The application of behavioural science to symbol Design

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D A V I D S L E S S

The Application of Behavioural Science to Symbol Design

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A B S T R A C T

In order to develop a sound basis for the development of design education, we need to study the behaviour of designers. This enquiry focuses on the process of symbol design. A definition of design is offered which takes due account of prior definitions, design methods, psychological theory, the interdisciplinary nature of design, and of greatest importance, the need for a definition which underpins empirical investigation. The nature of symbols is discussed in relation to Semiotics. The difficulties of research are considered and an approach is developed after investigating methods of classifying symbols. The limiting conditions of this approach are specified.

The above discussion is integrated into a definition of symbol design and a model of the potential influences on the process is evolved. Two pilot studies of symbol design are reported and refinements to the methodology of such experiments are suggested. Some tentative conclusions emerge from these experiments, which, along with the basic theoretical framework, are used to evaluate a number of design methods. The study concludes with a discussion of future research possibilities.

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Needless to say, any faults herein are all my own.

C O N T E N T S

INTRODUCTION

"Design has many connotations. It is the organisation of materials and processes in the most productive, economic way, in a harmonious balance of all elements necessary for a certain function. It is not a matter of facade, of mere external appearance; rather it is the essence of products and institutions, penetrating and comprehensive. Designing is a complex and intricate task. It is the integration of technological, social and economic requirements, biological necessities, and the psychophysical effects of materials, shape, colour, volume and space; thinking in relationships." (Moholy Nagy 1946)

Watching designers at work is exhilarating and humbling. Exhilarating, because in the face of so many conflicting and intangible demands one sees ideas born and brought to fruition; humbling, because one is at a loss to understand how. This study is an attempt to lay a foundation for understanding the behaviour of designers. It has grown out of my involvement with Art and Design education. As a psychologist, working in a School of Art, one leads a hazardous academic life. One's scientific conscience flinches frequently at the seeming vagueness. One is tempted to wade in with big precision-made boots and sort it all out. On the other hand one is all too conscious of the limitations of one's own discipline to solve problems in the 'real' world. This all takes place against a background of highly productive work which constantly surprises and impresses me. The only sensible thing to do is to stand back and observe.

Most of the students I work with are on a three-year college diploma course in Visual Communications. It has a strong,

practical basis. The visual communication systems we consider and ask students to design are: instructional systems, man/machine interfaces, sign-posting systems and corporate identity programmes. Our constant problem is how to teach students to design such systems. There are, as we shall see, many 'prefabricated' methods for designing which we could use but they have no proven record of either success or failure. The number and variety of these methods has mushroomed in recent years. Regrettably we have not seen a corresponding growth in research into design behaviour. This is a serious imbalance in our knowledge, since theories and knowledge of design behaviour are necessarily of more fundamental importance than design methods. Unless the balance is redressed we are open to the accusation that we are telling designers what to do without considering the merits of what they already do, suggesting ways of modifying their behaviour without knowing what it is we modify. We are like locksmiths, obsessed with making keys without considering the locks they must fit. This is the background which has motivated this enquiry.

There are wider implications on which this thesis has a bearing. The education problems which confront my colleagues and me are common in all areas of design and hopefully this work will find some relevance in those areas. As our society becomes more complex, more use is made of remote forms of communication, as opposed to face to face contact. Many of these remote forms are visual; from the office memo to the television programme. We need to understand these and the people who use them.

I have focused this enquiry on the design of symbols. It offers a circumscribed area of interest which can be looked at experimentally and in a limited way it contains the basic

ingredients of other more complex design problems. It may seem strange that a study so intimately linked with the visual arts, contains no reference to aesthetics. The omission is deliberate. Our concern is with operative symbols: trade marks, road signs, indeed any symbol which has a specific message to communicate. We are not concerned with beautiful objects, though I would not seek to deny a link between beauty and efficiency. An artist once remarked that Aesthetics is to the artist as Ornithology is to the birds. In that sense, and insofar as a designer is an artist, this whole thesis is concerned with Aesthetics but it is outside our scope to consider the artist's proposition.

The thesis looks at symbol design and tries to develop a framework for enquiry into the behaviour of designers. In the opening chapter we review the nature of design activity and evolve a definition of design, suitable for our needs. In Chapter II we explore the nature of symbols through the way in which man uses them. The term 'sign' is used in favour of 'symbol' throughout the body of the text because it is used in the studies we shall draw from and it has more general scope in application. Following this, in Chapter III we bring together the notion of design and signs and evolve a definition of sign design. This basic definition is used to consider in detail the potential influences on the process. This is followed in Chapter IV by pilot studies in sign design which result in some tentative conclusions. We then, in chapter V scrutinise some of the design methods which are available for the sign designer. Finally in Chapter VI we consider the problems the enquiry has posed and offer some suggestions for future research.

CHAPTER 1

Towards a Definition of Design

"Definitions are not ends in themselves, but instrumentalities for facilitating the development of a concept into forms where its applicability to given facts may best be tested." (J. Dewey)

Summary

This chapter proposes the following definition of design: DESIGN IS THE PROCESS OF ORIGINATING SYSTEMS AND PREDICTING THEIR FULFILMENT OF GIVEN OBJECTIVES. The origins of the definition are based on a consideration of prior definitions, design methods, psychological theory, the interdisciplinary nature of design and finally, and of greatest importance, on the need for a definition which leads us towards an empirical investigation of the design process.

1.1 Purpose of a New Definition of Design

1.1.1. Design, as a discipline in its own right, is in its infancy. The first international conference on design methods occurred in 1963 (Jones and Thornley). Since then there has been a proliferation of definitions of design. (Appendix 1). To add yet another definition would seem to complicate matters rather than to clarify them. However, none of the existing definitions fulfil the requirements of a definition for the purpose of this thesis. This is not to suggest that what is offered is a radical departure from existing concepts; rather, it represents a

distillation of ideas present both implicitly and explicitly in existing definitions. It is hoped thereby that it will clarify rather than confuse.

1.1.2 By far the greatest volume of research in design has been directed towards a consideration of design methods. From an analysis of these it is possible to shed some light on the nature of the design process. There is a need to evaluate the usefulness of design methods and say something about their relative merits in a variety of contexts. To do this we need a framework which is common to all methods and provides a basis for comparison from a unified position. Accordingly, one of the functions of the definition will be to provide such a framework.

1.1.3 Because this thesis is concerned with design behaviour it is necessary to provide a definition which relates design behaviour to the corpus of psychological theory. The design tradition has for too long been separated from the developments in psychology which have a contribution to make in this field and psychologists have been slow to consider it worthy of attention. Accordingly the definition developed here attempts to bridge this gap in tradition.

Design is an interdisciplinary activity at two levels. Firstly, it occurs in a wide variety of situations: architecture, engineering, fashion, communication, and even politics. It is difficult to see what all these areas have in common other than the word 'design'. It is beyond the scope of this enquiry to explore fully the contexts in which the word is used. My purpose is not universal and even if it were, it is probably within the realms of linguistics or philosophy rather than psychology to attempt to

disentangle the semantic and pragmatic knots which have arisen over the use of the term 'design'. My purpose here is to investigate the area of communication design and within that, is concerned with certain limited objectives. As such, although I have considered and indeed derived the present definition from other areas of design, and believe that this definition may be of use within other areas, it remains for theorists in these areas to evaluate its usefulness.

A second way in which design straddles many disciplines is in the wide range of factors that a designer takes into account in developing a design. He has to consider information from many fields of knowledge. Human, economic, technical and aesthetic considerations are all pertinent.

The results of such interdisciplinary involvement is that problems constantly arise out of differences in terminology and usage. For example, it is doubtful whether a psychologist and an engineer would agree as to the meaning of the word 'need'. I have tried where possible in evolving the definition to take this into account.

1.1.5 What is the relationship between definition and theory in this context? My purpose is to evolve a theory of design behaviour and the definition offered is the basis upon which it is hoped to build such a theory. It does not constitute a theory in itself. It is essentially a statement at the meta-theoretical level. It proposes a model which contains certain assumptions and implications leading to certain empirical studies upon which it is hoped to build a theory of design behaviour. Therefore every attempt has been made to ensure that the interpretation of terms in the definition can be

unambiguously related to experimental studies.

1.2 The Origin of the Present Definition from Existing Definitions of Design

1.2.1 Appendix 1 contains a broad range of definitions offered to date. They testify to the diversity of the design activity as perceived by design theorists. We are faced with a common problem that bedevils any discipline which has aspirations towards scientific clarity where terms can be used with precision and agreed meanings can be developed to form a systematic basis for research.

1.2.2 Examining the offerings in the appendix we find the following words describing the design activity.

"finding the right"
"Goal directed, problem solving"
"decision making"
"simulating"
"act of faith"
"imaginative jump"
"creative"

All these could be said to be purposeful human activities insofar as they have an end in mind if not actually in view. To encompass this aspect of the nature of design we shall use the word OBJECTIVE which has received wide usage in education, management and design theory. (Bloom 1965, Blake 1971, Archer (in press)). In many respects it is synonymous with the word intention, but that had the disadvantage of suggesting a subjective origin, and as will become apparent (1.2.4), this is a suggestion we wish to avoid.

1.2.3 It is necessary to distinguish between designing something and making something. Designing is in some manner separate from its final OBJECTIVE. We could say that a designer seeks to PREDICT

rather than produce. This is implicit in the use of the term "initiate" by Jones (1970) and in some of the other definitions i.e.: Oxford Dictionary, Eder (1966), Archer (1965), Asimow (1962), Booker (1964), Jones (1966), Page(1966), Reswick (1965). Thus we can say that PREDICTION forms a part of the design activity.

1.2.4 The conclusion in 1.2.3 forces us to make a distinction between science and design. Both are concerned with prediction but as Gregory (1966) suggests, "The scientific method is a pattern of problem solving behaviour employed in finding out the nature of what exists, whereas the design method is a pattern of behaviour employed in inventing things of value which do not yet exist. Science is analytic, design is constructive." There are many aspects of both activities which overlap and it is doubtful that an exclusive distinction could be made. If the behaviour involved is the same there seems little point in making a distinction. However, taking into account the above point, we can add a further distinction by saying that design is concerned exclusively with OBJECTIVES that are GIVEN by a client. Many scientific projects are undertaken at the behest of a client but insofar they are constructive rather than analytic, they could be regarded as design projects.

1.2.5 Extending the argument from Gregory's point in 1.2.4, we come to a consideration of the "things" the designer invents. We have already established an important distinction in that respect in 1.2.3, and in view of that we need an appropriate term to designate these"things". At the moment, by implication it would appear that the end product is material. This however, does not include all aspects of design and certainly excludes the area of design with which this thesis is concerned, namely communication design. As I

shall demonstrate in Chapter 3, the primary objective of communication design is to change or maintain a pattern of human behaviour, in which process, objects are a necessary part, but it is the process which is most important. Because of this we need a term which will describe the designer's 'product' without restricting ourselves to material objects. The word SYSTEM is therefore used, defined as "a set of inter-related elements" (Klir & Valach 1965).

1.2.6 It is clear from what has been said so far that the designer is involved in a creative activity in which originality is almost by definition present. It is arguable that the designer may be concerned with the modification of systems, or he may arrive at the conclusion that an existing system fulfils the objective without creating a new or even a modified system. From this point of view, the designer's originality is not an absolute requirement in a definition of design. However, in this enquiry we shall be concerned with situations for which there are no known systems and we will therefore incorporate ORIGINALITY into our definition.

1.2.7 Amalgamating the above analysis into a single definitive statement we can say that:

DESIGN IS THE PROCESS OF ORIGINATING SYSTEMS AND PREDICTING THEIR FULFILMENT OF GIVEN OBJECTIVES.

1.2.8 The above definition, if compared with those in Appendix 1 will be seen to be more general (in some respects) than some of the definitions offered. Eder's definition restricts itself to en gineering design and seems to imply that economy and efficiency are the prime constraint. This may be a tenable proposition in a narrow industrial and commercially orientated context but would not necessarily pertain outside this context. Alexander's definition

being related to architecture, suffers from a similar disadvantage as well as begging the question "How does one know what are the 'right' physical components of a structure when one has found them?" Farr, on the other hand, seems to refer to only the outcome of the design process, and while his humanitarian motives are laudable, they are not necessarily the only objective of a design, even though they may be the most important.

1.2.9 In another respect our definition is more specific than those in Appendix 1. Archer's definition is general and a truism. There are many kinds of problem solving that would not be considered designing, e.g. solving a mathematical problem or a crossword, and problem solving is by definition goal directed, the goal being to solve the problem. Similarly Asimow's conception of the design process could refer to a great many activities which would not necessarily be regarded as designing. Jones, while capturing the essence of the notion of prediction as we have used it, could be talking about a parachutist about to make his first jump. It is of interest that in a later work Jones (1970) revises this definition, (see Appendix 1) and while being more specific, he could still be referring to our parachutist pulling his rip cord and thus falls short (if I may be excused the pun) of providing an adequate definition.

1.2.10 Examining the remaining definitions, we can see that the major differences are terminological. The Oxford Dictionary contains the essential ingredients of our definition but in a form too vague for scientific purposes. Gregory is vague in his use of the phrases 'certain classes of problems' and 'satisfaction', and limits his definitions to 'products'. McCrory is similarly vague

in his use of the phrase 'valuable purpose' and also one might ask whether it is humanly possible to apply the "total spectrum of science and technology". Booker is in many ways closest to our definition but implies a particular method, i.e. successive approximation, which may not be used in all design behaviour and it would be dangerous to make the assumption that it was. Matchett sidesteps the question of what is design behaviour and offers us a definition of what he considers to be a satisfactory design. Finally, Reswick, while in many ways similar in his approach to the one we have taken here leaves us with the word 'useful' and room for speculation.

