comp.	Admin.
1	83.33	84.21	77.42	60.00	50.00	100.00	80.00
2	50.00	63.16	80.65	54.29	50.00	60.00	70.00
3	50.00	52.63	77.42	60.00	50.00	20.00	60.00
4	8.33	26.32	38.71	17.14	0.00	20.00	5.00
5	0.00	10.53	6.45	5.71	0.00	0.00	5.00
6	58.33	68.42	51.61	54.29	0.00	80.00	50.00
7	91.67	68.42	87.10	82.86	50.00	80.00	60.00
8	91.67	89.47	96.77	88.57	50.00	100.00	80.00
9	66.67	57.89	80.65	65.71	50.00	80.00	65.00
10	16.67	31.58	45.16	31.43	50.00	20.00	30.00
11	41.67	42.11	54.84	28.57	0.00	60.00	35.00
12	58.23	68.42	96.77	60.00	50.00	60.00	50.00
13	25.00	47.37	51.61	25.71	0.00	20.00	20.00
14	58.33	84.21	83.87	71.43	50.00	80.00	75.00
15	25.00	42.11	41.94	40.00	0.00	60.00	40.00
16	58.33	42.11	58.06	34.29	0.00	60.00	55.00
17	75.00	68.42	77.42	60.00	0.00	80.00	40.00
18	33.33	42.11	54.84	28.57	50.00	40.00	35.00
19	8.33	52.63	41.94	31.43	50.00	20.00	45.00
20	25.00	63.16	51.61	71.43	0.00	80.00	55.00
21	41.67	42.11	45.16	28.57	50.00	40.00	35.00
22	41.67	52.63	58.06	48.57	0.00	60.00	40.00
23	0.00	26.32	16.13	34.29	0.00	40.00	30.00
24	41.67	42.11	35.48	31.43	0.00	40.00	30.00
25	66.67	57.89	54.84	48.57	50.00	80.00	30.00
26	83.33	68.42	83.87	45.71	50.00	80.00	65.00
27	33.33	47.37	61.29	28.57	50.00	20.00	40.00
28	50.00	73.68	70.97	68.57	50.00	60.00	60.00
29	25.00	36.84	25.81	31.43	50.00	80.00	20.00
30	33.33	57.89	80.65	60.00	50.00	20.00	65.00
n	12	19	31	35	2	5	20

Org. - Organisational
Prod. - Production
Prod. Eng. - Production Engineering
Eng. - Engineering
Fin. - Finance
Comp. - Computing

App 4

FREQUENTLY CHOSEN CHARACTERISTICS: ALL RESPONDENTS

Occupational Role

(1) Organisational

High

8) Reliability	(94.74%)
1) Initial Cost	(89.47%)
7) Time Saving	(89.47%)
26) After-sales Service	(89.47%)
17) Effects on Labour Requirement	(84.21%)

Low

5) Re-sale Value	(10.53%)
19) Complexity	(26.34%)
23) Perceived Risk of Adoption	(31.58%)
4) Raw Material Cost	(36.84%)
10) Energy Costs	(36.84%)

(2) Production Engineering

High

8) Reliability	(87.50%)
1) Initial Cost	(83.33%)
12) Effect on Quality	(75.00%)
14) Ease in Operation	(75.00%)
17) Effects on Labour Requirement	(75.00%)

Low

5) Re-sale Value	(12.50%)
23) Perceived Risk of Adoption	(25.00%)
4) Raw Material Costs	(33.33%)
10) Energy Requirements	(33.33%)
21) Trial on a Small Scale	(33.33%)
29) Sophistication of Machine	(33.33%)

(3) Production

High

12) Effects on Quality (95.24%)
8) Reliability (90.48%)
7) Time Saving (88.10%)
26) After-sales Service (85.71%)
2) Running Cost (83.33%)
3) Rate of Return (83.33%)
17) Effects on Labour Requirements (83.33%)

Low

5) Re-sale Value (9.52%)
23) Perceived Risk of Adoption (23.81%)
29) Sophistication of Machine (23.81%)
15) Need for Retraining (33.33%)
24) Possibility of Modification (35.71%)

(4) Engineering

High

8) Reliability (89.13%)
7) Time Saving (86.13%)
14) Ease in Operation (73.91%)
20) Compatibility (71.74%)
9) Ease of Maintenance (69.57%)
12) Effects on Quality (69.57%)
17) Effects on Labour Requirement (69.57%)
28) Availability of Technical Advice (69.57%)

Low

5) Re-sale Value (8.70%)
21) Trial on a Small Scale (28.26%)
4) Raw Material Costs (28.86%)
11) Space Requirements (30.43%)
13) Variations in End Product (30.43%)

(5) Finance

High

1) Initial Cost	(85.71%)
3) Rate of Return	(85.71%)
7) Time Saving	(85.71%)
8) Reliability	(85.71%)
12) Effects on Quality	(85.71%)

Low

5) Re-sale Value	(0.00%)
11) Space Requirement	(14.29%)
16) Operator Comfort	(28.57%)
4) Raw Material Costs	(42.86%)
10) Energy Requirement	(42.86%)
23) Perceived Risk of Adoption	(42.86%)

(6) Computing

High

1) Initial Cost	(100.00%)
8) Reliability	(100.00%)
7) Time Saving	(92.31%)
9) Ease of Maintenance	(92.31%)
20) Compatibility with Existing Equipment	(92.31%)
25) Supplier's Reputation	(92.31%)

Low

5) Re-sale Value	(23.08%)
10) Energy Requirement	(46.15%)
13) Variations in End Product	(46.15%)
19) Complexity	(46.15%)
24) Possibility of Modification	(46.15%)

App 4

OCCUPATIONAL ROLE PERCENTAGES: ALL RESPONDENTS

Chars	Org.	Prod. Eng.	Prod.	Eng.	Fin.	Comp.	Admin.
1	89.47	83.33	78.57	67.39	85.71	100.00	80.00
2	68.42	54.17	83.33	56.52	71.43	76.92	70.00
3	68.42	62.50	83.33	63.04	85.71	61.54	60.00
4	36.84	33.33	40.48	28.86	42.86	53.85	5.00
5	10.53	12.50	9.52	8.70	0.00	23.08	5.00
6	63.16	70.83	54.76	50.00	57.14	84.62	50.00
7	89.47	70.83	88.10	86.96	85.71	92.31	60.00
8	94.74	87.50	90.48	89.13	85.71	100.00	80.00
9	68.42	62.50	73.81	69.57	71.43	92.31	65.00
10	36.84	33.33	45.24	36.96	42.86	46.15	30.00
11	52.63	45.83	52.38	30.43	14.29	69.23	35.00
12	73.68	75.00	95.24	69.57	85.71	84.62	50.00
13	52.63	41.67	52.38	30.43	71.43	46.15	20.00
14	73.68	75.00	80.95	73.91	57.14	76.92	75.00
15	42.11	37.50	33.33	39.13	57.14	61.54	40.00
16	57.89	41.67	57.14	45.65	28.57	61.54	55.00
17	84.21	75.00	83.33	69.57	57.14	84.62	40.00
18	47.37	41.67	52.38	36.96	57.14	61.54	35.00
19	26.32	45.83	47.62	36.96	57.14	46.15	45.00
20	47.37	66.67	57.14	71.74	57.14	92.31	55.00
21	47.37	33.33	50.00	28.26	71.43	53.85	35.00
22	52.63	45.83	57.14	58.70	57.14	61.54	40.00
23	31.58	25.00	23.81	36.96	42.86	61.54	30.00
24	47.37	37.50	35.71	32.61	57.14	46.15	30.00
25	73.68	62.50	59.52	50.00	57.14	92.31	30.00
26	89.47	66.67	85.71	52.17	71.43	69.23	65.00
27	52.63	58.33	71.43	45.65	57.14	69.23	40.00
28	63.16	62.50	69.05	69.57	57.14	53.85	60.00
29	42.11	33.33	23.81	32.61	57.14	69.23	20.00
30	52.63	54.17	64.29	47.83	71.43	53.85	65.00
n	19	24	42	46	7	13	20

Org. - Organisational
Prod. - Production
Prod. Eng. - Production Engineering
Eng. - Engineering
Fin. - Finance
Comp. - Computing

App 4

FREQUENTLY CHOSEN CHARACTERISTICS: SURVEY I

Management Level

(1) Management Level One

High

1) Initial Cost	(100.00%)
2) Running Cost	(100.00%)
3) Rate of Return	(100.00%)
8) Reliability	(100.00%)
12) Effects on Quality	(100.00%)
13) Variations in End Product	(100.00%)
14) Ease in Operation	(100.00%)
17) Effects on Labour Requirement	(100.00%)
26) After-sales Service	(100.00%)

Low

5) Re-sale Value	(28.57%)
16) Operator Comfort	(57.14%)
19) Complexity	(57.14%)
21) Trial on a Small Scale	(57.14%)
24) Possibility of Modification	(57.14%)

(2) Management Level Two

High

3) Rate of Return	(100.00%)
12) Effects on Quality	(100.00%)
17) Effects on Labour Requirement	(100.00%)
27) Unit Costs	(93.75%)
7) Time Saving	(87.50%)
25) Supplier's Reputation	(87.50%)
26) After-sales Service	(87.50%)

Low

5) Re-sale Value	(12.50%)
15) Need for Retraining	(25.00%)
29) Sophistication of Machine	(25.00%)
24) Possibility of Modification	(37.50%)
30) Effects on Safety	(37.50%)

(3) Management Level Three

High

1) Initial Cost	(100.00%)
2) Running Cost	(100.00%)
7) Time Saving	(100.00%)
8) Reliability	(100.00%)
12) Effects on Quality	(100.00%)
26) After-sales Service	(100.00%)
27) Unit Costs	(100.00%)
28) Availability of Technical Advice	(100.00%)

Low

10) Energy Requirement	(14.27%)
30) Effects on Quality	(14.29%)
5) Re-sale Value	(28.57%)
13) Variations in End Product	(28.57%)
21) Trial on a Small Scale	(28.57%)

(4) Management Level Four

High

1) Initial Cost	(100.00%)
7) Time Saving	(100.00%)
2) Running Cost	(83.33%)
3) Rate of Return	(83.33%)
8) Reliability	(83.33%)
9) Ease of Maintenance	(83.33%)
12) Effects on Quality	(83.33%)
13) Variations in End Product	(83.33%)
17) Effects on Labour Requirement	(83.33%)
27) Unit Costs	(83.33%)

Low

5) Re-sale Value	(33.33%)
11) Space Requirement	(33.33%)
16) Operator Comfort	(33.33%)
18) Effects on Noise	(33.33%)

(A further seven at 50.00%)

(5) Management Level Five

High

7) Time Saving	(100.00%)
9) Ease of Maintenance	(100.00%)
12) Effects on Quality	(100.00%)
17) Effects on Labour Requirement	(100.00%)
27) Unit Costs	(100.00%)

Low

5) Re-sale Value	(22.22%)
24) Possibility of Modification	(22.22%)
29) Sophistication of Machine	(22.22%)
30) Effects on Safety	(22.22%)
15) Need for Retraining	(33.33%)
21) Trial on a Small Scale	(33.33%)
23) Perceived Risk of Adoption	(33.33%)

(6) Management Level Six

Sample too small for meaningful comparison.