1.2.11 Thus the definition we offer avoids many of the problems of previous conceptions of design. However, it is not suggested that we have arrived at an ultimate definition, only that we have at this stage clarified some aspects of the nature of design, in that we have drawn a boundary round the area with which we shall be concerned and adopted a terminology that clarifies some of the aspects of the process. It remains to other sections of this chapter to demonstrate the usefulness of our definition which in the final analysis is its only justification.

1.3

The Origins of the Present Definition from Design Methods*

1.3.1 To date there has been little scientific study of design behaviour, although a substantial amount of research has been conducted into design methods. It is important to distinguish between the two. Design behaviour is what a designer actually does, whereas a design method is a set of instructions or heuristics telling a designer what he should do.

* This section is mainly an extract from Sless (1972).

1.3.2 This creates a dilemma. How can we tell a designer how and where to modify his behaviour without first knowing how he actually behaves? Jones (1970) impales himself on the horns of this particular dilemma. "The writings of design (method) theorists imply that the traditional method of design-by-drawing is too simple for the growing complexity of the man made world. This belief is widely held and may not require any further justification. However, it is not obvious that the new methods that are reviewed in this book are any better. There is not much evidence that they have been used with success, even by their inventors, and there is reason to believe that newcomers to design methodology often revert to more familiar, if less adequate, procedures when difficulties are encountered."

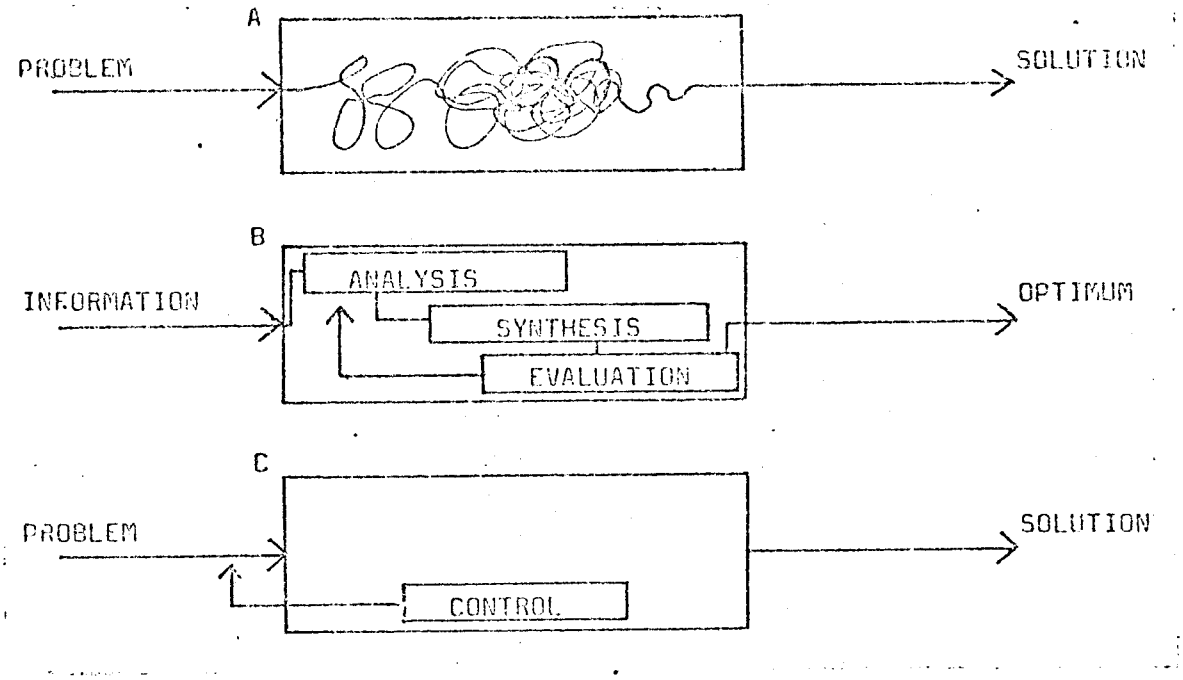
1.3.3 It is clear from what Jones says, that there is a much greater need at this stage in our knowledge, to evolve a theory of design behaviour, based on sound research, rather than a proliferation of instructions and heuristics for changing designers' behaviour.

1.3.4 In the absence of an established theory of design behaviour, it is useful to look at design methods since they must imply some notions of how a designer actually behaves. The only comprehensive review of design methods to date is by Jones (1970) and he provides us with a useful threefold classification of the methods in behavioural terms, as follows:

1. Designers as black boxes
2. Designers as glass boxes
3. Designers as self-organising systems

In Fig. 1 (after Jones 1970) we have the essential differences between the three kinds of design behaviour.

Fig. 1

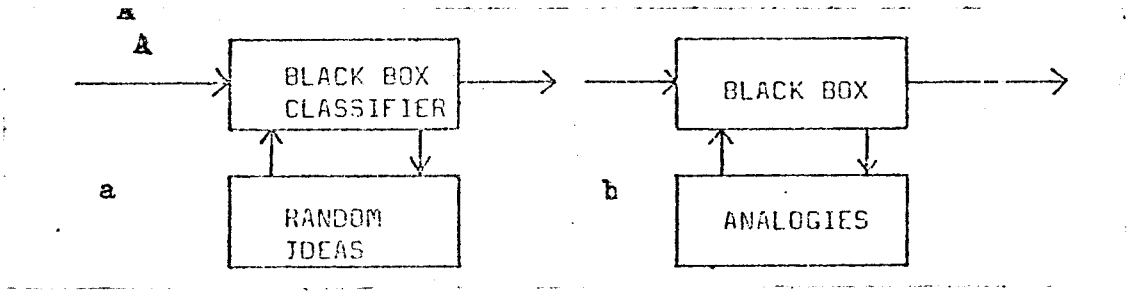


1.3.5 If we look at the black box designer in more detail, it becomes apparent that the process as represented above is incomplete. As Jones says, "The most useful thing to do with the results of brain-storming is to feed it into the 'black box' of a single person who has the task of classifying the random ideas into a coherent pattern". He further suggests, "Using again the black box view of designing, we can regard... synectics as the feedback of black box output into black box input using carefully chosen types of analogy as instruments with which to transform outputs into inputs". Brain-storming and synectics are essentially techniques for developing new ideas and involve the suspension of any conscious evaluations of these ideas during their generation. Synectics, developed by Gordon (1961) is very similar to the technique developed by De Bono (1969) which he calls 'lateral thinking'. Basically they are methods for inducing creativity.

Returning to our model of design behaviour in terms of a 'black box', we can represent the above notion diagramatically in

respective order in Fig. 2a & b, in a way which better corresponds to what is actually happening.

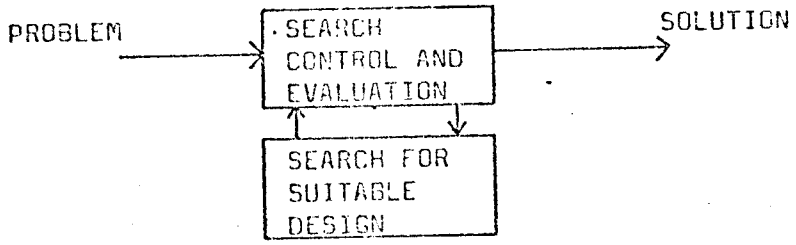
Fig. 2



1.3.6 If we now look more closely at the second kind of design method, the glass box designers, Fig. 1 (b), we can see that although the various stages are represented as taking place within the designer, when we come to look at the methods in practice we find that the designer is expected to externalize these methods and acts as a controller. Given the complexity of many design problems it is impossible for the designer to hold all the relevant factors within his span of apprehension and therefore he has to resort to the use of tools such as pencil and paper or even computers. Two of the unanswered questions about design behaviour, which we shall seek to clarify later are - what is the span of apprehension of a designer, and what factors influence it? It is the problems underlying this which Jones (1970) highlights in 1.3.2.

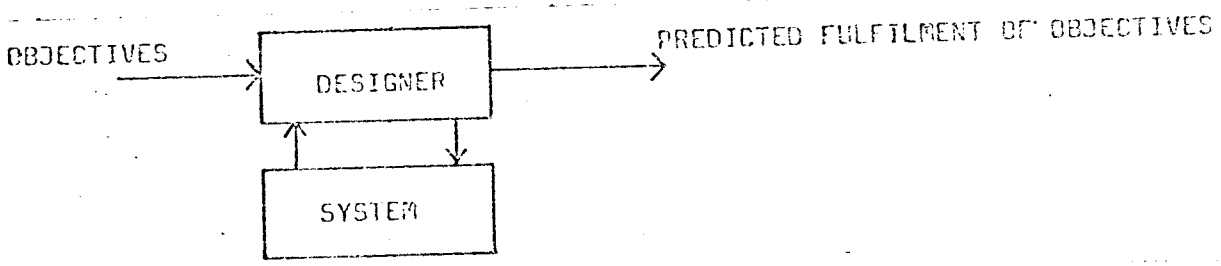
Returning now to our model of the 'glass box' designer, we can represent what actually happens more accurately in Fig. 3.

Fig. 3



Even if we are concerned with relatively simple design problems where the designer does not need to externalize his thinking because his span of apprehension can cope with the problem, he is still conforming to our model, but in a different sense. He will evolve a system which he will at some point externalize and evaluate against the objectives he is trying to fulfil. Thus we could represent this process as in Fig. 4.

Fig. 4



It is obvious that the model in Fig. 4 corresponds with our definition in 1.2.7 and we shall be returning to this point at the end of this section.

1.3.7 Moving finally to the designer as a 'self organising system', Jones points out that both 'black box' and 'glass box' methods generate too much novelty to evaluate all at once and there is then a

need for him to organise himself into two distinct areas of activity:

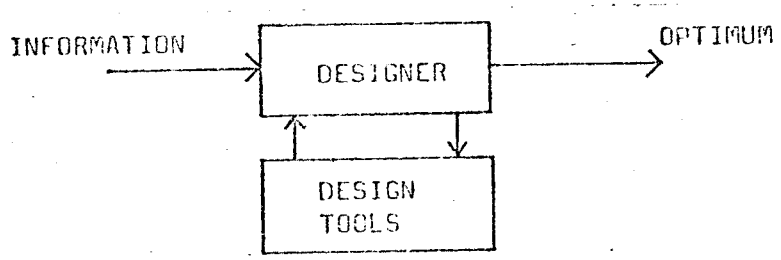
"1. That which carries out the search for a suitable design"

"2. That which controls and evaluates the pattern of design"

It is interesting to observe that we are in this method faced with the same basic problem that arose from 1.3.6, i.e. the span of apprehension of the designer. Put in a form relevant to this section - how much novelty from 'black box' and 'glass box' methods can a designer evaluate all at once?.

Representing the two areas of activity suggested above diagrammatically is Fig. 5 below.

Fig. 5



1.3.8 It will be obvious that a consistent pattern is emerging and that underlying the methods developed by design method theorists is a common conception of the nature of design behaviour. The notion common to all is the principle of feedback. The major differences between glass box and black box designers is in terms of highlighting different aspects of the process, and in the willingness or ability of methodologists to make explicit intervening variables and processes or to ignore them. Comparing these two with the designer as a self organising system, the difference is one of hierarchy in the level at which the process is

considered. Also, there is a distinction to be made between the flow of decision making and control as in Fig. 4 and Fig. 5.

1.3.9 As we demonstrated in 1.3.6 the 'glass box' designer conforms to our definition of design as developed in 1.2.7. How far can we generalise this finding to apply to the other two methods? Given that in both cases we are concerned with means-ends systems we can talk about OBJECTIVES and the FULFILMENT OF OBJECTIVES as part of the process. Also, as both are concerned with evolving SYSTEMS to fulfil objectives, then we can say that our definition is appropriate. It is only when we come to consider how these systems ORIGINATE that we can see marked differences. As we have suggested, the differences between 'black and glass boxes' is one of taking an intuitive as opposed to a logical approach and that between these two and the final method there is only a hierarchical difference. Yet there is no doubt that they are both concerned with ORIGINATING SYSTEMS. What differs is their interpretation of how they go about originating them.

Because of the relationship between systems and the fulfilment of objectives it is implicit that PREDICTION is involved, and thus we can see that our definition coincides with design behaviour as perceived by design methodologists and is derivable from a consideration of design methods.

1.3.10 We must point out that the definition and model of design behaviour as represented in Fig. 4 and which we have shown to apply to all methods considered, is a gross over-simplification of a very complex integrated aspect of human behaviour. However, at this stage we are concerned with evolving a framework and it will be our

task in Chapter 3 to demonstrate in more detail how this behaviour can be viewed in greater detail with reference to a particular area of design.

1.3.11 Given that our definition can apply to all design methods, how well does it satisfy the need for a framework to evaluate different methods? As we have already suggested in 1.3.8 we can evaluate at what level of the design process any particular method operates. Therefore we can consider comparative evaluation of methods only when we can show them to be concerned with the same hierarchical activity in the design process. Having established the above principle we can ask the practical questions - which method is best and under what circumstances? We must defer the way in which we can do this until section 1.6.5 where we shall consider the empirical status of our definition.

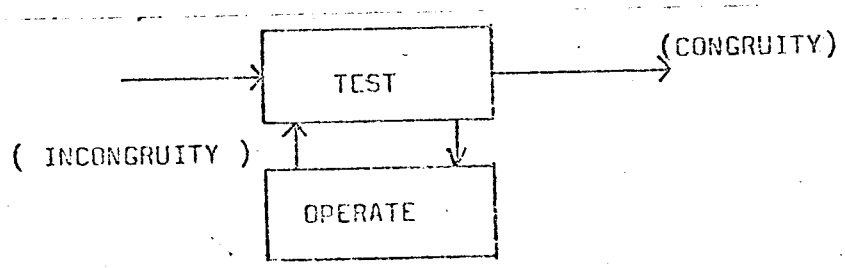
1.4 The Origins of the Present Definition from Psychological Theory

As design is an aspect of human behaviour, there is a need to establish a definition of design which enables us to relate design behaviour via a unified theoretical approach to other aspects of human behaviour. Therefore we must ask the questions - what particular theoretical framework is best suited to enlarge our understanding of design behaviour and within that, to what area of knowledge is it most closely related?

1.4.2 As our review of both design definitions and methods suggests, any theory of design behaviour must be able to encompass the cognitive activity of the designer as well as its behavioural manifestations and must do so in a way which will lead to an experimental investigation of design behaviour.

1.4.3 The framework which best suits our purpose in this enquiry has been developed by Miller, Galanter and Pribram (1960). In their discussion they demonstrate that both cognitive and behavioural activity can be brought together in a unit of analysis which they call a TOTE, which stands for: test, operate, test, exit. This is shown diagrammatically in Fig. 6.

Fig. 6



1.4.4 We shall not seek to justify this model at a fundamental level, rather we shall show as the thesis proceeds that it can be usefully applied to the behaviour of designers.

1.4.5 It is clear that the principle of feedback which we have shown to underlie the concept of design behaviour is the basic principle behind the TOTE. Thus it remains only to suggest how the definition of design that we have evolved from other considerations can be equally evolved from the present generalised model of human behaviour.

1.4.6 In what sense is 'incongruity' and 'congruity' related to design behaviour? Miller et al regard the TOTE as an "incongruity - sensitive mechanism" and believe it can be generalised to consider situations where there may be a change, a difference, or no difference in the proximal stimulus, the response being dependent on the nature of any particular TOTE. Therefore we must ask to what

particular kind of incongruity is the TOTE of design behaviour sensitive? Put another way, what is the starting point, the stimulus, which precipitates design behaviour? A designer works from a brief given by a client, i.e. in the terminology we have used so far, the GIVEN OBJECTIVES are that brief. Thus we can say that the transition from incongruity to congruity in the design process is the transition from GIVEN OBJECTIVES to the FULFILMENT OF THOSE OBJECTIVES and that the TOTE is the process of ORIGINATING SYSTEMS in the OPERATE part of the system and the PREDICTION is in the TEST phase of that system. Thus, we can see that our definition is derivable from a general framework of human behaviour.

1.4.7 We must now consider into what branch of Psychology design behaviour fits. Archer (in press) regards design as a special case of problem solving behaviour and everything that we have pointed to so far has suggested this conclusion. Most current research in problem solving is typified, and indeed derives from the pioneer work of Simon & Newell (1972). In their particular research paradigm the existence of the solution to the problem set is known in advance and the behaviour of the subject is observed in following the route towards the solution. This kind of problem solving is often referred to as 'reproductive' as opposed to 'productive' problem solving in design where solutions are not known in advance. Whether the psychological processes involved are the same in both kinds of problem solving or different is an interesting question but we can only answer that question after a comparison of the research results from studies of design behaviour. The problem of developing an adequate research paradigm for

evaluating the effectiveness of design problem solving, in the absence of known solutions will be discussed in the final section of this chapter.

1.5 The Interdisciplinary Nature of Design and the Present Definition

1.5.1 How far does the present definition cope with the problems raised by the interdisciplinary nature of design? We can approach the problem from two points of view. Firstly, does the definition accommodate the array of different contexts in which the design process occurs? Secondly, can it cope with the wide range of factors which the designer has to cope with which stem from fields of knowledge with widely varied terminologies?

1.5.2 When talking of the different contexts in which design occurs, we are referring to the different kinds of SYSTEMS which designers evolve. These could be designs for buildings, machines, communication systems and many others. It would not appear that any problem arises from calling all of these by the generic term SYSTEMS.

1.5.3 The requirements, purposes and constraints with which an engineering designer is faced are very different from those faced by an architect or a communication system designer but in the sense in which we use the term GIVEN OBJECTIVES all of these factors can be encompassed without any loss of meaning to the individual factors.

1.5.4 Both terms used are of sufficient level of generality and enjoy current usage. Beyond that, however, we can only rely on the discretion and wisdom with which they are applied by others.

1.6 The Relationship Between the Definition and a Theory of Design Behaviour

Referring to section 1.1.5 we must now look at the manner in which the present definition leads us to an empirical investigation which will enable the development of a theory of design behaviour. As we have suggested in section 1.4.7, a problem arises in developing a research paradigm for 'productive' problem solving. Because the outcome of 'productive' problem solving is indeterminate, how can we evaluate the solution objectively? The need to evaluate the solution objectively is of paramount importance in the context of this enquiry. Since we are concerned with design behaviour in itself, we must bear in mind that as a problem solving activity the outcome is the most important thing, because ultimately whatever a designer's behaviour is, it must produce a solution which FULFILS GIVEN OBJECTIVES. Therefore any theory of design behaviour must be founded on the basic premise that, where there may be many ways of arriving at successful designs, which may differ according to the design problem, the personality of the designer, and the context in which he operates, it must always see effective design as the fundamental objective of any design process.

1.6.2 What, in terms of our definition constitutes effective design? EFFECTIVE DESIGN IS THAT PROCESS WHICH FULFILS THE GIVEN OBJECTIVES. Although some studies have been conducted into design behaviour, no attempt is made to evaluate the solutions objectively. A typical example of this is the work of Eastman (1968) in which the designer's attempts to re-design a bathroom are monitored in order to study the way in which he processes information. However, the weakness of this study lies in the fact that the problem is stated in such a form, that, whatever the solution, it would be difficult to evaluate objectively its effectiveness such that we may end up with a description of an attempted design process, but not know whether it is a description of an effective design process. This is best illustrated

by quoting Eastman's brief, which he presented to the subjects.

"The accompanying plan and photograph represent an existing bathroom plan for one model of a home sold by Pearson Developers in California. This model of house has not sold well. The sales personnel have heard prospective buyers remark on the poor design of the bath. Several comments are remembered: "That sink wastes space", "I was hoping to find a more luxurious bath". You are hired to remodel the existing bath and propose changes for all future ones. (These should be the same)".

"The house is the cheapest model of a group of models selling between 23,000 and 35,000. It is two stories with a ranch style exterior. The bath is at the end of a hall serving two bedrooms and guests".

"You are to come up with a total design concept. The developer is willing to spend more for the new design - up to fifty dollars. For all other questions, Mr Eastman will serve as client. He will answer other questions".

1.6.3 There is no doubt that this is a very 'real' design problem and one which can and does arise frequently in design practice but how 'real' is it in terms of studying design behaviour? So many of the terms used are open to such wide interpretation that no objective evaluation of outcome is possible. Therefore, for the purpose of developing a theory of design behaviour, the problem of evaluating outcomes rests first and foremost with a clear objective statement of GIVEN OBJECTIVES. Only then can we evaluate solutions and decide how successful the behaviour has been. Put very simply, you cannot tell whether what you get is what you wanted, unless you know what you wanted in the first place.

.6.4 Thus we are establishing a basic principle about research into design behaviour, and that is THE GIVEN OBJECTIVES MUST BE STATED IN A FORM WHICH ALLOWS US TO EVALUATE SOLUTIONS OBJECTIVELY AGAINST OBJECTIVES. In the language of science, OBJECTIVES when used in research in design behaviour must have OPERATIONAL status.

.6.5 Looked at in terms of our definition of design we can then ask a whole series of questions about design behaviour.

1. What factors affect successful PREDICTION?
2. Are some OBJECTIVES easier to FULFIL than others?
3. How many OBJECTIVES can a designer cope with?
4. What is the relationship between design methods and successful PREDICTION?
5. How can we improve a designer's ability to predict and how do we educate designers of the future?

6.7 Because we are insisting that for the purpose of research all OBJECTIVES must have OPERATIONAL STATUS we are necessarily excluding many aspects of the design process which are not subject, and could not be subjected to the scrutiny of measurement in scientific terms. This limitation is acknowledged but is regarded as a necessary one for the purpose of scientific enquiry.

6.8 In Chapters 3 and 4 we will spell out in detail the kind of GIVEN OBJECTIVES with OPERATIONAL STATUS which we shall apply to the study of behaviour of communication system designers.

CHAPTER II

The Sign Process

"The Psychologist of all people must not stand in awe of the stimulus. Uniformity and simplicity of structure of stimulus are no guarantee whatever of uniformity and simplicity of structure in organic response, particularly at the human level". (Bartlett, 1932).

Summary

The sign process is discussed in relation to the whole field of semiotics. The difficulties of enquiry in the field are considered generally, and particularly in relation to the study of sign behaviour. A potential approach to the study of pragmatics is developed after a consideration of methods of classifying signs. The limiting conditions of this approach are specified.

2.1 Purpose of a Reappraisal of the Sign Process

2.1.1 In order to lay the foundation for a theory of sign design, we need to consider the nature of the sign process. For reasons which will become apparent as we proceed, it has not been possible to be as circumscribed as in Chapter I, and arrive at a suitable definition which has operational status.

The study of the sign process is extremely diffuse and cuts across many disciplines. We can find references to the process in the work of philosophers, historians, linguists, psychologists, designers and many others. It is one of the most fascinating, yet least understood of subjects. To attempt a comprehensive study of the ideas related to this is a task outside

the scope of this enquiry. We will accordingly limit ourselves to more modest objectives. Our overall purpose is to develop a framework for understanding the process of sign design. We will attempt in this chapter to shed some light on the relationship between signs and their users as a preliminary to Chapter III, where we shall widen our framework to include the relationship between signs and their makers. Thus our reappraisal will focus on a limited aspect of the sign process.

2.1.2 Before narrowing our discussions down to the above objective we will sketch the outline of the whole field of semiotics and point out its features. In doing so we will attempt to show the breadth of the field and why there are barriers to progress in our knowledge of it. We will also show in what way our own interests fit into the field.

2.1.3 We will then focus our attention on theories of sign behaviour. This will provide us with a platform on which to develop our concept of the relation between signs and their users.

2.1.4 We will then address our attention to the problem of classification of signs. This will reinforce the need for treating the area in terms of relationships. Finally, we will explore the framework of enquiry which we shall use in the rest of this study and consider its limitations.

2.2 Semiotics - The Science of Signs

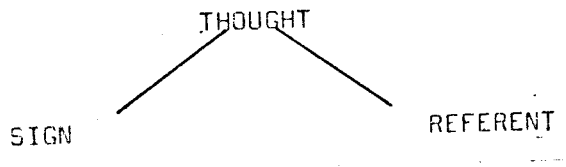
2.2.1 The term 'semiotic' has a long history. It was introduced into the English vocabulary by John Locke, who borrowed it from Stoic terminology. However, despite extensive study over many centuries, the formulation of semiotics into a definite field with

clear areas of concern, has been relatively recent. The precurser of modern semiotics was undoubtedly Charles Pierce who developed the idea of meaning as a Triadic relation. This was later used by Ogden and Richards (1923), in their classic work 'The Meaning of Meaning'. Morris (1938), drawing on Ogden and Richards and Pierce, formulated the framework of semiotics into three areas of concern; Syntactics, Semantics and Pragmatics.* We shall discuss the nature of these areas in 2.2.3. Morris's explicit intention was to lay the foundation for a truly interdisciplinary field of enquiry "....bridging the gap between the biological sciences on the one hand, and the psychological and human social sciences on the other and throwing a new light on the relation of the so called 'formal' and 'empirical' sciences". (Morris 1938)

However, this promise was never realised and resulted in a narrowly behaviourist analysis of the sign process in his later work (1946). Despite recent attempts to remedy this by Maldonado (1961), the bias remains.

2.2.2 Looking now in more detail at the areas of consideration which delineate the field of semiotics, we will start with the model proposed by Ogden and Richards (1923). They postulated a triadic relation to define the nature of a sign (Fig. 7)

Fig. 7



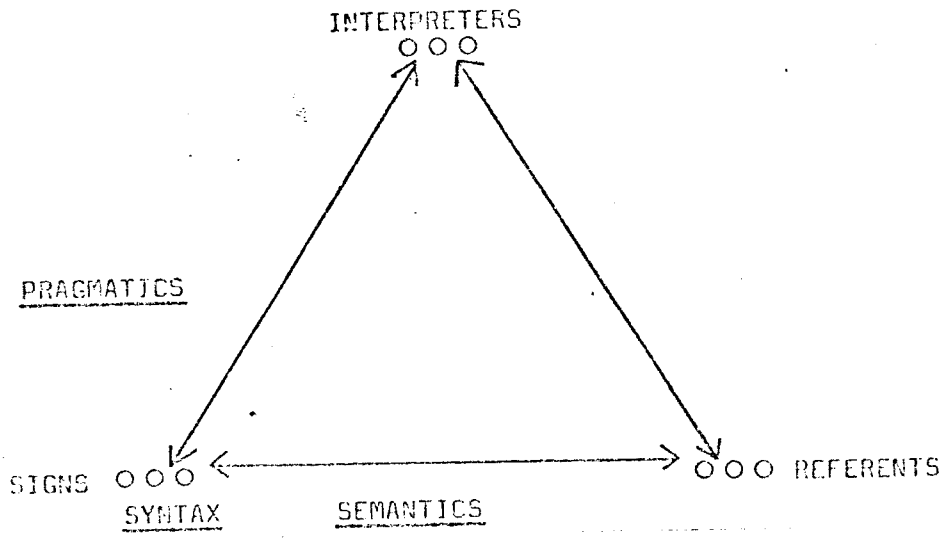
The importance of this model lies in the realisation that a sign

* This brief resume is taken from Meredith (1955).

only refers to something via a thought process. This implies that a sign cannot be defined in isolation but only in terms of this triadic relation. Thus the meaning of the sign is not only intrinsic to the sign but is a function of the relationship. If we accept their analysis we must conclude that it is logically meaningless to ask the question:- "What does that sign mean?", since the meaning is not a function of a sign but a function of a relationship, in which the sign is an element. This point is central to our argument and we shall return to it later.

2.2.3 Morris (1938, 1946) expanded the above framework to identify the whole field of semiotics as in Fig. 8 (after Meredith 1955).