App 4

MANAGEMENT LEVEL PERCENTAGES: SURVEY I

Chars	1	2	3	4	5	6
1	100.00	81.25	100.00	100.00	88.89	100.00
2	100.00	62.50	100.00	83.33	55.56	100.00
3	100.00	100.00	85.71	83.33	77.78	100.00
4	85.71	50.00	57.14	66.67	66.67	100.00
5	28.57	12.50	28.57	33.33	22.22	0.00
6	71.43	75.00	71.43	50.00	44.44	100.00
7	85.71	87.50	100.00	100.00	100.00	100.00
8	100.00	81.25	100.00	83.33	88.89	100.00
9	71.43	68.75	57.14	83.33	100.00	100.00
10	71.43	43.75	14.29	50.00	77.78	100.00
11	71.43	50.00	42.86	33.33	55.56	50.00
12	100.00	100.00	100.00	83.33	100.00	100.00
13	100.00	56.25	28.57	83.33	44.44	100.00
14	100.00	62.50	85.71	66.67	66.67	100.00
15	71.43	25.00	57.14	50.00	33.33	50.00
16	57.14	50.00	85.71	33.33	77.78	50.00
17	100.00	100.00	85.71	83.33	100.00	100.00
18	71.43	56.25	42.86	33.33	77.78	100.00
19	57.14	56.25	42.86	50.00	55.56	100.00
20	85.71	81.25	71.43	66.67	88.89	100.00
21	57.14	50.00	28.57	66.67	33.33	100.00
22	71.43	50.00	71.43	66.67	77.78	100.00
23	85.71	43.75	71.43	50.00	33.33	100.00
24	57.14	37.50	57.14	66.67	22.22	50.00
25	85.71	87.50	71.43	50.00	55.56	100.00
26	100.00	87.50	100.00	50.00	55.56	50.00
27	85.71	93.75	100.00	83.33	100.00	100.00
28	85.71	50.00	100.00	66.67	44.44	0.00
29	71.43	25.00	57.14	66.67	22.22	50.00
30	85.71	37.50	14.29	66.67	22.22	100.00
n	7	16	7	6	9	2

1 – Management Level One
2 – Management Level Two
3 – Management Level Three
4 – Management Level Four
5 – Management Level Five
6 – Management Level Six

FREQUENTLY CHOSEN CHARACTERISTICS: SURVEY II

Management level

(1) Management Level One

Sample too small for meaningful comparison.

(2) Management Level Two

High

8)	Reliability	(92.86%)
7)	Time Saving	(85.71%)
3)	Rate of Return	(78.57%)
9)	Ease of Maintenance	(78.57%)
2)	Running Cost	(71.43%)
14)	Ease in Operation	(71.43%)
26)	After-sales Service	(71.43%)

Low

23)	Perceived Risk of Adoption	(0.00%)
5)	Re-sale Value	(7.14%)
15)	Need for Retraining	(7.14%)
4)	Raw Material Costs	(14.29%)
29)	Sophistication of Machine	(14.29%)

(3) Management Level Three

High

7)	Time Saving	(76.00%)
14)	Ease in Operation	(76.00%)
1)	Initial Cost	(72.00%)
8)	Reliability	(72.00%)
16)	Operator Comfort	(68.00%)

Low

5) Re-sale Value	(4.00%)
4) Raw Material Costs	(12.00%)
19) Complexity	(24.00%)
23) Perceived Risk of Adoption	(28.00%)
29) Sophistication of Machine	(28.00%)

(4) Management Level Four

High

8) Reliability	(92.86%)
7) Time Saving	(85.71%)
1) Initial Cost	(82.14%)
12) Effects on Quality	(75.00%)
14) Ease in Operation	(73.21%)
26) After-sales Service	(73.21%)

Low

5) Re-sale Value	(7.14%)
10) Energy Requirements	(25.00%)
4) Raw Material Costs	(26.79%)
23) Perceived Risk of Adoption	(26.79%)
29) Sophistication of Machine	(32.14%)

(5) Management Level Five

High

8) Reliability	(100.00%)
14) Ease in Operation	(84.00%)
28) Availability of Technical Advice	(76.00%)
9) Ease of Maintenance	(72.00%)
1) Initial Cost	(64.00%)
12) Effects on Quality	(64.00%)
17) Effects on Labour Requirement	(64.00%)
30) Effects on Safety	(64.00%)

Low

5)	Re-sale Value	(4.00%)
4)	Raw Material Costs	(16.00%)
24)	Possibility of Modification	(24.00%)
21)	Trial on a Small Scale	(28.00%)
23)	Perceived Risk of Adoption	(28.00%)

(6) Management Level Six

Sample too small for meaningful comparison.

MANAGEMENT LEVEL PERCENTAGES: SURVEY II

Chars	1	2	3	4	5	6
1	100.00	64.29	72.00	82.14	64.00	100.00
2	50.00	71.43	60.00	67.86	56.00	100.00
3	50.00	78.57	48.00	62.50	56.00	100.00
4	50.00	14.29	12.00	26.79	16.00	50.00
5	0.00	7.14	4.00	7.14	4.00	0.00
6	100.00	35.71	64.00	58.93	48.00	50.00
7	50.00	85.71	76.00	85.71	60.00	100.00
8	50.00	92.86	72.00	92.86	100.00	100.00
9	0.00	78.57	56.00	71.43	72.00	100.00
10	0.00	35.71	40.00	25.00	44.00	50.00
11	0.00	35.71	52.00	35.71	44.00	50.00
12	100.00	64.29	60.00	75.00	64.00	50.00
13	0.00	28.57	32.00	37.50	32.00	50.00
14	50.00	71.43	76.00	73.21	84.00	100.00
15	0.00	7.14	40.00	48.21	40.00	50.00
16	50.00	35.71	68.00	37.50	52.00	100.00
17	50.00	64.29	64.00	62.50	64.00	100.00
18	0.00	28.57	44.00	37.50	44.00	100.00
19	0.00	21.43	24.00	41.07	52.00	50.00
20	0.00	21.43	56.00	64.29	64.00	100.00
21	50.00	50.00	48.00	35.71	28.00	0.00
22	0.00	28.57	52.00	57.14	48.00	0.00
23	0.00	0.00	28.00	26.79	28.00	50.00
24	50.00	35.71	32.00	39.29	24.00	50.00
25	100.00	57.14	36.00	60.71	44.00	0.00
26	100.00	71.43	52.00	73.21	64.00	50.00
27	50.00	50.00	32.00	42.86	48.00	0.00
28	100.00	28.57	64.00	69.64	76.00	100.00
29	0.00	14.29	28.00	32.14	40.00	50.00
30	0.00	42.86	60.00	66.07	64.00	100.00
n	2	14	25	56	25	2

1 - Management Level One
2 - Management Level Two
3 - Management Level Three
4 - Management Level Four
5 - Management Level Five
6 - Management Level Six

App 4

FREQUENTLY CHOSEN CHARACTERISTICS: ALL RESPONDENTS

Management Level

(1) Management Level One

High

1)	Initial Cost	(100.00%)
12)	Effects on Quality	(100.00%)
26)	After-sales Service	(100.00%)
2)	Running Cost	(88.89%)
3)	Rate of Return	(88.89%)
8)	Reliability	(88.89%)
14)	Ease in Operation	(88.89%)
17)	Effects on Labour Requirement	(88.89%)
25)	Supplier's Reputation	(88.89%)
28)	Availability of Technical Advice	(88.89%)

Low

5)	Re-sale Value	(22.22%)
19)	Complexity	(44.44%)
9)	Ease of Maintenance	(55.56%)
10)	Energy Requirements	(55.56%)
11)	Space Requirements	(55.56%)
15)	Need for Retraining	(55.56%)
16)	Operator Comfort	(55.56%)
18)	Effects on Noise	(55.56%)
21)	Trial on a Small Scale	(55.56%)
22)	Observability of Results	(55.56%)

(2) Management Level Two

High

3)	Rate of Return	(90.00%)
7)	Time Saving	(86.67%)
8)	Reliability	(86.67%)
12)	Effects on Quality	(83.33%)
17)	Effects on Labour Requirement	(83.33%)

Low

5) Re-sale Value	(10.00%)
15) Need for Retraining	(16.67%)
29) Sophistication of Machine	(20.00%)
23) Perceived Risk of Adoption	(23.33%)
4) Raw Material Costs	(33.33%)

(3) Management Level Three

High

7) Time Saving	(81.25%)
1) Initial Cost	(78.12%)
8) Reliability	(78.12%)
14) Ease in Operation	(78.12%)
16) Operator Comfort	(71.87%)
28) Availability of Technical Advice	(71.87%)

Low

5) Re-sale Value	(9.37%)
4) Raw Material Costs	(21.87%)
19) Complexity	(28.12%)
13) Variations in End Product	(31.25%)
10) Energy Requirements	(34.37%)
29) Sophistication of Machine	(34.37%)

(4) Management Level Four

High

8) Reliability	(91.94%)
7) Time Saving	(87.10%)
1) Initial Cost	(83.87%)
12) Effects on Quality	(75.81%)
9) Ease of Maintenance	(72.58%)
14) Ease in Operation	(72.58%)

Low

5) Re-sale Value (9.68%)
10) Energy Requirement (27.42%)
23) Perceived Risk of Adoption (29.03%)
4) Raw Material Costs (30.65%)
11) Space Requirements (35.48%)
29) Sophistication of Machine (35.48%)

(5) Management Level Five

High

8) Reliability (97.06%)
9) Ease of Maintenance (79.41%)
14) Ease in Operation (79.41%)
12) Effects on Quality (73.53%)
17) Effects on Labour Requirement (73.53%)

Low

5) Re-sale Value (8.82%)
24) Possibility of Modification (23.53%)
4) Raw Material Costs (29.41%)
21) Trial on a Small Scale (29.41%)
23) Perceived Risk of Adoption (29.41%)

(6) Management Level Six

Sample too small for meaningful comparison.