Fig. 8



Pragmatics is the study of the relationship between signs and interpreters. This usage differs from common usage and will be used throughout this study in the sense here defined. Semantics is the study of signs in relation to the object or idea to which they refer and Syntactics is the relation of signs to each other. An important

feature of all the areas of semiotics which Morris defines, is that the fundamental focus of enquiry is not an object but a relationship. We will have occasion to consider this point more fully as our enquiry proceeds. (2.2.8)

2.2.4 The three relationships considered above are limited. In order to give semiotics a firm base on which to develop, we must take account of other considerations. What of the third side of the triangle, the relation between interpreters and referents, or put in more conventional terms, the relation between man and the rest of the world? This could be regarded as an issue underlying the basis of science. Whatever observations a scientist makes of the world and whatever conclusion he draws from those observations must be based on some philosophical theory of knowledge. Morris, however, regards this as a sub-problem which can be solved by semiotics:

"Problems which are often classed as epistemological or methodological fall in large part under semiotic, thus empiricism and rationalism are at heart theories as to when the relations of denotation obtain or may be said to obtain; discussion of truth and knowledge are inseparably linked with semantics and pragmatics."

But one might ask what assumption does a semiotician make about his methods of observation, which somehow transcend epistemological consideration? Far from being one of the range of problems to which semiotics might address itself, epistemology is the third side of the semiotic triangle. Although in some way distinct from, a sign is part of the world inhabited by man and is thus subject also to epistemological consideration.

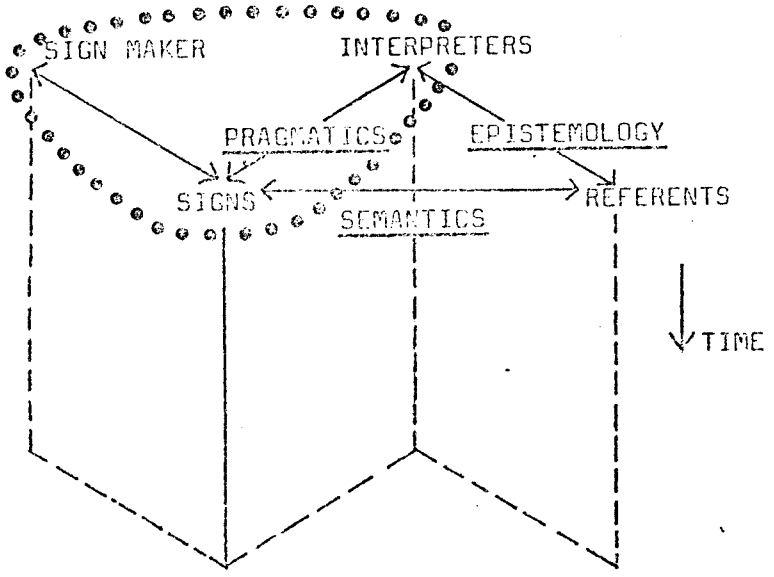
2.2.5 A further area of semiotics which is omitted by Morris but suggested by Ullman (1962) is the historical aspect. No science of signs could be complete without considering the evolution of signs

to their present form. If semiotics is to be truly comprehensive, it must address its attention to the problem of how culture is transmitted to us from countless generations using the sign process.

2.2.6 Finally, but of great significance in the present enquiry is the relation between the sign and its maker. This is not to suggest that all signs are made rather than naturally occurring, but a high proportion of signs used by man are of his own making and it is with this process that this thesis concerns itself. We shall leave any discussion of this until Chapter III where we shall explore the detailed complexity of this relationship.

2.2.7 We have now completed our brief sketch of the area of semiotics. We have expanded the semiotic framework to include areas other than those suggested by Morris. In Fig. 9 we can see a diagrammatic representation of the field. The addition of a third dimension in the vertical plane shows the historical aspect. The use of broken lines in the diagram indicates the areas where our knowledge is imperfect or inferential. The circle of broken lines indicates the particular area of interest in this thesis.

Fig. 9



On the basis of Fig. 9 we can draw a number of conclusions. It is immediately apparent that historical enquiry in semiotics is fraught with difficulty. Very often the only concrete information is a preserved sign or sign system such as a work of art or a document. In the case of the sign maker and the interpreter, we may have scant biographical information. In some cases, such as the cave paintings, we have very little except the signs themselves. This results in endless and often sterile controversy as to the 'meaning' of the paintings. We can also see that our own area of interest is limited to a very small fragment of the total field.

2.2.8 So far we have been content to express the nexus which joins the various points in the field by the term 'relationship'. In 2.2.3 we observed that the focus of enquiry in semiotics was a set of relationships, not an object. Therefore, we must now ask, what is the nature of those relationships? Nowhere in his early work (1938) does Morris make these clear. What is the relationship between signs and interpreters? Does a cause-effect relationship pertain? If so, in which direction does it operate? Is the relationship interactive, pushing and pulling in both directions? We are given few clues to this. If we look at his later work (1946) we find the following definition for a sign:

"If A is a preparatory - stimulus that, in the absence of stimulus object initiating response sequence of a certain behaviour - family, causes in some organism a disposition to respond by response - sequence of this behaviour - family, then A is a sign" (my underlining).

There is no doubt that he is suggesting here a very definite cause-effect relationship moving from sign to interpreter. However, the very choice of the term interpreter suggests that some activity affecting the relationship arises from the organism. We are therefore

dealing here with a DYNAMIC situation, a process, Berlo (1960) suggests in his discussion on the nature of the communication process:

"If we accept the concept of process, we view events and relationships as dynamic, on-going, ever changing, continuous. When we label something as a process, we also mean that it does not have a beginning, an end, a fixed sequence of events. It is not static, at rest. It is moving. The ingredients within a process interact; each affects all of the others".

If we accept the concept of process as applying to semiotics, which would seem reasonable, our problems are just beginning, as Berlo points out:

"Much of the scientific research in communication attempts to isolate factors which do or do not make a difference in the development of the process. Obviously all the ingredients have not been determined - in fact, there is considerable basis for doubt as to whether they ever will be determined".

"In any case, we need constantly to remember that our discussion of a process is incomplete, with a forced order and possibly a distorted perspective. Discussion is useful, it can lead to greater insight about a process. But it is not a complete picture, it can never reproduce the process itself. We cannot list all the ingredients nor talk adequately about how they affect each other. We can provide some suggestions, some hints about both the ingredients and the dynamic of the process".

The problems raised here are at the heart of the difficulties in arriving at adequate explanations and understanding of semiotics. We have no adequate heuristics for exploring the dynamics of communication. There are possible directions which an enquiry into developing adequate heuristics might proceed and the present author has gone some way towards developing these but at this stage they are

purely speculative and a long way from serious application. We shall briefly discuss these in Chapter 6. For the purpose of this enquiry we will have to muddle along with the English language as the only means at our disposal.

2.3 Pragmatics - Signs and Behaviour

We will now address our attention to the relationship between signs and interpreters. Given the qualifications we have made in 2.2.8 above, we can see the controversy over definitions of the sign process in man as revolving around two points. Firstly, the lack of an adequate language to describe the dynamics of the process and the contradictions that this has entailed. Secondly, but closely related to the first, a problem of defining the possible mechanisms in man which explain how we behave in the presence of signs. We will consider the latter point first.

2.3.2.

The debate on the potential mechanism in man which explains sign behaviour is reviewed by Osgood (1953). He distinguishes four approaches. The first of these he terms the Mentalistic View, which he summarises as follows:

"According to this view, the relation between signs and objects is established through the mediation of ideas".

The main proponents of this view are Ogden and Richards (1923). Considering their literary background they may be forgiven their naivety of psychological concepts. However, this does not excuse psychologists, as Osgood points out:

"The major difficulty with this theory from the point of view of science is that it is completely untestable. Actually it merely substitutes a word (idea) for an explanation; in order to explain the sign process we must first explain the nature of idea".

2.3.3 The second viewpoint which tries to ignore the problem of internal processes is based on a classical conditioning model. Osgood refers to this as "Substitution theory" and summarises it as follows:

"Whenever something which is not the object evokes in an organism the same reaction evoked by the object, it is a sign of that object".

Clearly, however, this is not the case. We do not respond to the word WATER in the same way that we respond to the object WATER, and further Osgood points out:

"The simple substitution theory of learning on which this view of the sign process is based has itself been shown to be insufficient; the response to the conditioned stimulus is seldom if ever identical with the response to the unconditioned stimulus".

2.3.4 Morris's view which Osgood calls "the Sign Process as a 'Set' " has already been given earlier (2.2.8). It is an attempt to avoid the pitfalls of the previous theories. Osgood summarises the theory as follows:

".... any pattern of stimulation which is not the object becomes a sign of the object if it produces in an organism a 'disposition' to make any of the responses previously elicited by the object".

As Osgood points out, far from resolving the problems of the other theories it ends up by falling between them. We are left with the term 'disposition' which is open to the same criticism as the term 'idea'. It also in part suggests 'substitution' since it relies heavily on the elicited behaviour being at least part of the repertoire of previous responses. Whereas substitution states simply that an object and a sign for that object only elicit one response, Morris is suggesting that one object can elicit many responses.

2.3.5 In an attempt to clarify the position Osgood says: "If all sign processes must be learned, but not all learned stimulus response connections confer sign properties upon their eliciting stimuli, we must discover some reasonable distinction within the class of learned behaviours" and further states that:

"The distinguishing condition is the presence or absence of a representational mediation process in association with the stimulus". This then results in the final theory of sign behaviour. Osgood puts the proposition formally as follows:

"A pattern of stimulation which is not the object is a sign of the object if it evokes in an organism a mediating reaction (a) being some fractional part of the total behaviour elicited by the object and (b) producing distinctive self-stimulation that mediates responses which would not occur without previous association of none object and object patterns of stimulation". The mediation hypothesis brings us closer to a reconciliation between semiotics and learning theory. The work of Horton and Kjeldergaard (1961) and Rossel and Storms (1955) using paired associated learning situations, has provided experimental support for the mediation hypothesis.

2.3.6 There is one further point to consider before we conclude our discussion of the sign process. Osgood, in seeking to draw a distinction between sign and non-sign processes (2.3.5) assumes that all sign processes must be learnt. There is ample evidence from animal studies that instinctive sign processes do exist. Whether such mechanisms exist in man is subject to some doubt but there is a great deal of suggestive evidence in the work of a number of research workers. Coss (1965) has investigated innate arousal mechanisms in man. His work was initiated by the NASA programme.

In order to maintain a high state of arousal for long periods in astronauts, he conducted a search of visual stimuli which affected arousal level, with a view to incorporating these in cockpit design. Lessler (1962) and Jones (1956 and 1961) have produced evidence which suggests that there is some basis for the theory of sexual symbolism advanced by Freud (1938). The implication of these findings is that there may be a 'universal' basis for signs which is common to all mankind. While we will not pursue this line any further at this stage, it would be wrong to exclude it as a possibility. We will therefore not assume that all sign processes must be learnt.

2.4 The Classification of Signs

2.4.1 Within recent years there has been a considerable proliferation of signs and symbols. Attendant upon this have been a large number of attempts to classify the phenomena. We will not attempt to review all these attempts, partly because many of the criticisms we shall make are common to all. We will look at two of the most recent systems, by Dreyfuss (1972) and Shepherd (1971).

2.4.2 Dreyfuss restricts himself "to those graphic symbols currently in use that serve to give instructions, directions and warnings". He does not include alphabets, numbers, trademarks and emblems. His basic categories are according to 'discipline'. By this he means such categories as: accommodation and travel, agriculture, architecture, astronomy etc. He also categorises by what he calls 'Graphic Form', by which he means those having similar shape. The criterion for this category are not made explicit. As Dreyfuss says: "The overall classification and arrangement of the symbols is therefore of necessity a purely personal judgement, based

only on an individual 'eye' for the determination of graphic form". The outcome of this individualistic approach results in a certain confusion. For example, in his sections in which the human body is used as a classification, we find such a variety of shapes and stylistic methods of representing those shapes that one is led to the conclusion that he would seem to be confusing 'semantic' forms with graphic forms. A further category in use is the index into what he calls 'Design Categories' which he introduces as follows: "Certain ideas, functions and physical states are common to many disciplines and have a wide variety of applications". Once again we have no set of verifiable criteria against which these can be judged. They include such categories as: building signage, forward and reverse, in and out, increase and decrease.

2.4.3 Shepherd's classification is based on biological nomenclature:

"Thus, the first broad groupings are labelled classes and their subgroups divisions, orders, families and genera". The basis on which signs and symbols are allocated into these categories is their visual appearance. His system for doing this is highly elaborated but at root has no greater validity that Dreyfuss's 'Graphic Form'. He also includes a cross referencing system by 'discipline' similar to Dreyfuss.

2.4.4 We must now consider how useful these classification systems are in relation to this enquiry. There seem to be two basic principles of classification at work. The first of these is semantic. In this category both authors have attempted to classify signs and symbols according to their INTENDED use. There is however, a discrepancy which arises between that intention and the use to which the sign may be put. In terms of semiotic terminology there may be a discrepancy

between semantic and pragmatic considerations. While semantic considerations may remain constant the pragmatic considerations are in a constant state of flux. If the meaning of a sign is prescribed but it is misused, we cannot appeal to a glossary, we must look at the whole process. Thus we cannot use the classification system developed without extending it by asking the question: How do the signs operate in a particular context? By this we are suggesting that we must include the user and his behaviour in relation to the sign. We shall return to this point in 2.5.

The second classification principle used is apparently simple but is very complex and misleading. It is based on the 'Graphic Form' of the symbol or sign. We have suggested there is evidence that meaning and form are linked. As we shall see in 5.2.2 this link is used in a design method and in 5.2.4 further evidence for this is offered. There may well be semantic 'units' in visual forms but their nature must be discovered before they can be applied to the classification of signs.

As we have shown above, the classification of signs which ignores the pragmatic context is of limited use. To examine the pragmatic context we must pursue our enquiry in another direction.

2.5 Pragmatics - The Measurement of Meaning

2.5.1

There are two components in pragmatics - the sign and the interpreter. We have shown that attempts to classify signs while ignoring the interpreter are inadequate. This is at the very heart of the relationship concept we have developed. In order to examine the relationship fully we must explore ways of observing the reactions of an interpreter to a sign.

2.5.2 For reasons which will become apparent in Chapter 3, in this enquiry we shall always be concerned with situations in which the INTENDED use of a sign is GIVEN. Thus we are specifying the pragmatic context i.e., the relation between sign and user, and we will be studying the effect of variables on this relation. This approach, which will be developed fully as our enquiry proceeds, rests on a number of assumptions. Firstly, we are assuming that pragmatics can be determined to some limited extent. We do not know as yet what the limits are and what variables influence those limits but we accept that it is possible, given these qualifications, to control the relation between signs and interpreters.

So far, our discussions have been theoretical and abstract. When discussing the use of signs we move into a practical area. Signs must be legible, distinct from other signs, meaningful etc. If we look at an individual road sign we can specify a number of criteria which must apply:

1. It must be within the field of vision of the motorist.
2. It must be visible under all road conditions.
3. It must be legible at a given distance.
4. It must be sited to give the motorist adequate time to respond.
5. It must be distinguishable from other road signs.
6. It must be easily learnt.

This is not a comprehensive list, nor is it very precise but it gives an indication that the use of a sign can be specified and all of the features mentioned are potentially measurable. Insofar as our enquiry is scientific we will only be concerned with those aspects of the use of a sign which can be specified operationally. This necessarily limits the scope of our enquiry in

two directions. Firstly we can only specify uses in operational terms, and secondly, our measurement of users will be limited to those specified.

2.5.3 The most challenging future enquiry outside the main theme of this study will be to relate the study of purely visual signs which are not part of a written language, to the current studies in the field of linguistics and to try and establish the nature of the relationship between form (in a visual sense) and meaning.

C H A P T E R III

Sign Design

"This basic need, which certainly is obvious only in man, is the need of symbolization. The symbol-making function is one of man's primary activities, like eating, looking, or moving about. It is the fundamental process of the mind and goes on all the time". (S. K. Langer).

Summary

This chapter integrates the conclusions of Chapter I and Chapter II on the nature of the design and the sign process and arrives at a definition of sign design as being the PROCESS OF ENCODING WHICH ORIGINATES A POTENTIAL MESSAGE AND PREDICTS ITS FULFILMENT OF GIVEN OBJECTIVES.

The basis for enquiry into this field is discussed and a model of the potential influences on the design process is evolved.

3.1 Introduction

3.1.1 Our task in this chapter is to integrate the conclusions of Chapters I and II and provide a framework for studying the process of sign design. This is the main focus of our enquiry and the point towards which the previous chapters lead us. In those we laid the groundwork evolving a definition of design and a framework for enquiry into pragmatics.

3.1.2 We shall begin by defining the kind of system with which we are concerned and we will narrow our discourse down to a particular sub-category within that system. We are concerned, as we have indicated in the Introduction, with communication systems and in particular, with visual communication systems. As part of this section we will consider the problem of measurement related to this kind of system.

3.1.3 We will then relate our conclusions about visual communication systems to the definition of design we evolved in Chapter I and demonstrate the manner in which these relate to each other.

3.1.4 The relationship, via the system of the designer to his audience, will form the basis of considerations in the next section, where we shall integrate our conclusions from Chapter II into our framework.

Having developed our framework in general terms we will explore its detailed ramifications.

3.2 Communication Systems

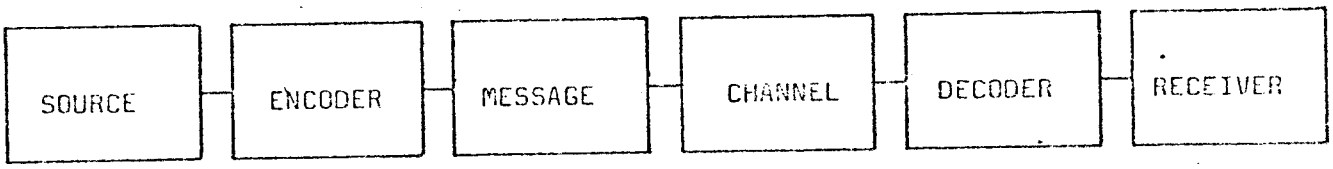
3.2.1 As we established in 1.2.8, design is concerned with the origination of SYSTEMS. We will now look in detail at the kind of SYSTEMS in which we are interested. These are communication systems. The term 'system' is widely used and we should at the outset distinguish between 'systems' as seen from the standpoint of an engineer, which is largely focused on the behaviour of the hardware, and our own view which focuses on the human components in the system. Authorities differ in the manner in which they represent such systems but there are underlying similarities.

3.2.2 Aristotle wrote the first treatise concerned with communication and identified three components: the speaker, the speech and the audience. (Roberts, 1946). Most current theories do not differ

significantly but tend towards greater complexity. A frequently used contemporary model was developed by Shannon and Weaver (1949). It included the following components: a source, a transmitter, a signal, a receiver and a destination. The components of this model do not differ greatly from Aristotle's. We can equate source with speaker, signal with speech and destination with audience, the remaining components i.e: transmitter and receiver can be seen to be refinements of the characteristics of the speaker and the audience.

The model we will use in this enquiry is as follows:

Fig. 12



We have chosen to call the transmitter and receiver, an encoder and decoder respectively. This more adequately describes their function in human communication. It is important to consider 'source' as embodying the notion of purpose. In this way we can talk about the OBJECTIVES of communication and this will help us relate the concept of a communication system to the concept of design.

3.3

Visual Communication Systems

3.3.1 In general, we can define a visual communication system as one which used patterns of light as the channel of communication. A surprisingly large number of systems fit into this category: gesture and facial expressions, all forms of printed material, photographs, film, television, deaf and dumb language, semaphore, painting and sculpture. Some of these are not 'pure' visual communication systems.

Film and television more frequently than not are accompanied by sound. Within this vast array we will be concerned with only a limited aspect.

3.3.2 We shall be addressing our attention to those forms of visual communication which are on a two-dimensional surface and stationary. We are therefore excluding any three-dimensional forms and any which involve movement. There are a number of reasons for this. The process we are studying is extremely complex. In order to reduce the complexity we have excluded three-dimensional and temporal considerations from this enquiry. It is hoped at a later date to introduce these elements into our framework but it would be beyond the scope of this enquiry to deal with them. A further basis for limitation is related to the absence of feedback. In gesture and facial expression, the source can correct its message on the basis of feedback from the receiver. A feature which characterises the kind of communication systems we are investigating is the absence of direct feedback to the source from the receiver. As we shall see, the ability of a designer to predict the response to a message in the absence of this feedback is one of the focuses of this enquiry.

3.3.3 We will now look, in principle, at the problem of measurement of the system. We will not consider at this point, the detailed measurement of parts of the system. We shall only look at the overall system. In this respect, we are asking the question: What is the outcome of communication? We cannot look at the outcome without reference to the OBJECTIVES of communication. If we assume that communication is purposeful, and in the context of this enquiry we can do so(3.2.2) then we must relate OBJECTIVES with outcome. A human system will produce many outputs which may have nothing to do

with the communication. Therefore, in order to narrow our search for data we must relate the output of the system to its input. What are the outputs of a communication system that are observable? As with most studies of human behaviour the only observable output is behaviour. Therefore our objectives must be in behavioural terms. This is not to suggest that behavioural objectives constitute the only objectives in communication, but they are the only ones which can be monitored against output and hence the only ones with which we will be concerned.

3.4 Visual Communication System Design

3.4.1 We can now tentatively integrate our definition of design with our model of the communication system. At the outset we must make a very clear distinction between the system the designer originates and the communication system we have been discussing. We have already suggested that the OBJECTIVES (SOURCE) of any design problem are GIVEN (1.2.4). We have in our previous section (3.3.2) decided what the CHANNEL will be and implied within these limitations are the nature of the DECODER and the RECEIVER. The channel we are proposing assumes that the human visual system will be the decoder and any statement of objectives would include a reference to a specific target audience i.e., a receiver.

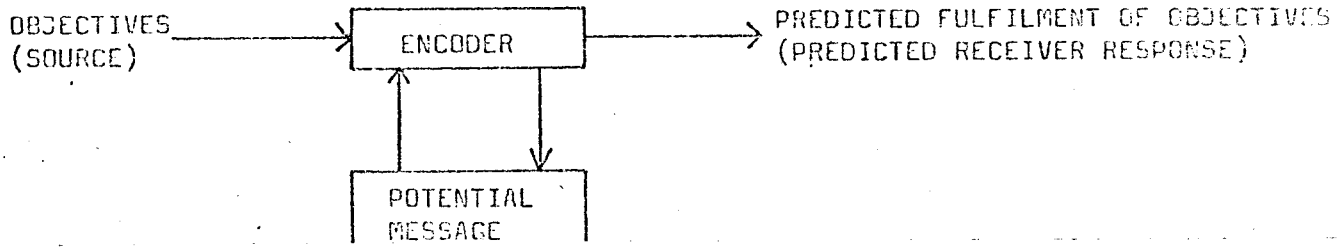
3.4.2 The part of the designer in the process as we have described it, is that of encoder. What he produces is a POTENTIAL message. It is described as potential because to some extent the designer works outside the process. In terms of our definition, the designer makes a prediction about the outcome of his encoding and the message which results, in terms of the response of a receiver. If that prediction is fulfilled then the message will no longer be potential. If on

the other hand the prediction is not fulfilled then the designer may have to modify his encoding and hence the message remains potential .

3.4.3 The relationship between encoder and message, or between designer and design is dynamic. There is a constant exchange, almost a dialogue which permeates the whole activity. It is the core around which our whole enquiry is built. The designer makes a mark, looks at it, modifies it. He wrestles with it until he is satisfied. We will be considering in a later section the more formal description of this relationship. From the above it is clear that between encoder and potential message, there is a feedback relationship.

3.4.4 If we translate the above observation into diagrammatic form we can picture the sign design process as in Fig. 13.

Fig. 13



This is the basic model of the design process which we evolved in Chapter I (1.3.6). We can now translate this into the following definition of the sign process.

SIGN DESIGN IS THE PROCESS OF ENCODING WHICH ORIGINATES A POTENTIAL MESSAGE AND PREDICTS ITS FULFILMENT OF GIVEN OBJECTIVES.

This can be seen to be a special case of the definition evolved in 1.2.8. We have now brought together two of the dominant concepts in this study - communication and design. We have specified the nature of the semiotic relationship between signs and

sign makers (see Fig. 9). We have not described what goes on in the relationship. We do not know. There are a number of observations which may direct research into this area. There is a motor skill component in the relationship which is a limiting factor. Stylistic skills in this area are teachable. There is a perceptual-cognitive component which would seem to have two possible functions. Firstly, in relation to the motor skill, as the necessary feedback loop to monitor the making of a sign, and secondly, as a tester of potential receiver response. When operating in this latter mode, the designer is 'putting himself' in the role of audience. This duality in design behaviour is very important. At one point the designer is a maker and at another he is an observer but not necessarily 'through his own eyes'. He attempts, to a greater or lesser degree, to see his work as an audience would.

This is a purely speculative analysis which will have to be the subject of a great deal of research before we can postulate a more precise model. It is possible to say that there are two basic ingredients in the sign design process as we have described it above. Firstly, a making of signs, and secondly, a monitoring of the making. We can relate this to Jones's (1970) model of design behaviour as a 'self organising system' (1.3.7) in which he postulated two distinct areas of activity which correspond to the above analysis (see 1.3.7).

3.4.5 The logic of design activity is not the logic of receiver response. What the designer does, what the designer thinks he is doing and how a receiver responds are three very distinct domains. For the sake of a tidy model and an easy life we may be tempted to postulate that all three are logically related. However, a designer may have a very distorted and even completely wrong image of the receiver. He may see the sign he produces as satisfying his own

personal taste and yet the sign may not elicit the desired receiver response. Moreover, we might make him a worse designer if we try and correct his knowledge and attitudes. We must be careful not to let our model of design behaviour become a design method (1.3.2). In the discussion which follows on the potential influences on design behaviour we must constantly bear this point in mind. The educational implications of the above discussion should be obvious from the comments made in the Introduction.

3.4.6 A principle which has guided our approach so far, must be re-stated. We have defined what constitutes 'normal' functioning in design behaviour i.e., the fulfilment of given objectives. When this process breaks down we look for causes and cures. We do not start by assuming as design method theorists do, that the designer needs help. The function of research is to find out IF he needs help and only then to suggest possible changes. Our method is therefore based on an enquiry into the pathology of design behaviour.

3.5 Pragmatics and Design

3.5.1 To complete the overall shape of the jigsaw of phenomena in this study we must now relate the conclusions of Chapter II to our model of sign design.

3.5.2 In 3.4.6 we made explicit our approach to sign design behaviour via the pathology of design. The same principle can be seen to underlie our approach to the study of pragmatics (2.5.2). Not all pragmatic phenomena are 'intended' in the sense that someone has given a particular object a sign value or has produced an object which is a sign, with a particular interpreter in mind. The significance of a cloud is a product of nature or the whim of an interpreter, and many signs are of this kind.

The signs we are concerned with are, by contrast, all 'intended' and we have limited ourselves both when talking about design and pragmatics to situations where 'intention' is operationally definable. Thus the OBJECTIVES in the design process are the 'intentions' in the pragmatic context. In this way we have demonstrated a clear and interlocking set of heuristics for integrating both domains. The underlying principle in pragmatic enquiry is also via the pathology of the process, looking for causes and cures for the breakdown of a determined relationship.