App 4

MANAGEMENT LEVEL PERCENTAGES: ALL RESPONDENTS

Chars	1	2	3	4	5	6
1	100.00	73.33	78.12	83.87	70.59	100.00
2	88.89	66.67	68.75	69.35	55.88	100.00
3	88.89	90.00	56.25	64.52	61.76	100.00
4	77.78	33.33	21.87	30.65	29.41	75.00
5	22.22	10.00	9.37	9.68	8.82	0.00
6	77.78	56.67	65.62	58.06	47.06	75.00
7	77.78	86.67	81.25	87.10	70.59	100.00
8	88.89	86.67	78.12	91.94	97.06	100.00
9	55.56	73.33	56.25	72.58	79.41	100.00
10	55.56	40.00	34.37	27.42	52.94	75.00
11	55.56	43.33	50.00	35.48	47.06	50.00
12	100.00	83.33	68.75	75.81	73.33	75.00
13	77.78	43.33	31.25	41.94	35.29	75.00
14	88.89	66.67	78.12	72.58	79.41	100.00
15	55.56	16.67	43.75	48.39	38.24	50.00
16	55.56	43.33	71.87	37.10	58.82	75.00
17	88.89	83.33	68.75	64.52	73.53	100.00
18	55.56	43.33	43.75	37.10	52.94	100.00
19	44.44	40.00	28.12	41.94	52.94	75.00
20	66.67	53.33	59.37	64.52	70.59	100.00
21	55.56	50.00	43.75	38.71	29.41	50.00
22	55.56	40.00	56.25	58.06	55.88	50.00
23	66.67	23.33	37.50	29.03	29.41	75.00
24	55.56	36.67	37.50	41.94	23.53	50.00
25	88.89	73.33	43.75	59.68	47.06	50.00
26	100.00	80.00	62.50	70.97	61.76	50.00
27	77.78	73.33	46.87	46.77	61.76	50.00
28	88.89	40.00	71.87	69.35	67.65	50.00
29	55.56	20.00	34.37	35.48	35.29	50.00
30	66.67	40.00	50.00	66.13	52.94	100.00
n	9	30	32	62	34	4

1 - Management Level One
2 - Management Level Two
3 - Management Level Three
4 - Management Level Four
5 - Management Level Five
6 - Management Level Six

App 4

FREQUENTLY CHOSEN CHARACTERISTICS: SURVEY I

Educational Level

(1) No Qualifications

High

1) Initial Cost	(100.00%)
7) Time Saving	(100.00%)
8) Reliability	(100.00%)
9) Ease of Maintenance	(100.00%)
12) Effects on Quality	(100.00%)
13) Variations in End Product	(100.00%)
14) Ease in Operation	(100.00%)
17) Effects on Labour Requirement	(100.00%)
20) Compatibility with Existing Equipment	(100.00%)
27) Unit Costs	(100.00%)

Low

5) Re-sale Value	(0.00%)
15) Need for Retraining	(0.00%)
4) Raw Material Costs	(25.00%)
10) Energy Costs	(25.00%)
16) Operator Comfort	(25.00%)
22) Observability of Results	(25.00%)

(2) City and Guilds or Similar

High

7) Time Saving	(100.00%)
12) Effects on Quality	(100.00%)
17) Effects on Labour Requirement	(100.00%)
27) Unit Costs	(100.00%)

(A further eight at 80%)

Low

5) Re-sale Value	(20.00%)
11) Space Requirements	(20.00%)
15) Need for Retraining	(20.00%)
28) Availability of Technical Advice	(20.00%)
29) Sophistication of Machine	(20.00%)

(3) HNC or Similar

High

3) Rate of Return	(100.00%)
7) Time Saving	(100.00%)
1) Initial Cost	(100.00%)
12) Effects on Quality	(100.00%)
17) Effects on Labour Requirement	(100.00%)
27) Unit Costs	(100.00%)

Low

5) Re-sale Value	(28.57%)
28) Availability of Technical Advice	(35.71%)
29) Sophistication of Machine	(35.71%)
16) Operator Comfort	(42.86%)
21) Trial on a Small Scale	(42.86%)
24) Possibility of Modification	(42.86%)

(4) First Degree

High

1) Initial Cost	(100.00%)
2) Running Cost	(100.00%)
3) Rate of Return	(100.00%)
4) Raw Material Cost	(100.00%)
12) Effects on Quality	(100.00%)
13) Variations in End Product	(100.00%)
17) Effects on Labour Requirement	(100.00%)
20) Compatibility with Existing Equipment	(100.00%)
26) After-sales Service	(100.00%)
27) Unit Costs	(100.00%)
30) Effects on Safety	(100.00%)

Low

5) Re-sale Value	(42.86%)
24) Possibility of Modification	(42.86%)
16) Operator Comfort	(57.14%)
29) Sophistication of Machine	(57.14%)

(A further six at 71.43%)

(5) Higher Degree

Sample too small for meaningful comparison.

App 4

QUALIFICATIONS PERCENTAGES: SURVEY I

Chars	1	2	3	4	5
1	100.00	80.00	92.86	100.00	100.00
2	50.00	40.00	78.57	100.00	100.00
3	50.00	80.00	100.00	100.00	100.00
4	25.00	60.00	64.29	100.00	0.00
5	0.00	20.00	28.57	42.86	0.00
6	75.00	80.00	85.71	71.43	100.00
7	100.00	100.00	100.00	85.71	100.00
8	100.00	80.00	85.71	85.71	100.00
9	100.00	80.00	71.43	71.43	0.00
10	25.00	40.00	57.14	85.71	0.00
11	25.00	20.00	64.29	71.43	0.00
12	100.00	100.00	92.86	100.00	100.00
13	100.00	40.00	50.00	100.00	100.00
14	100.00	60.00	57.14	85.71	100.00
15	0.00	20.00	50.00	71.43	0.00
16	25.00	40.00	42.86	57.14	100.00
17	100.00	100.00	92.86	100.00	100.00
18	50.00	40.00	57.14	85.71	0.00
19	50.00	60.00	57.14	71.43	100.00
20	100.00	40.00	85.71	100.00	0.00
21	50.00	60.00	42.86	71.43	0.00
22	25.00	60.00	57.14	85.71	100.00
23	50.00	40.00	57.14	85.71	100.00
24	25.00	80.00	42.86	42.86	0.00
25	75.00	80.00	78.57	85.71	100.00
26	50.00	80.00	71.43	100.00	100.00
27	100.00	100.00	92.86	100.00	100.00
28	75.00	20.00	35.71	85.71	100.00
29	50.00	20.00	35.71	57.14	100.00
30	50.00	40.00	50.00	100.00	0.00
n	4	5	14	7	1

1 - None
2 - City and Guilds or Similar
3 - HNC or Similar
4 - First Degree
5 - Higher Degree

App 4

FREQUENTLY CHOSEN CHARACTERISTICS: SURVEY II

(1) Educational Level

High

8) Reliability	(92.31%)
1) Initial Cost	(84.62%)
7) Time Saving	(76.92%)
2) Running Cost	(69.23%)
3) Rate of Return	(69.23%)
14) Ease in Operation	(69.23%)

Low

4) Raw Material Cost	(7.89%)
5) Re-sale Value	(7.89%)
13) Variations in End Product	(15.38%)
19) Complexity	(15.38%)
23) Perceived Risk in Adoption	(15.38%)
24) Possibility of Modification	(15.38%)
29) Sophistication of Machine	(15.38%)

(2) City and Guilds or Similar

High

8) Reliability	(93.55%)
12) Effects on Quality	(80.65%)
7) Time Saving	(77.42%)
9) Ease of Maintenance	(77.42%)
26) After-sales Service	(77.42%)

Low

5) Re-sale Value	(6.45%)
23) Perceived Risk of Adoption	(16.13%)
4) Raw Material Costs	(22.58%)
21) Trial on a Small Scale	(29.03%)
24) Possibility of Modification	(29.03%)

(3) HNC or Similar

High

8) Reliability	(87.80%)
14) Ease in Operation	(78.05%)
7) Time Saving	(70.73%)
28) Availability of Technical Advice	(70.73%)
1) Initial Cost	(68.29%)

Low

5) Re-sale Value	(4.88%)
4) Raw Material Costs	(14.34%)
10) Energy Requirements	(24.39%)
23) Perceived Risk of Adoption	(24.39%)
24) Possibility of Modification	(26.83%)

(4) First Degree

High

1) Initial Cost	(89.66%)
14) Ease in Operation	(89.66%)
7) Time Saving	(86.21%)
8) Reliability	(86.21%)
2) Running Cost	(82.76%)

Low

5) Re-sale Value	(6.90%)
4) Raw Material Cost	(34.48%)
10) Energy Requirement	(34.48%)
23) Perceived Risk of Adoption	(34.48%)
27) Unit Costs	(34.48%)
29) Sophistication of Machine	(34.48%)

(5) Higher Degree

High

1)	Initial Cost	(90.00%)
7)	Time Saving	(90.00%)
8)	Reliability	(90.00%)
14)	Ease in Operation	(90.00%)
9)	Ease of Maintenance	(80.00%)
12)	Effects on Quality	(80.00%)
17)	Effects on Labour Requirement	(80.00%)
22)	Observability of Results	(80.00%)
26)	After-sales Service	(80.00%)

Low

5)	Re-sale Value	(0.00%)
4)	Raw Material Costs	(20.00%)
18)	Effects on Noise	(20.00%)
10)	Energy Requirements	(30.00%)
13)	Variations in End Product	(30.00%)
16)	Operator Comfort	(30.00%)
23)	Perceived Risk of Adoption	(30.00%)