3.5.3 Are we perhaps making a value judgement about both design and pragmatics? We have made an assumption that design has a function, a purpose. This is perfectly in keeping with other definitions of design (see Appendix 1). We have also, for the purpose of this enquiry, adopted a particular way of measuring this, i.e., objectives are to be stated operationally and as we are dealing with pragmatic relations, they must be stated in behavioural terms. When objectives are fulfilled they can be measured in behavioural terms. If the system is functioning abnormally, the wrong behaviour will result. In this sense we can talk about the pathology of both design and pragmatics. If we are making a value judgement, it is that design has a purpose or that communication is purposeful.

3.6 Potential Variables Affecting Sign Design

3.6.1 We will now explore the range of potential influences on sign design. Before doing so there are two important qualifications. The designer may be influenced by a great many aspects of the context in which he operates. He is however, always selective and he also interprets (Gagné, 1962). Therefore we must take into account not only the potential range of variables but also the power of the designer to

ignore a particular influence. If he accepts a particular influence we cannot simply assume that our perception of that influence is the same as the designer's. For example, the design of a wall chart for classroom use will be more than likely initiated by a teacher. He will give the designer his objectives, which may include the information to be presented and the age and type of children who will use it. The designer, realising that the acceptance of the wall chart depends on the teacher's judgement may exercise his selective judgement and regard the teacher as his audience rather than the children. Further his work will be influenced by what he thinks the teacher will want. We may still end up with a very satisfactory wall chart for the children. There are therefore two basic designer variables which operate over and above any potential variables coming to the designer and these are: selection and interpretation.

3.6.2 We can classify the potential influences on sign design into five categories in terms of the origin of the influence. These are:

1. The objectives
2. The designer
3. The channel
4. The decoder and receiver
5. Knowledge of results

3.6.3 Logically, it would seem appropriate to begin with the objectives. The nature of the origin of objectives could be an important determinant in the design process. The example of the teacher given above illustrates this (3.6.1). The relationship between a designer and his client is of interest in a practical sphere because the client is usually different from the receiver, but the designer must seek approval for the design from the client and in that sense the client can become the receiver. It is an interesting question related to design practice as to whether the designer should seek to educate the client.

A second set of influences arising from the objectives relates specifically to the objectives themselves. How complex is the task? Complexity is one of the main reasons given for the development of design methods (1.3.2), yet we do not know what amount of complexity a designer can handle. We will not dispute that it is a potential influence on the sign design process.

The nature of the objectives in terms of precision could be important. The legibility of a road sign is critical and must operate within certain limits. Accordingly the choice of typeface is extremely important. In the case of a printed page the choice of typeface is not so critical.

The content of the information may be a further influence. Is neutral information easier to translate into a message than emotive information? There are many potential variables within this particular area which could affect the process.

We can summarise the above by saying that the potential influences arising from the OBJECTIVES are:

1. Client
2. Complexity
3. Precision
4. Content

3.6.4 The differences between designers could seriously affect the process. Although many other influences exist, it is fundamentally the behaviour of the designer which is critical. Broadly speaking, there are three kinds of influence: genetic, developmental and experiential. The implications that follow from these are manifold, and give rise to a large number of questions.

Are there innate encoding abilities which differ from one individual to the next which may affect the ability of one person to become a successful designer as opposed to another with lesser

ability? Can we discern a pattern of development in a child's ability to use visual images as a means of communication? Do personality variables affect design ability? Can design ability be taught? All these questions are extremely significant in the area of design education. We are a long way from answering these questions but we will attempt in a later section to formulate some guidelines for research in this area.

At this stage, we can do little more than include these areas as potential influences on the design process. Before embarking on a specific study of individual differences in designers, we need to establish the kinds of limits which exist within the area. Our key concept in this is the notion of PREDICTION . What are the limits of this? Clearly from what we have said in Chapter II, the limits are likely to be fairly loose. Some information on this may be gleaned from the pilot studies reported in Chapter IV, but the methodology of these experiments needs considerable refinement before the results can be used in any way.

We will be returning to this area when we consider the relationship between encoder and decoder, designer and receiver. We will, at the moment, conclude by summarising the above by saying that the potential influences arising from the ENCODER are:

1. Genetic
2. Developmental
3. Learnt

3.6.5 What influences does the channel bring to bear on the encoding process? We have in this study restricted ourselves to a particular channel (3.3.2) and a basic 'manual' technology applied to encoding. Therefore, our preoccupation with this will necessarily be limited. However, for the sake of a comprehensive framework, we will note a number of potential influences.

A basic influence is the intensity of light available. This is a key factor in decoding, and is a well documented and researched area in psychophysics. What influence this has on encoding is not known. Will a designer intuitively take such phenomena into account or does he need explicit information about decoding processes? We will return to this question in 3.6.7.

The quality of light could be regarded as another aspect of the same problem i.e., sunlight or some form of artificial light. We can also ask some questions of this as we did with intensity.

The normal characteristic of any channel is the presence of noise. In this context we may think in terms of such hazards as rain, snow and fog. In addition we could regard distance at which an image may be legible.

Summarising the above we can say that the potential influences on design arising from the CHANNEL are:

1. Intensity
2. Quality
3. Noise
4. Distance

3.6.6 It is convenient to group the DECODER and RECEIVER together since they are part of the same individual, and apart from the designer himself, these are the most critical areas of potential influences, always bearing in mind that we are talking about what <u>does</u> influence a designer rather than what <u>should</u> influence a designer. It will be of interest to psychologists not familiar with art education, to realise that very little formal consideration has been given to this until recently in art education. (Wrolstad, 1969, Sless, 1970, D.E.S., 1971, Wright, 1973). Some of the implications of this are already mentioned in the Introduction and will be further elaborated on in Chapter V.

Specifically in relation to encoding, we may think of basic perceptual processes. The receiver shares these in common with the encoder and as such, the dual role of designer (3.4.4) is significant here, as indeed it is throughout this section. It is an important principle in the process of communication that encoders and decoders must be similar in operation for communication to take place. We may in addition think of perceptual abnormalities such as colour blindness and optical defects as being potentially influential.

The age and social background of the receiver are also critical influences. We may be tempted to say that these are the most critical influences. One reason for the use of visual communication in culturally heterogeneous situations, such as airport terminals or olympic games, is the belief that they provide a universally understandable system (Dreyfuss, 1972). This is by no means an unequivocal point of view (2.3.9). The above belief may lead one to ignore critical social influences. For example, the credibility of a message or even a channel has been shown to affect the outcome of communication (Hovland et al, 1953) and this can vary just as any other attitude can from group to group.

We are, to remind the reader, concerned with those influences which affect the accuracy of any prediction a designer may make. It would seem reasonable to suggest that the social 'distance' between a designer and a receiver may be a significant factor. One would almost assume that communication with one's peers was the most easily predictable in terms of response and that this predictability would diminish as the 'distance' between designer and audience grew.

We may summarise the influences of the DECODER/RECEIVER as follows:

1. Perceptual processes
2. Perceptual abnormalities

3. Age

4. Social background and distance

3.6.7 What do we mean by knowledge of results? Two distinct kinds of information fall into this category. The first of these relates to the information of a general theoretical nature that may be related to design or specific research studies of aspects of his own area, of which he is aware and uses to inform his design activity. This is a special case of what we have already mentioned in 3.6.4. We have singled it out because there are some notable educationalists who take the view that information can have a very bad effect on the designer's ability.

"The student who has to secure implicit approval from the psychologist, the biologist and all the other ologists may find them even more inhibiting mentors. Many practising designers are deeply suspicious of these trends in art education. They find it hard to name the outstanding practitioners the method has produced. They suspect that it fosters cultural name dropping and that this disguises a sort of creative castrate at worst and at best a scissors-and-paste pattern maker" (Holland, 1966).

Strong words indeed, from a man who is Chief Education Officer for the Society of Industrial Artists and Designers. We will take a more open view and suggest that we need to be able to conduct some research into this whole area before we can throw knowledge away.

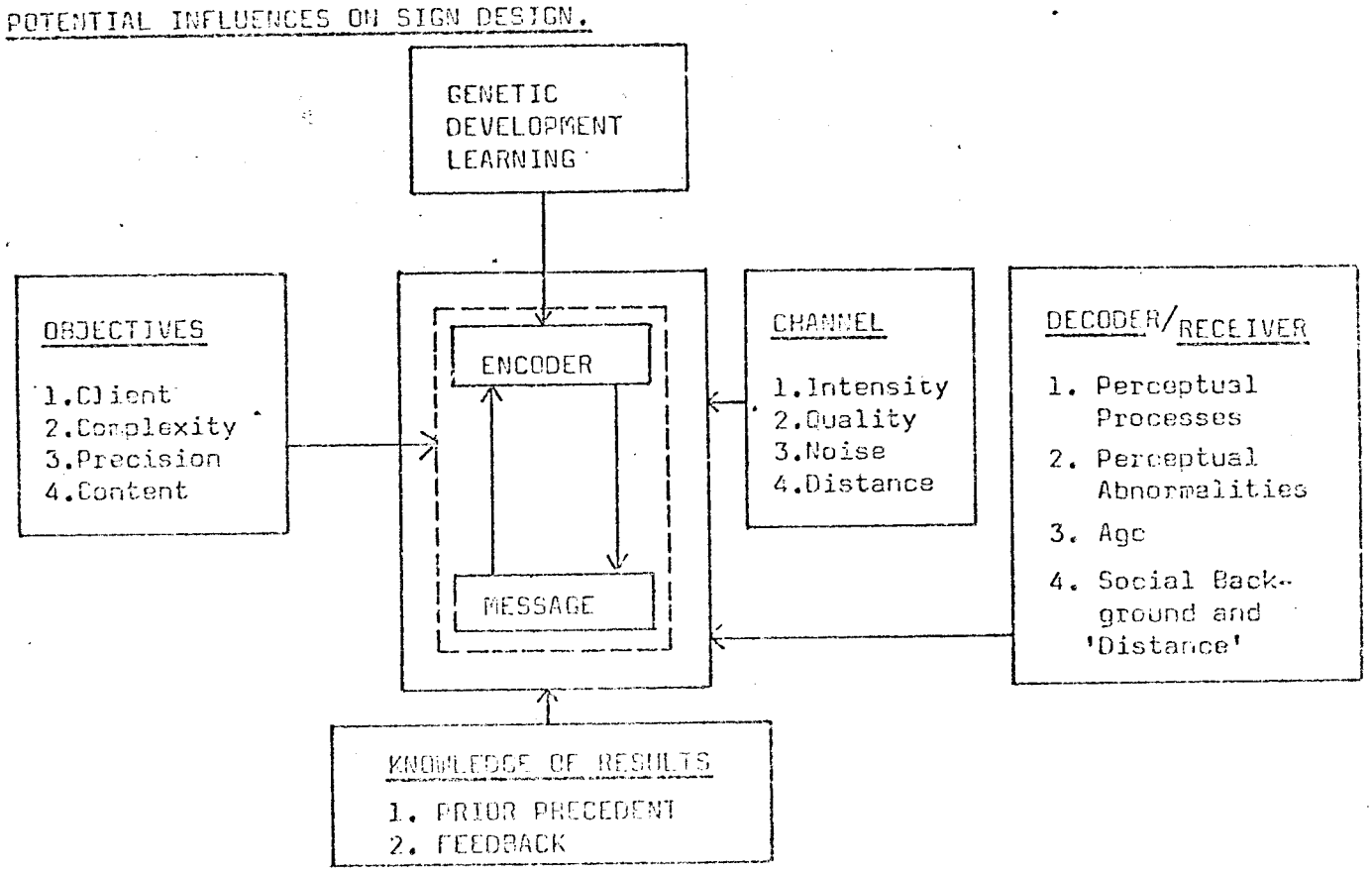
The second area covered by this category is knowledge derived from testing a particular potential message i.e., feedback from the receiver. How effectively can a designer compensate in his encoding for a failure to make a satisfactory prediction? Can he do it in one attempt or is it a matter of successive approximation? We will discuss some interesting results on this in Chapter IV.

We can now summarise the potential influences in this area by enumerating the following:

1. Prior Precedent
2. Feedback

3.6.8 The above is a sketch, an outline, based on firsthand experience in design practice and education. It is not intended to be comprehensive but merely a start along the road towards defining the potential influences on design behaviour. By way of summarising the entire pattern of influences we have discussed, we have crystalized it into diagrammatic form in Fig. 14.

Fig. 14



The double shell round the encoder and message indicates the selective and interpretive function (3.6.1). The penetration of the arrows indicates the necessary minimum for design to occur at all.

From Fig. 14 we can see that the potential range of observable phenomena in studying design behaviour is vast, ranging from the social to the psychological, and through the physiological to the physical. The pilot studies in Chapter IV can be seen as a first attempt at exploration in this area.

CHAPTER IV

Pilot Studies in Design Behaviour

"If a picture paints a thousand words, why can't I paint you?" (pop song).

Summary

This chapter reports two pilot studies of design behaviour which use the Semantic Differential (S.D.). They represent the first development of a methodology for empirical analysis of design behaviour. A number of criticisms of the instruments and statistics are discussed and an outline of a more adequate methodology is proposed in the conclusion.

4.1 Introduction

4.1.1 The vast range of potential influences on design behaviour offers a wide variety of avenues of enquiry. With no adequate precedent, it was felt necessary to conduct some exploratory studies to iron out a methodology and to investigate the potential of a future, more rigorous enquiry.

4.1.2 The studies reported here are all concerned with the process of PREDICTION as discussed in 3.4.4. The opportunity for the first study was provided by the work undertaken on behalf of Sunderland Polytechnic, to design a house style for the institution when it was established in 1970.* The house style is, in general terms, the way

* This work was undertaken jointly by the author and Mr Richard Rainer of the Department of Visual Communication, Sunderland Polytechnic.

Fig. 15.

Sunderland Polytechnic.

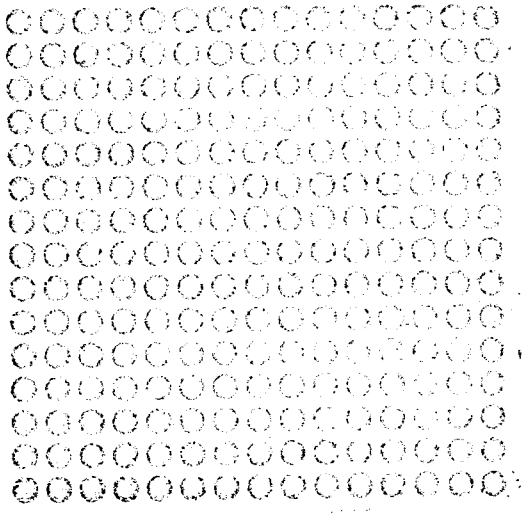
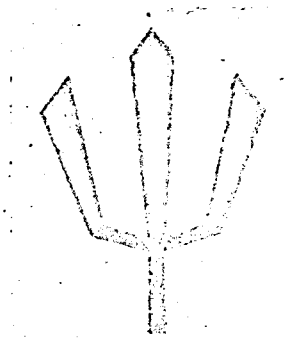


Fig. 16.

Newcastle Polytechnic.



in which an institution appears to the public through its livery, sign-posting, publications etc., as a unified body.

The second study is part of the first year educational programme of the Sunderland Polytechnic Diploma in Visual Communication.

4.2 Pilot Study 1 - A Study of the Connotative Neutrality of Two Symbols

4.2.1 When Sunderland Polytechnic was formed in 1970, the Board of Governors asked the Visual Communication Department to develop the house style for the new institution. The Polytechnic was formed by combining the former colleges of Art and Technology. It thus represented an amalgam of many interests. The OBJECTIVE which was given for the house style, was that it should be capable of reflecting this diversity of interest.

4.2.2 It was decided by the design team to use a symbol which would be a 'vehicle' for representing this diversity. A 15 x 15 matrix of dots was chosen (see Fig. 15), such that each separate department could be identified as a symbol within the matrix thus giving it a specific identity within an overall house style. The number, size and spacing of the dots was determined by studies of legibility, readability and flexibility in use, which was reported in the final recommendations submitted to the Board of Governors. The symbol was designed for use on sign-posting, stationery and publications.

4.2.3 As the symbol, which would be the main source of identity, was to be a 'vehicle', it was felt that it should be connotatively neutral. When the prototype was evolved, it was decided by the author to see just how far it was possible using existing techniques to test this OBJECTIVE in terms of audience response. As designers, we had originated a POTENTIAL MESSAGE which we had PREDICTED would FULFIL GIVEN OBJECTIVES: that the symbol for Sunderland Polytechnic

would be connotatively neutral.

4.2.4 The test instrument used was the Semantic Differential (S.D.), developed by Osgood, Suci and Tanenbaum (1957). It has been used in a great many studies of communication, but mainly in the study of effect divorced from intention. Its usefulness in this study stemmed from the fact that it is a BEHAVIOURAL measure. It can be translated into OBJECTIVES and it is extremely flexible. Thus, in the present study, we were PREDICTING that a RECEIVER would respond by filling a S.D. at the mid-point of each scale. The list of polar opposite adjectives used in this study was developed by Tucker (1955), from responses of subjects to abstract and representational paintings at an exhibition (see Fig. 17). No other scale developed specifically for visual material was available and other studies which have examined responses to visual material, notably Craddick, Thumin and Barclay (1971) and Siddiqi & Thieme (1969) do not make explicit the origin of the scales they used. We shall return to the question of choice of scales in the conclusion.

As there was no existing data on connotative neutrality against which to compare the result, it was decided to test another symbol alongside the one we had designed. The symbol chosen was the one for Newcastle Polytechnic (see Fig. 16). This was also included in order to see how the profile of another polytechnic compared with Sunderland.

4.2.5 The choice of 'RECEIVER' in this study was critical. It was decided that the most important audience was potential students. They would be susceptible to the manner in which an institution presented itself. Accordingly the subjects chosen for the test were forty-four sixth formers (nineteen male, twenty-five female) from a local comprehensive school. Each subject was given two sheets of

polar opposite adjectives and instructions (see Appendix II). The order in which subjects filled in the test sheets for each symbol was randomised.

Fig. 17

Semantic Differential Scale used in Pilot Study 1 (After Tucker 1955)

hot	:___:___:___:___:___:___:___:	cold
pleasant	:___:___:___:___:___:___:___:	unpleasant
lush	:___:___:___:___:___:___:___:	austere
vibrant	:___:___:___:___:___:___:___:	still
repetitive	:___:___:___:___:___:___:___:	varied
happy	:___:___:___:___:___:___:___:	sad
chaotic	:___:___:___:___:___:___:___:	ordered
smooth	:___:___:___:___:___:___:___:	rough
superficial	:___:___:___:___:___:___:___:	profound
passive	:___:___:___:___:___:___:___:	active
blatant	:___:___:___:___:___:___:___:	muted
meaningless	:___:___:___:___:___:___:___:	meaningful
simple	:___:___:___:___:___:___:___:	complex
relaxed	:___:___:___:___:___:___:___:	tense
obvious	:___:___:___:___:___:___:___:	subtle
serious	:___:___:___:___:___:___:___:	humorous
violent	:___:___:___:___:___:___:___:	gentle
sweet	:___:___:___:___:___:___:___:	bitter
static	:___:___:___:___:___:___:___:	dynamic
clear	:___:___:___:___:___:___:___:	hazy
unique	:___:___:___:___:___:___:___:	commonplace
emotional	:___:___:___:___:___:___:___:	rational
thick	:___:___:___:___:___:___:___:	thin
ugly	:___:___:___:___:___:___:___:	beautiful

dull	:___:___:___:___:___:___:___:	sharp
sincere	:___:___:___:___:___:___:___:	insincere
rich	:___:___:___:___:___:___:___:	poor
bad	:___:___:___:___:___:___:___:	good
intimate	:___:___:___:___:___:___:___:	remote
masculine	:___:___:___:___:___:___:___:	feminine
vague	:___:___:___:___:___:___:___:	precise
ferocious	:___:___:___:___:___:___:___:	peaceful
soft	:___:___:___:___:___:___:___:	hard
usual	:___:___:___:___:___:___:___:	unusual
controlled	:___:___:___:___:___:___:___:	accidental
wet	:___:___:___:___:___:___:___:	dry
strong	:___:___:___:___:___:___:___:	weak
stale	:___:___:___:___:___:___:___:	fresh
formal	:___:___:___:___:___:___:___:	informal
calming	:___:___:___:___:___:___:___:	exciting
full	:___:___:___:___:___:___:___:	empty

4.2.6 The total results on each scale for each symbol were averaged in the normal way. The means thus derived for both symbols are presented in Appendix II. The results give rise to a number of questions. The first of these relates to the use of the mean with this kind of data. The mean is the usual measure taken when analysing the S.D. results. It was noticed with some of the data that Ss' judgements were at times polarised at opposite ends of the scale. The resulting mean gives an impression of neutrality. Further if data are evenly distributed across the entire scale, the mean will again be neutral. In some circumstances this may be an acceptable compression and loss of data. In this case however, the loss is inadmissible, since it runs contrary to the objectives of communication. This leads on to the second question. Given that under all

circumstances a certain fluctuation from subject to subject will occur, what degree of variation is acceptable? What criterion can we evoke which will enable us to say that the OBJECTIVES have been FULFILLED? For example, the highest score for neutrality on any scale was 18 out of 44 subjects (41%). Could it be argued that some such percentage will provide the basis for deciding whether an OBJECTIVE has been FULFILLED or not? We shall return to this problem later.

The choice of scales for this study was pragmatic but on closer scrutiny, it was thought that a set of scales should have been designed specifically with this study in mind. It is hoped at some later date to conduct a factor analysis on this data to aid in the construction of a new set of scales. Because the scales in this study are inter-related no overall meaningful statistic can be given.

Perhaps the clearest, though rudimentary indication of neutrality comes from looking at the individual scales and the results for the two symbols. By taking results with a mean of 1.5 or over on either side of scale we find there are a total of eight such scores for NEWCASTLE and only three for SUNDERLAND.

NEWCASTLE	
Ordered	1.8
Serious	1.7
Clear	2.0
Sharp	1.5
Masculine	1.7
Hard	1.7
Controlled	2.0
Strong	2.3
Formal	1.6

SUNDERLAND	
Repetitive	2.1
Ordered	1.5
Controlled	2.0

This indicates that the NEWCASTLE symbol has many more strong connotations.

On a purely relative basis, the Sunderland symbol comes close to FULFILLING THE OBJECTIVE of connotative neutrality. The NEWCASTLE results, coincidently, lend support to the findings of LESSLER (1962) on Freudian symbolism in that an obvious male symbol (in Freudian terms) does reveal a very 'masculine' syndrome of connotations. It may be that this is a potential factor for the development of a new set of scales.

4.2.7 In conclusion, we can say that the use of the S.D. in its present form is inappropriate for this kind of study. Firstly, a new set of scales must be designed and secondly, a form of statistical analysis more suited to the theoretical framework of this study must be achieved.

The rudimentary analysis of the data does indicate that the SUNDERLAND symbol has few strong connotative values.

4.3 Pilot Study 2 - Prediction of Denotative and Connotative Meaning and the Modification of Design

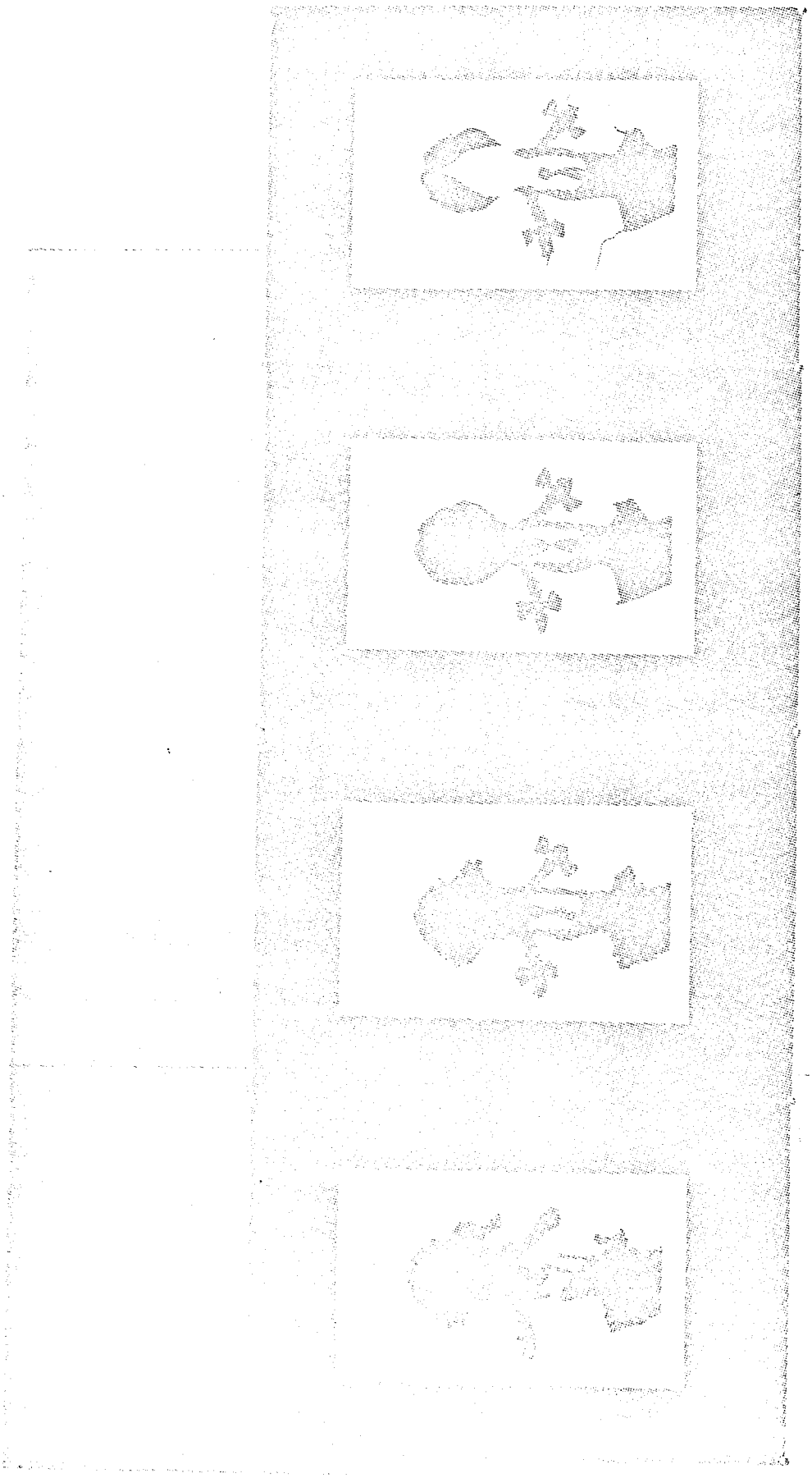
4.3.1 The study we are about to discuss has a curious history. The original idea derived from Bartlett's (1932) now classic experiment using ink blots in which a wide range of responses were elicited to a single stimuli. The experiment was used as a set practical on an introductory course in the Psychology of Perception for art students. With the development of the Visual Communication course at Sunderland the same basic experiment was introduced by the author as a first year exercise for students on this course. Since the objective of the course was to train communication system designers, the experiment took on a different emphasis. Design is concerned with controlling responses, with FULFILLING OBJECTIVES, which is not the case in the Bartlett study where the variety of responses which a single stimulus produces is the focus.

Instead of concentrating on variety, the emphasis here was shifted to modifying the actual ink blot so as to maximise the occurrence of a particular response.

Many of the ideas in this thesis grew out of these first year exercises which are reported here. It should be emphasised that what follows is not a rigorous scientific experiment. It is the first structured exercise on an interdisciplinary course. It is the first time that a student on the course considers the practical and theoretical problems of visual communication. It is a learning vehicle. The knowledge, skills and attitudes required for the exercise are in a formative stage and it gives them substance.