App 4

QUALIFICATIONS PERCENTAGES: SURVEY II

Chars	1	2	3	4	5
1	84.62	61.29	68.29	89.66	90.00
2	69.23	67.74	48.78	82.76	60.00
3	69.23	74.19	46.34	58.62	70.00
4	7.69	22.58	14.34	34.48	20.00
5	7.69	6.45	4.88	6.90	0.00
6	46.15	51.61	60.98	55.17	60.00
7	76.92	77.42	70.73	86.21	90.00
8	92.31	93.55	87.50	86.21	90.00
9	61.54	77.42	63.41	65.42	80.00
10	30.77	45.16	24.39	34.48	30.00
11	46.15	45.16	29.27	48.28	40.00
12	61.54	80.65	58.54	68.97	80.00
13	15.38	35.48	29.27	48.28	30.00
14	69.23	58.06	78.05	89.66	90.00
15	23.08	32.26	29.27	68.97	40.00
16	46.15	51.61	41.46	58.62	30.00
17	61.54	64.52	48.78	79.31	80.00
18	46.15	48.39	36.59	37.93	20.00
19	15.38	51.61	29.27	37.93	50.00
20	38.46	58.06	48.78	72.41	70.00
21	30.77	29.03	31.71	55.71	50.00
22	30.77	45.16	39.02	65.52	80.00
23	15.38	16.13	24.39	34.48	30.00
24	15.38	29.03	26.83	51.72	60.00
25	46.15	38.71	51.22	62.07	70.00
26	61.54	77.42	63.41	58.62	80.00
27	38.46	58.06	29.27	34.48	70.00
28	46.15	64.52	70.73	68.97	70.00
29	15.38	35.48	26.83	34.48	40.00
30	61.54	74.19	58.54	58.62	40.00
n	13	31	41	29	10

1 - None
2 - City and Guilds or Similar
3 - HNC or Similar
4 - First Degree
5 - Higher Degree

FREQUENTLY CHOSEN CHARACTERISTICS: ALL RESPONDENTS

Educational Level

(1) No Qualifications

High

8) Reliability	(94.12%)
1) Initial Cost	(88.24%)
7) Time Saving	(82.35%)
14) Ease in Operation	(76.47%)
9) Ease of Maintenance	(70.59%)
12) Effects on Quality	(70.59%)
17) Effects on Labour Requirement	(70.59%)

Low

5) Re-sale Value	(5.88%)
4) Raw Material Costs	(11.76%)
15) Need for Retraining	(17.65%)
24) Possibility of Modification	(17.65%)
19) Complexity	(23.53%)
23) Perceived Risk of Adoption	(23.53%)
29) Sophistication of Machine	(23.53%)

(2) City and Guilds or Similar

High

8) Reliability	(91.67%)
12) Effects on Quality	(83.33%)
7) Time Saving	(80.56%)
9) Ease of Maintenance	(77.78%)
26) After-sales Service	(77.78%)

Low

5) Re-sale Value	(8.33%)
23) Perceived Risk of Adoption	(19.44%)
4) Raw Material Costs	(27.78%)
15) Need for Retraining	(30.56%)
21) Trial on a Small Scale	(33.33%)
29) Sophistication of Machine	(33.33%)

(3) HNC or Similar

High

8) Reliability	(87.27%)
7) Time Saving	(78.18%)
1) Initial Cost	(74.55%)
14) Ease in Operation	(72.73%)
6) Relative Advantage	(67.27%)
12) Effects on Quality	(67.27%)

Low

5) Re-sale Value	(10.91%)
4) Raw Material Costs	(27.27%)
29) Sophistication of Machine	(29.09%)
24) Possibility of Modification	(30.91%)
10) Energy Requirements	(32.73%)
23) Perceived Risk of Adoption	(32.73%)

(4) First Degree

High

1) Initial Cost	(91.67%)
14) Ease in Operation	(88.89%)
2) Running Cost	(86.11%)
7) Time Saving	(86.11%)
8) Reliability	(86.11%)

Low

5) Re-sale Value	(13.89%)
29) Sophistication of Machine	(38.89%)
10) Energy Requirement	(44.44%)
19) Complexity	(44.44%)
23) Perceived Risk of Adoption	(44.44%)

(5) Higher Degree

High

1) Initial Cost	(90.91%)
7) Time Saving	(90.91%)
8) Reliability	(90.91%)
14) Ease in Operation	(90.91%)
12) Effects on Quality	(81.82%)
17) Effects on Labour Requirement	(81.82%)
22) Observability of Results	(81.82%)
26) After-sales Service	(81.82%)

Low

5) Re-sale Value	(0.00%)
4) Raw Material Cost	(18.18%)
18) Effects on Noise	(18.18%)
10) Energy Requirements	(27.27%)

(A further seven at 36.36%)

App 4

QUALIFICATIONS PERCENTAGES: ALL RESPONDENTS

Chars	1	2	3	4	5
1	88.24	63.89	74.55	91.67	90.91
2	64.71	63.89	56.36	86.11	63.64
3	64.71	75.00	60.00	66.67	72.73
4	11.76	27.78	27.27	47.22	18.18
5	5.88	8.33	10.91	13.89	0.00
6	52.94	55.56	67.27	58.33	63.64
7	82.35	80.56	78.18	86.11	90.91
8	94.12	91.67	87.27	86.11	90.91
9	70.59	77.78	65.45	66.67	72.73
10	29.41	44.44	32.73	44.44	27.27
11	41.18	41.67	38.18	52.78	36.36
12	70.59	83.33	67.27	75.00	81.82
13	35.29	36.11	34.55	58.33	36.36
14	76.47	58.33	72.73	88.89	90.91
15	17.65	30.56	34.55	69.44	36.36
16	41.18	50.00	41.82	58.33	36.36
17	70.59	69.44	60.00	83.33	81.82
18	47.06	47.22	41.82	47.22	18.18
19	23.53	52.78	36.36	44.44	54.55
20	52.94	55.56	58.18	77.78	63.64
21	35.29	33.33	34.55	58.33	45.45
22	29.41	47.22	43.64	69.44	81.82
23	23.23	19.44	32.73	44.44	36.36
24	17.65	36.11	30.91	50.00	54.55
25	52.94	44.44	58.18	66.67	72.73
26	58.82	77.78	65.45	66.67	81.82
27	52.94	63.89	45.45	47.22	72.73
28	52.94	58.33	61.82	72.22	72.73
29	23.53	33.33	29.09	38.89	45.45
30	58.82	69.44	56.36	66.67	36.36
n	17	36	55	36	11

1 – None
2 – City and Guilds or Similar
3 – HNC or Similar
4 – First Degree
5 – Higher Degree

FREQUENTLY CHOSEN CHARACTERISTICS: SURVEY II

Organisational Size

(1) 20 or less employees

High

12) Effects on Quality	(100.00%)
1) Initial Cost	(75.00%)
7) Time Saving	(75.00%)
8) Reliability	(75.00%)
25) Supplier's Reputation	(75.00%)
26) After-sales Service	(75.00%)
28) Availability of Technical Advice	(75.00%)

Low

5) Re-sale Value	(0.00%)
10) Energy Requirement	(0.00%)
13) Variations in End Product	(0.00%)
18) Effects on Noise	(0.00%)
19) Complexity	(0.00%)
22) Observability of Results	(0.00%)
23) Perceived Risk of Adoption	(0.00%)
29) Sophistication of Machine	(0.00%)

(2) 21-100 employees

High

9) Ease of Maintenance	(73.33%)
1) Initial Cost	(66.67%)
7) Time Saving	(66.67%)
8) Reliability	(66.67%)
26) After-sales Service	(66.67%)

Low

4) Raw Material Costs	(0.00%)
19) Complexity	(0.00%)
23) Perceived Risk of Adoption	(0.00%)
5) Re-sale Value	(6.67%)
15) Need for Retraining	(6.67%)

(3) 101-500 employees

High

8)	Reliability	(96.97%)
7)	Time Saving	(78.79%)
9)	Ease of Maintenance	(72.73%)
14)	Ease in Operation	(72.73%)
30)	Effects on Safety	(72.73%)

Low

5)	Re-sale Value	(3.03%)
4)	Raw Material Costs	(21.21%)
29)	Sophistication of Machine	(21.21%)
23)	Perceived Risk of Adoption	(24.24%)
15)	Need for Retraining	(30.30%)
24)	Possibility of Modification	(30.30%)
25)	Supplier's Reputation	(30.30%)

(4) 501-1000 employees

High

8)	Reliability	(100.00%)
14)	Ease in Operation	(100.00%)
6)	Relative Advantage	(81.82%)
7)	Time Saving	(81.82%)
16)	Operator Comfort	(72.73%)

Low

5)	Re-sale Value	(18.18%)
21)	Trial on a Small Scale	(18.18%)
4)	Raw Material Costs	(27.27%)
10)	Energy Requirements	(27.27%)
18)	Effects on Noise	(27.27%)

(5) 1001-2500 employees

High

14) Ease in Operation	(95.83%)
8) Reliability	(91.67%)
1) Initial Cost	(87.50%)
7) Time Saving	(83.33%)
3) Rate of Return	(79.17%)
9) Ease of Maintenance	(79.17%)
26) After-sales Service	(79.17%)
28) Availability of Technical Advice	(79.17%)

Low

5) Re-sale Value	(4.17%)
4) Raw Material Costs	(16.67%)
23) Perceived Risk of Adoption	(16.67%)
13) Variations in End Product	(25.00%)
10) Energy Requirements	(33.33%)

(6) 2501-5000 employees

High

8) Reliability	(92.59%)
1) Initial Cost	(88.89%)
7) Time Saving	(85.19%)
12) Effects on Quality	(81.48%)
14) Ease in Operation	(81.48%)
17) Effects on Labour Requirement	(81.48%)

Low

5) Re-sale Value	(7.41%)
4) Raw Material Costs	(29.63%)
10) Energy Requirements	(29.63%)
19) Complexity	(37.04%)
23) Perceived Risk of Adoption	(37.04%)
24) Possibility of Modification	(37.04%)

(7) 5001 or more employees

High

3) Rate of Return	(80.00%)
8) Reliability	(80.00%)
12) Effects on Quality	(80.00%)
15) Need for Retraining	(80.00%)
17) Effects on Labour Requirement	(80.00%)
22) Observability of Results	(80.00%)
23) Perceived Risk of Adoption	(80.00%)
28) Availability of Technical Advice	(80.00%)

Low

4) Raw Material Costs	(0.00%)
5) Re-sale Value	(0.00%)
11) Space Requirements	(0.00%)
13) Variations in End Product	(0.00%)
19) Complexity	(20.00%)
21) Trial on a Small Scale	(20.00%)
24) Possibility of Modification	(20.00%)
25) Supplier's Reputation	(20.00%)
27) Unit Costs	(20.00%)

App 4

SIZE PERCENTAGES: SURVEY II

Chars	1	2	3	4	5	6	7
1	75.00	66.67	63.64	63.64	87.50	88.89	40.00
2	50.00	40.00	66.67	45.45	70.83	77.78	60.00
3	50.00	46.67	63.64	36.36	79.17	51.85	80.00
4	25.00	0.00	21.21	27.27	16.67	29.63	0.00
5	0.00	6.67	3.03	18.18	4.17	7.41	0.00
6	50.00	46.67	48.48	81.82	54.17	59.26	60.00
7	75.00	66.67	78.79	81.82	83.33	85.19	40.00
8	75.00	66.67	96.97	100.00	91.67	92.59	80.00
9	25.00	73.33	72.73	63.64	79.17	62.96	40.00
10	0.00	26.67	42.42	27.27	33.33	29.63	40.00
11	25.00	26.67	36.36	63.63	54.17	44.44	0.00
12	100.00	46.67	63.64	54.55	70.83	81.48	80.00
13	0.00	13.33	42.42	54.55	25.00	44.44	0.00
14	50.00	40.00	72.73	100.00	95.83	81.48	60.00
15	25.00	6.67	30.30	45.45	45.83	59.26	80.00
16	25.00	33.33	39.39	72.73	54.17	55.56	40.00
17	50.00	53.33	66.67	45.45	62.50	81.48	80.00
18	0.00	26.67	42.42	27.27	54.17	44.44	40.00
19	0.00	0.00	39.39	45.45	58.33	37.04	20.00
20	25.00	40.00	51.52	54.55	54.17	77.78	60.00
21	50.00	33.33	42.42	18.18	41.67	40.74	20.00
22	0.00	40.00	42.42	54.55	50.00	55.56	80.00
23	0.00	0.00	24.24	36.36	16.67	37.04	80.00
24	25.00	33.33	30.30	54.55	37.50	37.04	20.00
25	75.00	53.33	30.00	36.36	70.83	70.37	20.00
26	75.00	66.67	69.70	63.64	79.17	62.96	40.00
27	50.00	26.67	48.48	36.36	37.50	44.44	20.00
28	75.00	60.00	66.67	63.64	79.17	59.26	80.00
29	0.00	20.00	21.21	45.54	37.50	40.74	40.00
30	50.00	33.33	72.73	54.55	62.50	70.37	60.00
n	4	15	33	11	24	27	5

1 - 20 or less employees
2 - 21-100 employees
3 - 101-500 employees
4 - 501-1000 employees
5 - 1001-2500 employees
6 - 2501-5000 employees
7 - 5001 or more employees

FREQUENTLY CHOSEN CHARACTERISTICS: ALL RESPONDENTS

Organisational Size

(1) 20 or less employees

High

12) Effects on Quality	(100.00%)
1) Initial Cost	(75.00%)
7) Time Saving	(75.00%)
8) Reliability	(75.00%)
25) Supplier's Reputation	(75.00%)
26) After-sales Service	(75.00%)
28) Availability of Technical Advice	(75.00%)

Low

5) Re-sale Value	(0.00%)
10) Energy Requirement	(0.00%)
13) Variations in End Product	(0.00%)
18) Effects on Noise	(0.00%)
19) Complexity	(0.00%)
22) Observability of Results	(0.00%)
23) Perceived Risk of Adoption	(0.00%)
29) Sophistication of Machine	(0.00%)

(2) 21-100 employees

High

9) Ease of Maintenance	(73.33%)
1) Initial Cost	(66.67%)
7) Time Saving	(66.67%)
8) Reliability	(66.67%)
26) After-sales Service	(66.67%)

Low

4) Raw Material Costs	(0.00%)
19) Complexity	(0.00%)
23) Perceived Risk of Adoption	(0.00%)
5) Re-sale Value	(6.67%)
15) Need for Retraining	(6.67%)

(3) 101-500 employees

High

8) Reliability	(96.97%)
7) Time Saving	(78.79%)
9) Ease of Maintenance	(72.73%)
14) Ease in Operation	(72.73%)
30) Effects on Safety	(72.73%)

Low

5) Re-sale Value	(3.03%)
4) Raw Material Costs	(21.21%)
29) Sophistication of Machine	(21.21%)
23) Perceived Risk of Adoption	(24.24%)
15) Need for Retraining	(30.30%)
24) Possibility of Modification	(30.30%)
25) Supplier's Reputation	(30.30%)

(4) 501-1000 employees

High

8) Reliability	(100.00%)
14) Ease in Operation	(100.00%)
6) Relative Advantage	(81.82%)
7) Time Saving	(81.82%)
16) Operator Comfort	(72.73%)

Low

5) Re-sale Value	(18.18%)
21) Trial on a Small Scale	(18.18%)
4) Raw Material Costs	(27.27%)
10) Energy Requirements	(27.27%)
18) Effects on Noise	(27.27%)

(5) 1001-2500 employees

High

14) Ease in Operation	(95.83%)
8) Reliability	(91.67%)
1) Initial Cost	(87.50%)
7) Time Saving	(83.33%)
3) Rate of Return	(79.17%)
9) Ease of Maintenance	(79.17%)
26) After-sales Service	(79.17%)
28) Availability of Technical Advice	(79.17%)

Low

5) Re-sale Value	(4.17%)
4) Raw Material Costs	(16.67%)
23) Perceived Risk of Adoption	(16.67%)
13) Variations in End Product	(25.00%)
10) Energy Requirements	(33.33%)

(6) 2501-5000 employees

High

12) Effects on Quality	(91.89%)
1) Initial Cost	(90.54%)
7) Time Saving	(90.54%)
8) Reliability	(90.54%)
17) Effects on Labour Requirement	(90.54%)

Low

5) Re-sale Value	(16.22%)
24) Possibility of Modification	(41.89%)
29) Sophistication of Machine	(41.89%)
10) Energy Requirements	(44.59%)
21) Trial on a Small Scale	(45.93%)
11) Space Requirement	(48.65%)
15) Need for Retraining	(48.65%)
19) Complexity	(48.65%)
23) Perceived Risk of Adoption	(48.65%)

(7) 5001 or more employees

High

3) Rate of Return	(80.00%)
8) Reliability	(80.00%)
12) Effects on Quality	(80.00%)
15) Need for Retraining	(80.00%)
17) Effects on Labour Requirement	(80.00%)
22) Observability of Results	(80.00%)
23) Perceived Risk of Adoption	(80.00%)
28) Availability of Technical Advice	(80.00%)

Low

4) Raw Material Costs	(0.00%)
5) Re-sale Value	(0.00%)
11) Space Requirements	(0.00%)
13) Variations in End Product	(0.00%)
19) Complexity	(20.00%)
21) Trial on a Small Scale	(20.00%)
24) Possibility of Modification	(20.00%)
25) Supplier's Reputation	(20.00%)
27) Unit Costs	(20.00%)

App 4

SIZE PERCENTAGES: ALL RESPONDENTS

Chars	1	2	3	4	5	6	7
1	75.00	66.67	63.64	63.64	87.50	90.54	40.00
2	50.00	40.00	66.67	45.45	70.83	77.03	60.00
3	50.00	46.67	63.64	36.36	79.17	77.03	80.00
4	25.00	0.00	21.21	27.27	16.67	51.35	0.00
5	0.00	6.67	3.03	18.18	4.17	16.22	0.00
6	50.00	46.67	48.48	81.82	54.17	63.51	60.00
7	75.00	66.67	78.79	81.82	83.33	90.54	40.00
8	75.00	66.67	96.97	100.00	91.67	90.54	80.00
9	25.00	73.33	72.73	63.64	79.17	71.62	40.00
10	0.00	26.67	42.42	27.27	33.33	44.59	40.00
11	25.00	26.67	36.36	63.64	54.17	48.65	0.00
12	100.00	46.67	63.64	54.55	70.83	91.89	80.00
13	0.00	13.33	42.42	54.55	25.00	55.41	0.00
14	50.00	40.00	72.73	100.00	95.83	77.03	60.00
15	25.00	6.67	30.00	45.45	45.83	48.65	80.00
16	25.00	33.33	39.39	72.73	54.17	58.11	40.00
17	50.00	53.33	66.67	45.45	62.50	90.54	80.00
18	0.00	26.67	42.42	27.27	54.17	54.05	40.00
19	0.00	0.00	39.39	45.45	58.33	48.65	20.00
20	25.00	40.00	51.52	54.55	54.17	79.73	60.00
21	50.00	33.33	42.42	18.18	41.67	45.93	20.00
22	0.00	40.00	42.42	54.55	50.00	62.16	80.00
23	0.00	0.00	24.24	36.36	16.67	48.65	80.00
24	25.00	33.33	30.30	54.55	37.50	41.89	20.00
25	75.00	53.33	30.30	36.36	70.83	72.97	20.00
26	75.00	66.67	69.70	63.64	79.17	72.97	40.00
27	50.00	26.67	48.48	36.36	37.50	75.68	20.00
28	75.00	60.00	66.67	63.64	79.17	60.81	80.00
29	0.00	20.00	21.21	45.45	37.50	41.89	40.00
30	50.00	33.33	72.73	54.55	62.50	54.05	60.00
n	4	15	33	11	24	74	5

1 - 20 or less employees
2 - 21-100 employees
3 - 101-500 employees
4 - 501-1000 employees
5 - 1001-2500 employees
6 - 2501-5000 employees
7 - 5001 or more employees

FREQUENTLY CHOSEN CHARACTERISTICS: SURVEY I

Age Range

(1) 21-30

Sample too small for meaningful comparison.

(2) 31-40

High

7) Time Saving	(80.00%)
12) Effects on Safety	(80.00%)
17) Effects on Labour Requirement	(80.00%)
27) Unit Costs	(80.00%)

(A further eight at 70.00%)

Low

5) Re-sale Value	(20.00%)
11) Space Requirement	(20.00%)
10) Energy Requirement	(30.00%)
9) Ease of Maintenance	(40.00%)
18) Effects on Noise	(40.00%)
20) Compatibility with Existing Equipment	(40.00%)
30) Effects on Safety	(40.00%)

(3) 41-50

High

3) Rate of Return	(81.82%)
7) Time Saving	(81.82%)
8) Reliability	(81.82%)
12) Effects on Quality	(81.82%)
17) Effects on Labour Requirement	(81.82%)
27) Unit Costs	(81.82%)

Low

5) Re-sale Value	(18.18%)
10) Energy Requirement	(36.36%)
11) Space Requirement	(36.36%)
18) Effects on Noise	(36.36%)
21) Trial on a Small Scale	(36.36%)
30) Effects on Safety	(36.36%)

(4) 51-60

High

1) Initial Cost	(100.00%)
9) Ease of Maintenance	(100.00%)
12) Effects on Quality	(100.00%)
3) Rate of Return	(88.89%)
7) Time Saving	(88.89%)
8) Reliability	(88.89%)
17) Effects on Labour Requirement	(88.89%)
27) Unit Costs	(88.89%)

Low

5) Re-sale Value	(18.18%)
24) Possibility of Modification	(18.18%)
29) Sophistication of Machine	(18.18%)
21) Trial on a Small Scale	(33.33%)
23) Perceived Risk of Adoption	(33.33%)

(5) 61+

Sample too small for meaningful comparison.

App 4

AGE RANGE PERCENTAGES: SURVEY I

Chars	21-30	31-40	41-50	51-60	61+
1	33.33	70.00	72.73	100.00	50.00
2	33.33	60.00	72.73	66.67	50.00
3	66.67	70.00	81.82	88.89	50.00
4	33.33	60.00	54.55	77.78	0.00
5	33.33	20.00	18.18	18.18	0.00
6	0.00	50.00	72.73	77.78	0.00
7	66.67	80.00	81.82	88.89	100.00
8	33.33	70.00	81.82	88.89	100.00
9	33.33	40.00	63.64	100.00	100.00
10	66.67	30.00	36.36	77.78	0.00
11	33.33	20.00	36.36	66.67	50.00
12	33.33	80.00	81.82	100.00	100.00
13	33.33	50.00	54.55	66.67	100.00
14	33.33	70.00	72.73	66.67	100.00
15	0.00	50.00	54.55	44.44	0.00
16	33.33	50.00	63.64	44.44	50.00
17	66.67	80.00	81.82	88.89	100.00
18	33.33	40.00	36.36	44.44	50.00
19	0.00	60.00	45.46	55.56	50.00
20	33.33	40.00	72.73	77.78	100.00
21	0.00	50.00	36.36	33.33	50.00
22	33.33	70.00	63.64	66.67	0.00
23	33.33	70.00	63.64	33.33	0.00
24	0.00	70.00	54.55	18.18	0.00
25	33.33	60.00	63.64	66.67	100.00
26	33.33	70.00	63.64	55.56	50.00
27	67.67	80.00	81.82	88.89	100.00
28	33.33	60.00	54.55	55.56	100.00
29	0.00	50.00	45.46	18.18	50.00
30	0.00	40.00	36.36	55.56	50.00
n	3	10	11	9	2

FREQUENTLY CHOSEN CHARACTERISTICS: SURVEY II

Age Range

(1) 21-30

High

8) Reliability	(89.80%)
7) Time Saving	(85.71%)
14) Ease in Operation	(79.59%)
1) Initial Cost	(75.51%)
2) Running Cost	(73.41%)

Low

5) Re-sale Value	(2.04%)
23) Perceived Risk of Adoption	(20.41%)
4) Raw Material Costs	(26.53%)
29) Sophistication of Machine	(30.61%)
21) Trial on a Small Scale	(32.65%)

(2) 31-40

High

8) Reliability	(91.07%)
7) Time Saving	(75.00%)
1) Initial Cost	(73.21%)
14) Ease in Operation	(73.21%)
12) Effects on Quality	(71.43%)

Low

5) Re-sale Value	(7.14%)
4) Raw Material Costs	(21.43%)
10) Energy Requirements	(28.57%)
15) Need for Retraining	(30.36%)
23) Perceived Risk of Adoption	(30.36%)

(3) 41-50

High

1) Initial Cost	(78.57%)
8) Reliability	(78.57%)
7) Time Saving	(71.43%)
14) Ease in Operation	(71.43%)
16) Operator Comfort	(71.43%)
18) Effects on Noise	(71.43%)
26) After-sales Service	(71.43%)
30) Effects on Safety	(71.43%)

Low

4) Raw Material Costs	(7.14%)
5) Re-sale Value	(14.29%)
24) Possibility of Modification	(14.29%)
23) Perceived Risk of Adoption	(21.43%)
29) Sophistication of Machine	(21.43%)

(4) 51-60

High

8) Reliability	(100.00%)
1) Initial Cost	(75.00%)
9) Ease of Maintenance	(75.00%)
14) Ease in Operation	(75.00%)
17) Effects on Labour Requirement	(75.00%)

Low

4) Raw Material Cost	(0.00%)
5) Re-sale Value	(0.00%)
19) Complexity	(0.00%)
21) Trial on a Small Scale	(0.00%)
22) Observability of Results	(0.00%)
23) Perceived Risk of Adoption	(0.00%)
24) Possibility of Modification	(0.00%)

(5) 61+

Sample too small for meaningful comparison.

App 4

AGE RANGE PERCENTAGES: SURVEY II

Chars	21-30	31-40	41-50	51-60	61+
1	75.51	73.21	78.57	75.00	0.00
2	73.47	58.93	64.29	50.00	0.00
3	67.35	57.14	57.14	50.00	0.00
4	26.53	21.43	7.14	0.00	0.00
5	2.04	7.14	14.29	0.00	0.00
6	51.02	66.07	35.71	25.00	0.00
7	85.71	75.00	71.43	50.00	0.00
8	89.80	91.07	78.57	100.00	0.00
9	69.39	69.64	64.29	75.00	0.00
10	38.78	28.57	35.71	25.00	0.00
11	44.90	39.29	28.57	50.00	0.00
12	69.39	71.43	64.29	50.00	0.00
13	32.65	37.50	28.57	25.00	0.00
14	79.59	73.21	71.43	75.00	0.00
15	51.02	30.36	42.86	25.00	0.00
16	51.02	39.29	71.43	50.00	0.00
17	63.27	66.07	50.00	75.00	0.00
18	34.69	35.71	71.43	50.00	0.00
19	44.90	33.93	35.71	0.00	0.00
20	67.35	50.00	57.14	25.00	0.00
21	32.65	42.86	50.00	0.00	0.00
22	55.10	48.21	50.00	0.00	0.00
23	20.41	30.36	21.43	0.00	0.00
24	44.90	33.93	14.29	0.00	0.00
25	59.18	42.86	64.29	50.00	0.00
26	69.39	66.07	71.43	50.00	0.00
27	40.82	44.64	35.71	25.00	0.00
28	71.43	64.29	64.29	50.00	0.00
29	30.61	33.93	21.43	25.00	0.00
30	59.18	60.71	71.43	50.00	0.00
n	49	56	14	4	0

FREQUENTLY CHOSEN CHARACTERISTICS: ALL RESPONDENTS

Age Range

(1) 21-30

High

8) Reliability	(86.54%)
7) Time Saving	(84.62%)
14) Ease in Operation	(76.92%)
1) Initial Cost	(73.08%)
2) Running Cost	(71.15%)

Low

5) Re-sale Value	(3.85%)
23) Perceived Risk of Adoption	(21.15%)
4) Raw Material Cost	(26.92%)
29) Sophistication of Machine	(28.85%)
21) Trial on a Small Scale	(30.77%)

(2) 31-40

High

8) Reliability	(87.88%)
7) Time Saving	(75.76%)
1) Initial Cost	(72.73%)
12) Effects on Quality	(72.73%)
14) Ease in Operation	(72.73%)

Low

5) Re-sale Value	(9.09%)
4) Raw Material Cost	(27.27%)
10) Energy Requirement	(28.79%)
15) Need for Retraining	(33.33%)
11) Space Requirement	(36.36%)
18) Effects on Noise	(36.36%)
23) Perceived Risk of Adoption	(36.36%)
29) Sophistication of Machine	(36.36%)

(3) 41-50

High

8) Reliability (80.00%)
1) Initial Cost (76.00%)
7) Time Saving (76.00%)
12) Effects on Quality (72.00%)
14) Ease in Operation (72.00%)

Low

5) Re-sale Value (16.00%)
4) Raw Material Costs (28.00%)
11) Space Requirement (32.00%)
24) Possibility of Modification (32.00%)
29) Sophistication of Machine (32.00%)

(4) 51-60

High

1) Initial Cost (92.31%)
8) Reliability (92.31%)
9) Ease of Maintenance (92.31%)
12) Effects on Quality (84.62%)
17) Effects on Labour Requirement (84.62%)

Low

5) Re-sale Value (15.38%)
24) Possibility of Modification (15.38%)
21) Trial on a Small Scale (23.08%)
23) Perceived Risk of Adoption (23.08%)
29) Sophistication of Machine (23.08%)

(5) 61+

Sample too small for meaningful comparison.

App 4

AGE RANGE PERCENTAGES: ALL RESPONDENTS

Chars	21-30	31-40	41-50	51-60	61+
1	73.08	72.73	76.00	92.31	50.00
2	71.15	59.09	68.00	61.54	50.00
3	67.31	59.09	68.00	76.92	50.00
4	26.92	27.27	28.00	53.85	0.00
5	3.85	9.09	16.00	15.38	0.00
6	48.08	63.64	52.00	61.54	0.00
7	84.62	75.76	76.00	76.94	100.00
8	86.54	87.88	80.00	92.31	100.00
9	67.31	65.15	64.00	92.31	100.00
10	40.38	28.79	36.00	61.54	0.00
11	44.23	36.36	32.00	61.54	50.00
12	67.31	72.73	72.00	84.62	100.00
13	32.69	39.39	40.00	53.85	100.00
14	76.92	72.73	72.00	69.23	100.00
15	48.08	33.33	48.00	38.46	0.00
16	50.00	40.91	68.00	46.15	50.00
17	63.46	68.18	64.00	84.62	100.00
18	34.62	36.36	56.00	46.16	50.00
19	42.31	37.88	40.00	38.46	50.00
20	65.38	48.88	64.00	61.54	100.00
21	30.77	43.94	44.00	23.08	50.00
22	53.85	51.52	56.00	46.15	0.00
23	21.15	36.36	40.00	23.08	0.00
24	42.31	39.39	32.00	15.38	0.00
25	57.69	45.45	64.00	61.54	100.00
26	67.31	66.67	68.00	53.85	50.00
27	42.31	50.0	56.00	69.23	100.00
28	69.23	63.64	60.00	53.85	100.00
29	28.85	36.36	32.00	23.08	50.00
30	55.77	57.58	56.00	53.85	50.00
n	52	66	25	13	2

CHARACTERISTIC MEAN IMPORTANCE: SURVEY I

Management Level

(1) Management Level One

High

7) Time Saving	(2.93)
4) Raw Material Costs	(3.83)
27) Unit Costs	(4.50)
1) Initial Cost	(5.75)
3) Rate of Return	(5.93)

Low

16) Operator Comfort	(21.00)
18) Effects on Noise	(19.50)
20) Compatibility with Existing Equipment	(17.17)
30) Effects on Safety	(16.00)
19) Complexity	(15.90)
21) Trial on a Small Scale	(15.88)

(2) Management Level Two

High

3) Rate of Return	(3.57)
7) Time Saving	(4.28)
1) Initial Cost	(4.69)
2) Running Cost	(6.86)
12) Effects on Quality	(6.63)

Low

23) Percieved Risk of Adoption	(22.89)
24) Possibility of Modification	(21.75)
16) Operator Comfort	(20.38)
19) Complexity	(19.44)
18) Effects on Noise	(18.68)

(3) Management Level Three

High

6) Relative Advantage (6.50)
17) Effects on Labour Requirement (6.57)
23) Perceived Risk of Adoption (6.60)
7) Time Saving (6.67)
3) Rate of Return (7.00)

Low

5) Re-sale Value (22.00)
15) Need for Retraining (17.63)
30) Effects on Safety (17.00)
24) Possibility of Modification (16.50)
18) Effects on Noise (15.75)

(4) Management Level Four

High

3) Rate of Return (4.17)
7) Time Saving (4.60)
2) Running Cost (5.40)
27) Unit Cost (5.67)
8) Reliability (6.25)

Low

16) Operator Comfort (18.75)
24) Possibility of Modification (18.00)
19) Complexity (15.00)
11) Space Requirement (14.33)
5) Re-sale Value (14.00)
30) Effects on Safety (14.00)

(5) Management Level Five

High

7)	Time Saving	(4.33)
12)	Effects on Quality	(5.00)
8)	Reliability	(5.69)
1)	Initial Cost	(6.50)
6)	Relative Advantage	(6.67)

Low

5)	Re-sale Value	(25.00)
11)	Space Requirement	(24.33)
29)	Sophistication of Machine	(21.00)
23)	Perceived Risk of Adoption	(16.33)
18)	Effects on Noise	(16.00)

(6) Management Level Six

Sample too small for meaningful comparison.

App 5

MANAGEMENT LEVEL IMPORTANCE MEANS: SURVEY I

Chars	1	2	3	4	5	6
1	5.75	4.69	10.67	10.50	6.50	18.50
2	7.00	6.86	9.86	5.40	7.50	14.50
3	5.93	3.57	7.00	4.17	7.21	9.00
4	3.83	11.57	12.20	7.75	9.75	17.00
5	11.00	15.40	22.00	14.00	25.00	*
6	10.17	12.31	6.50	9.00	6.67	17.00
7	2.93	4.28	6.67	4.60	4.33	8.50
8	9.07	8.47	11.29	6.25	5.69	13.00
9	13.70	10.93	8.50	6.67	13.86	11.00
10	9.00	12.42	11.50	10.00	11.00	*
11	10.50	12.73	9.63	14.33	24.33	*
12	8.00	7.63	11.93	6.80	5.00	7.00
13	12.90	11.38	9.40	13.67	11.40	*
14	13.88	12.61	9.42	6.67	11.50	12.50
15	11.00	18.11	17.63	12.00	14.00	10.00
16	21.00	20.38	15.58	18.75	14.40	11.50
17	9.80	9.91	6.57	8.17	9.00	9.00
18	19.50	18.68	15.75	13.00	16.00	*
19	15.90	19.44	14.00	15.00	13.33	20.00
20	17.17	14.53	12.83	12.00	9.50	7.50
21	15.88	15.65	13.00	11.00	10.67	*
22	13.38	15.73	14.25	13.60	9.60	4.00
23	9.20	22.89	6.60	11.00	16.33	18.00
24	13.75	21.75	16.50	18.00	15.67	19.00
25	12.40	14.86	14.00	12.75	15.25	21.00
26	13.58	16.75	14.29	13.50	11.71	12.00
27	4.50	6.56	7.33	5.67	8.00	7.00
28	9.20	17.00	15.67	12.00	10.50	14.00
29	15.75	17.00	15.00	10.67	21.00	13.00
30	16.00	18.41	17.00	14.00	10.00	*
n	7	16	7	6	9	2

1 - Management Level One
2 - Management Level Two
3 - Management Level Three
4 - Management Level Four
5 - Management Level Five
6 - Management Level Six

CHARACTERISTIC IMPORTANCE MEANS: SURVEY I

Educational Level

(1) None

High

7) Time Saving	(2.50)
1) Initial Cost	(3.25)
3) Rate of Return	(5.00)
12) Effects on Quality	(5.50)
8) Reliability	(6.25)

Low

18) Effects on Noise	(26.00)
5) Re-sale Value	(24.00)
16) Operator Comfort	(21.50)
30) Effects on Safety	(21.50)
15) Need for Retraining	(21.00)

(2) City and Guilds or Similar

High

3) Rate of Return	(3.00)
27) Unit Costs	(3.00)
7) Time Saving	(4.25)
13) Variations in End Product	(5.00)
1) Initial Cost	(5.60)

Low

19) Complexity	(24.00)
23) Perceived Risk of Adoption	(21.00)
29) Sophistication of Machine	(19.50)
24) Possibility of Modification	(16.67)
15) Need for Retraining	(16.00)
6) Relative Advantage	(15.00)
30) Effects on Safety	(15.00)

(3) HNC or similar

High

7)	Time Saving	(5.25)
3)	Rate of Return	(5.77)
12)	Effects on Quality	(6.31)
27)	Unit Costs	(7.36)
2)	Running Costs	(7.45)

Low

19)	Complexity	(20.57)
24)	Possibility of Modification	(20.36)
29)	Sophistication of Machine	(20.00)
23)	Perceived Risk of Adoption	(19.38)
18)	Effects on Noise	(17.50)

(4) First Degree

High

7)	Time Saving	(3.64)
27)	Unit Costs	(5.00)
10)	Energy Requirements	(7.00)
8)	Reliability	(8.21)
12)	Effects on Quality	(8.24)
13)	Variations in End Product	(8.29)

Low

18)	Effects on Noise	(26.00)
22)	Observability of Results	(15.30)
30)	Effects on Safety	(15.00)
15)	Need for Retraining	(14.67)
19)	Complexity	(14.13)

(5) Higher Degree

Sample too small for meaningful analysis.

QUALIFICATIONS IMPORTANCE MEANS: SURVEY I

Chars	1	2	3	4	5
1	3.25	5.60	9.00	8.42	1.00
2	7.67	12.33	7.45	11.60	3.00
3	5.00	3.00	5.77	8.75	2.00
4	15.00	9.20	11.45	9.83	5.00
5	24.00	14.00	14.20	11.00	*
6	7.25	15.00	12.40	9.60	*
7	2.50	4.25	5.25	3.64	6.00
8	6.25	8.33	9.85	8.21	14.00
9	12.67	10.20	12.30	11.50	7.00
10	11.50	7.67	11.25	7.00	9.00
11	12.50	7.67	14.11	*	*
12	5.50	6.40	6.31	8.29	12.00
13	10.25	5.00	15.07	8.29	13.00
14	8.25	13.00	11.63	11.30	*
15	21.00	16.00	14.38	14.67	18.00
16	21.50	13.25	16.30	13.50	*
17	15.00	9.20	8.25	9.17	8.00
18	26.00	13.50	17.50	26.00	22.00
19	11.00	24.00	20.57	14.13	16.00
20	15.00	12.00	15.00	8.83	15.00
21	*	14.50	15.25	12.38	21.00
22	15.67	14.00	13.23	15.30	*
23	16.33	21.00	19.38	8.75	4.00
24	*	16.67	20.36	12.08	11.00
25	19.67	13.00	15.00	11.80	*
26	17.00	13.50	14.64	11.90	20.00
27	8.00	3.00	7.36	5.00	10.00
28	13.67	9.00	15.00	10.20	19.00
29	11.50	19.50	20.00	12.50	17.00
30	21.50	15.00	16.25	15.00	23.00
n	4	5	14	7	1

1 - None
2 - City and Guilds or Similar
3 - HNC or Similar
4 - First Degree
5 - Higher Degree

App 5

CHARACTERISTIC IMPORTANCE MEANS: SURVEY I

Age Range

(1) 21-30

High

12)	Effects on Quality	(1.00)
28)	Availabilty of Technical Advice	(2.00)
1)	Initial Cost	(3.00)
8)	Reliability	(3.00)
26)	After-sale Service	(4.00)

Low

25)	Supplier's Reputation	(21.00)
13)	Variations in End Product	(20.00)
18)	Effects on Noise	(19.00)
22)	Observability of Results	(16.00)
23)	Perceived Risk of Adoption	(15.00)

(2) 31-40

High

7)	Time Saving	(3.22)
3)	Rate of Return	(4.50)
1)	Initial Cost	(5.63)
27)	Unit Cost	(5.89)
2)	Running Cost	(7.71)

Low

19)	Complexity	(20.29)
29)	Sophistication of Machine	(19.20)
30)	Effects on Safety	(18.40)
16)	Operator Comfort	(18.17)
18)	Effects on Noise	(17.40)

(3) 41-50

High

7) Time Saving	(5.00)
27) Unit Cost	(5.90)
12) Effects on Quality	(6.40)
3) Rate of Return	(7.25)
17) Effects on Labour Requirement	(7.75)

Low

18) Effects on Noise	(21.63)
29) Sophistication of Machine	(19.20)
19) Complexity	(19.42)
23) Perceived Risk of Adoption	(16.86)
24) Possibility of Modification	(16.86)

(4) 51-60

High

7) Time Saving	(3.57)
12) Effects on Quality	(4.63)
3) Rate of Return	(5.57)
1) Initial Cost	(6.38)
27) Unit Cost	(6.43)

Low

30) Effects on Safety	(18.50)
23) Perceived Risk of Adoption	(18.00)
15) Need for Retraining	(17.67)
16) Operator Comfort	(17.33)
18) Effects on Noise	(17.00)

(5) 61+

Sample too small for meaningful comparison.

App 5

AGE RANGE IMPORTANCE MEANS: SURVEY I

Chars	21-30	31-40	41-50	51-60	61+
1	3.00	5.63	11.06	6.38	1.00
2	7.00	7.71	10.11	9.80	7.00
3	4.50	4.50	7.25	5.57	1.00
4	6.00	11.00	11.28	11.00	*
5	10.00	15.50	13.67	19.00	*
6	*	11.00	13.22	7.67	*
7	7.50	3.22	5.00	3.57	8.00
8	3.00	9.00	10.55	7.57	5.00
9	10.00	9.80	14.56	11.00	8.50
10	9.00	11.00	10.20	10.00	*
11	9.00	11.33	15.50	11.80	9.00
12	1.00	9.33	6.40	4.63	8.00
13	20.00	15.20	10.83	9.00	11.00
14	9.00	12.57	10.38	10.80	8.00
15	*	17.17	13.67	17.67	*
16	11.00	18.17	14.29	17.33	15.00
17	11.00	9.33	7.75	12.57	7.00
18	19.00	17.40	21.63	17.00	11.00
19	*	20.29	19.42	9.75	18.00
20	12.00	14.80	12.44	15.83	9.00
21	*	14.67	14.00	15.00	17.00
22	16.00	12.88	14.86	13.80	*
23	15.00	14.50	16.86	18.00	*
24	*	16.50	16.86	8.00	*
25	21.00	14.29	15.63	14.20	10.50
26	4.00	14.13	14.19	16.75	13.00
27	10.00	5.89	5.90	6.43	5.50
28	2.00	12.83	14.33	14.20	14.00
29	*	19.20	19.60	6.50	2.00
30	*	18.40	15.13	18.50	12.00
n	2	9	10	8	2

App 6

CHARACTERISTIC CHOICE HIERARCHICAL CLUSTER ANALYSIS: SURVEY I

Clusters at the 95% Level

(4) Production Manager (14) Works Manager
(10) Production Engineering Services Manager (9) Production Engineer

(35) Project Engineer (36) Manager Special Products Unit

Clusters at the 92.5% Level

(1) Chief of Production Engineering Services (11) Manufacturing Manager
(4) Production Manager (14) Works Manager (10) Production Engineering Services Manager (9) Production Engineer (42) Production Manager
(12) Works Accountant

(35) Project Engineer (36) Manager Special Products Unit

Clusters at the 90% Level

(1) Chief of Production Engineering Services (11) Manufacturing Manager
(4) Production Manager (14) Works Manager (10) Production Engineering Services Manager (9) Production Engineer (42) Production Manager
(12) Works Accountant (40) Area Manager (22) CAD Manager

(27) Manager (23) CAD Operator

(25) Technical Director (26) Drawing Office Manager

(35) Project Engineer (36) Manager Special Products Unit
(31) Production Engineering Manager

(7) Production Engineer (6) Production Engineer

Clusters at the 87.5% Level

(1) Chief of Production Engineering Services (11) Manufacturing Manager
(4) Production Manager (14) Works Manager (10) Production Engineering Services Manager (9) Production Engineer (42) Production Manager
(12) Works Accountant (40) Area Manager (22) CAD Manager

(27) Manager (23) CAD Operator

(25) Technical Director (26) Drawing Office Manager

(35) Project Engineer (36) Manager Special Products Unit
(31) Production Engineering Manager

(7) Production Engineer (6) Production Engineer

Clusters at the 85% Level

(1) Chief of Production Engineering Services (11) Manufacturing Manager (4) Production Manager (14) Works Manager (10) Production Engineering Services Manager (9) Production Engineer (42) Production Manager (12) Works Accountant (40) Area Manager (22) CAD Manager (28) System Manager (27) Manager (23) CAD Operator

(25) Technical Director (26) Drawing Office Manager (19) Chief of Engineering Computing

(16) Production Engineering Services Manager (35) Project Engineer (36) Manager Special Products Unit (31) Production Engineering Manager

(44) Works Accountant (45) Materials Costing Officer (15) Works Accountant

(2) Production Engineer (7) Production Engineer (6) Production Engineer

Clusters at the 82.5% Level

(1) Chief of Production Engineering Services (11) Manufacturing Manager (4) Production Manager (14) Works Manager (10) Production Engineering Services Manager (9) Production Engineer (42) Production Manager (12) Works Accountant (40) Area Manager (22) CAD Manager (28) System Manager (27) Manager (23) CAD Operator (25) Technical Director (26) Drawing Office Manager (19) Chief of Engineering Computing (17) Manufacturing Manager (16) Production Engineering Services Manager (35) Project Engineer (36) Manager Special Products Unit (31) Production Engineering Manager (3) Production Resources Manager (43) Production Engineering Manager

(44) Works Accountant (45) Materials Costing Officer (15) Works Accountant (29) Director

(2) Production Engineer (7) Production Engineer (6) Production Engineer (46) Design Engineer

Clusters at the 80% Level

(1) Chief of Production Engineering Services (11) Manufacturing Manager (4) Production Manager (14) Works Manager (10) Production Engineering Services Manager (9) Production Engineer (42) Production Manager (12) Works Accountant (40) Area Manager (22) CAD Manager (28) System Manager (27) Manager (23) CAD Operator (25) Technical Director (26) Drawing Office Manager (19) Chief of Engineering Computing (17) Manufacturing Manager (16) Production Engineering Services Manager (35) Project Engineer (36) Manager Special Products Unit (31) Production Engineering Manager (3) Production Resources Manager (43) Production Engineering Manager (41) Chief Production Engineer (38) Chief Development Engineer (37) Accountant (44) Works Accountant (45) Materials Costing Officer

(15) Works Accountant (29) Director. (34) Chief Development Engineer (32) Quality Control Manager (20) Section Leader (30) Technical Director (18) Assistant Production Director

(2) Production Engineer (7) Production Engineer (6) Production Engineer (46) Design Engineer

App 7

CHARACTERISTIC IMPORTANCE HIERARCHICAL CLUSTER ANALYSIS: SURVEY I

Clusters at the 97.5% Level

(45) Materials Costing Officer (34) Chief Development Engineer

Clusters at the 95% Level

(45) Materials Costing Officer (34) Chief Development Engineer

Clusters at the 92.5% Level

(45) Materials Costing Officer (34) Chief Development Engineer

Clusters at the 90% Level

(3) Production Resources Manager (46) Design Engineer

(44) Works Accountant (45) Materials Costing Officer (34) Chief Development Engineer (12) Works Accountant (15) Works Accountant (47) Design Engineer

Clusters at the 87.5% Level

(37) Accountant (39) Controller Capital Investment

(29) Director (3) Production Resources Manager (46) Design Engineer (44) Works Accountant (45) Materials Costing Officer (34) Chief Development Engineer (12) Works Accountant (15) Works Accountant (47) Design Engineer (14) Works Manager (33) Production Manager (30) Technical Director (8) Technical Director (35) Project Engineer (31) Production Engineering Manager

Clusters at the 85% Level

(37) Accountant (39) Controller Capital Investment (29) Director (3) Production Resources Manager (46) Design Engineer (44) Works Accountant (45) Materials Costing Officer (34) Chief Development Engineer (12) Works Accountant (15) Works Accountant (47) Design Enginee (14) Works Manager (33) Production Manager (30) Technical Director (8) Technical Director (35) Project Engineer (31) Production Engineering Manager (43) Production Engineering Manager (10) Production Engineering Services Manager

(6) Production Engineer (26) Drawing Office Manager

Clusters at the 82.5% Level

(13) Works Manager (37) Accountant (39) Controller Capital Investment (29) Director (3) Production Resources Manager (46) Design Engineer (44) Works Accountant (45) Materials Costing Officer (34) Chief Development Engineer (12) Works Accountant (15) Works Accountant (47) Design Engineer (14) Works Manager (33) Production Manager (30) Technical Director (8) Technical Director (35) Project Engineer (31) Production Engineering Manager (43) Production Engineering Manager (10) Production Engineering Services Manager (41) Chief Production Engineer (19) Chief of Engineering Computing (23) CAD Operator (24) Technical Director (38) Chief Development Engineer (2) Production Engineer (7) Production Engineer (5) Works Manager (6) Production Engineer (26) Drawing Office Manager (18) Assistant Production Director (40) Area Manager

(42) Production Manager (17) Manufacturing Manager

Clusters at the 80% Level

(13) Works Manager (37) Accountant (39) Controller Capital Investment (29) Director (3) Production Resources Manager (46) Design Engineer (44) Works Accountant (45) Materials Costing Officer (34) Chief Development Engineer (12) Works Accountant (15) Works Accountant (47) Design Engineer (14) Works Manager (33) Production Manager (30) Technical Director (8) Technical Director (35) Project Engineer (31) Production Engineering Manager (43) Production Engineering Manager (10) Production Engineering Services Manager (41) Chief Production Enginee (19) Chief of Engineering Computing (23) CAD Operator (24) Technical Director (38) Chief Development Engineer (2) Production Engineer (7) Production Engineer (5) Works Manager (6) Production Engineer (26) Drawing Office Manager (18) Assistant Production Director (40) Area Manager (25) Technical Director (32) Quality Control Manager (27) Manager (36) Manager Special Products Unit (42) Production Manager (17) Manufacturing Manager (9) Production Engineer