4.3.2 The exercise begins with each student preparing an ink blot. The ink is 'thrown' onto newsprint, allowed to dry and the resultant image is traced onto quality cartridge paper and rendered as a flat textureless black image. The shape of this blot is used as a basis for deciding what the image will be made to represent. In the next stage each student modifies his original image in as small a way as possible but so as to achieve a consensus of responses among a given target audience (usually other students). The students then experimentally test the image by asking a sample of the audience to give it a denotative meaning. If the sample does not give a 100% response on the PREDICTED denotation, the image is further modified. This cycle is repeated until 100% response is achieved. The next stage is to take the final image and ask each student to prepare a S.D. profile of the image which would in his judgement be the typical response of the target audience to the image. Having prepared this 'ideal' profile, the student then tests his PREDICTION against the audience response to a S.D. test. From the results of the test the image is modified in order to correct any discrepancies between the PREDICTED and the observed profile.

FIG 18



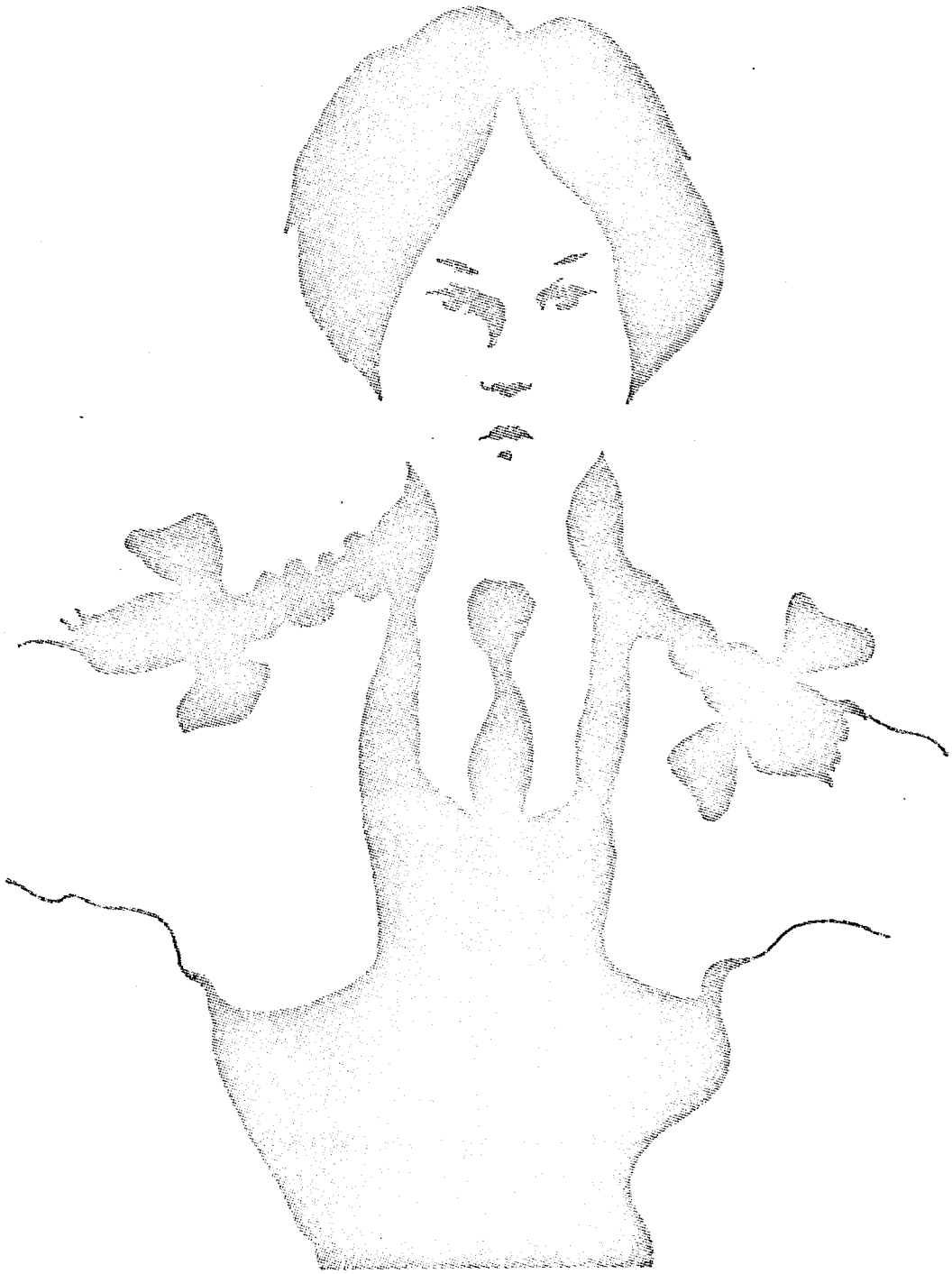
.3.3 The results of the above procedure vary considerably from one student to another, both as a result of different starting points in terms of ink blots and in terms of ability and application. For purposes of illustration, one such study involving one student has been included in detail, and in Appendix III, I have included some photographs of other images and their modifications.

In Fig. 18 we can see the successive modifications made to the original blot in order to achieve the desired result. It is interesting to note that this is a very difficult prediction to make. No student has ever succeeded in achieving a result in under three modifications. It would appear from discussions with the students, that once the denotation has been decided, it is very difficult to visualise the image in any other terms and it often comes as a surprise for some students to discover that the audience do not see the image in the same way. This phenomenon is related to the concept of 'set' and 'interference' as found by Bruner & Potter (1964) and to the notion of 'Schemata' as developed by Abercrombie (1960). It is obviously an extremely important variable in the behaviour of the designer and one which requires further study.

The desired denotative response was 'a school girl with pig-tails'. The next phase was to predict the connotative meaning of the image to an audience. The student here constructed his own list of antonyms, based on existing lists and predicted where the modal result for a group of 20 subjects should lie. The subjects tested were once again a group of students (ten male, ten female). The results are presented in Appendix III. Using the D score and converting it into a product moment correlation as in Osgood et al (1957, page 91), the following result was obtained:

$$r = -0.35$$

This negative correlation was attributed by the student to the absence of a face on the school girl. The image was then modified and the test



MODIFICATION (✱)
With EAGU

repeated with the same subjects. The resulting correlation:

$$r = 0.42$$

shows a considerable improvement in the final image (Fig. 19).

4.3.4 In this study we can see the influence of a number of factors arising firstly from the ENCODER and MESSAGE and secondly from the influence of FEEDBACK. Overall it gives considerable insight into the difficulty of controlling RECEIVER responses to a relatively simple image but it also demonstrates that limited control can be achieved and insofar as the student takes account of test results, the modifications do produce a change in response in the desired direction.

4.4.0 Conclusions and Outlines of Further Studies

4.4.1 It would seem from the previous studies that there is considerable scope for using the S.D. as a research tool in this area. However, before it can be applied successfully, a number of modifications both to the instrument and the method of analysing data must be considered. The initial problem to be resolved, however, is the formulation of a basic experimental paradigm.

4.4.2 In the previous studies, the OBJECTIVES emerged from within the actual design activity. However, the definition of design which was evolved in Chapter I and III speak of GIVEN OBJECTIVES. Therefore a basic starting point for any future study must be the statement of GIVEN OBJECTIVES. Further, these objectives must be stated in BEHAVIOURAL terms. The S.D. could be adapted to fulfil this requirement. The designer could be presented with a GIVEN profile on an S.D. and asked to design a visual stimulus which would elicit from a particular target audience the same response as the GIVEN S.D. The designers performance can be measured by comparing the GIVEN

OBJECTIVES, in the form of the given S.D. profile, against the actual FULFILMENT of those OBJECTIVES, in the form of the target audience's response.

4.4.3 The first question to consider is the origin and construction of the GIVEN PROFILE. A content analysis of design literature could be used to develop the basic source material for a list of polar opposite adjectives. These could be subjected to a factor analytic study to establish the major factors. The data from Pilot Study 1 could be used in this way. It may be that the evaluative, potency and activity factors established by Osgood et al would be adequate but the limited analysis of the data in Pilot Study 1 suggests that there may be other factors in the stimulus material used. The specific profile could be developed from the above data in two ways. Firstly, an actual design problem could provide the basis. There are a great many competitions and briefs provided by industry for designing symbols. One of these could be adapted to provide the basic profile. A further possibility would be to start with an existing symbol, find the profile for a given target audience and then present this to the designer and ask him to design a symbol conforming to the profile.

4.4.4 Using the GIVEN PROFILE as the variable in the experimental situation a number of questions could be asked. Firstly, how much complexity as measured by the number of scales can a designer adequately cope with? Secondly, are certain kinds of connotations easier to communicate than others? For example, is the connotation of dynamic or passive easier to communicate than ugly or beautiful? Are certain positions on the scales more easily attained than others? For example, is 'very hard' as easy to communicate as 'slightly hard'?

4.4.5 Certain aspects of the S.D. instrument need to be examined more fully. In an S.D. study not reported here, a sample of the

distribution of scores was taken. By adding the results vertically the distribution of results along the seven point scale was found to be in the following proportions:

12% 13% 14% 22% 14% 13% 12%

This may be a result of subjects' natural responses. It could be that subjects show a tendency towards giving neutral scores. A further possibility is suggested by the form of instructions given to subjects. Close examination of the instructions given in Appendix II shows that subjects are asked to make a neutral response to three conditions:

1. If the scale is neutral.
2. If the symbol is equally associated with either side of the scale.
3. If the scale is irrelevant.

It may be that the distribution of results, with the bulge in the middle, is because subjects are making more than one kind of response at the middle part. This could be tested experimentally by comparing two groups of subjects using the same stimulus material. For one group the S.D. would be in a standard form but the other group would receive modified test sheets which would enable them to provide a separate measure for Neutrality and Irrelevance. Such an experiment would be a necessary preliminary to establish whether such a distribution is a function of the test or the natural disposition of subjects.

4.4.6 It was suggested in 4.2.6 that the mean does not provide an adequate basis for analysing the data from S.D.'s as they are to be applied in this area. The basic problem is that neither the mean nor the mode provide satisfactory measures of successful prediction although the mode is marginally the better of the two. For the purpose of future studies we will ignore the linear assumption of the S.D. scale and adopt a different approach. Because we are dealing with an

expected response we will distinguish between correct, partially correct and incorrect responses. The system of measurement proposed will differ from one part of the scale to another. Taking each position in turn, the extreme position shown below has the following weighting:

Good 1 ¾ ½ 0 0 0 0 Bad

All results occurring on the extreme score are given a weighting of one. The two adjacent categories, being partially correct, are given weightings to reflect their degree of correctness. The neutral position and those on the opposite side of the scale are incorrect responses and are therefore ignored with a weighting of zero.

The next position as shown below is treated similarly. Once again we ignore the neutral and opposite side of the scale.

Good ¾ 1 ¾ 0 0 0 0 Bad

The next position is treated similarly to the extreme position but in reverse.

Good ½ ¾ 1 0 0 0 0 Bad

Finally, for the mid point, weak connotations are accepted and the weightings are as follows.

Good _ _ ½ 1 ½ _ _ Bad

The basis for this system of weightings is not empirical. It is designed to provide a distinction between correct, partially correct and incorrect responses, related to GIVEN OBJECTIVES.

The weightings of ¾ and ½ are to indicate degrees of partial correctness. The actual choice of ¾ and ½ is to some extent arbitrary but it provides a basis for consistent interpretations. The use of ½ only on the mid point is to emphasise that only a weak

connotation is in any way acceptable and then only marginally. To give a higher weighting would result in emphasising results which were clustered around the side of the scale rather than the centre.

4.4.7 The use of the above method is subject to a further set of restrictions. In any group response to an S.D. there is to be expected a certain variation beyond the control of the designer. The theoretical 'ideal' would be that all responses would be at the correct point on the scale. Somewhere below this will lie the practical 'ideal'. As yet we do not know what that is likely to be. From Pilot Study 1 the figure of 41% is quoted as the highest. This, however, was taking the mid point only. There are potential variations in this for different positions on the scale using the weightings developed above.

A more critical point is the lower limit of successful results. We can derive this by finding the lowest possible score which is statistically significant. Assuming we can shed some light on the problems raised in 4.2.6, we can determine for any sample size what the expected score is under Ho. using the weighting system. It would then be possible to compare this with the observed score using Chi squared.

4.4.8 We can summarise our conclusions by saying that given suitably constructed scales, a more refined instrument, and a more adequate method of statistical analysis, along the lines suggested, will provide a basis for a programme of experiments to investigate many of the variables in the sign design process.

C H A P T E R V

Review of Sign Design Methods

"Here is Edward Bear, coming downstairs now, bump, bump, bump, on the back of his head, behind Christopher Robin. It is, as far as he knows, the only way of coming downstairs, but sometimes he feels that there really is another way, if only he could stop bumping for a moment and think of it." (Winnie-the-Pooh, A.A. Milne)

Summary

This chapter reviews five methods which have been published on sign design and concludes that they do not constitute a reasonable basis for application without raising fundamental issues.

5.1 Introduction

5.1.1 In this chapter we will review a number of methods which have been published, which relate to sign design. They are only the tip of the iceberg. There are many designers involved in sign design and undoubtably many methods of designing signs. Designers are concerned with what they produce rather than with telling others how to produce. It is regrettable however, that more has not been published in this field to aid those involved in design education. There is an abundance of design methods as we suggested in Chapter I and these have been adequately reviewed elsewhere (Jones, 1970). However, there is no review of methods specifically related to sign design and it is to that task that this chapter will devote itself.

5.1.2 We shall use the framework we have developed in this study to critically underpin our review. In (1.1.2) we stated that any adequate theory of design should be able to evaluate the usefulness of different methods. While we are some way from an adequate theory, we

have developed a framework which we have shown can be related to all the aspects we have considered so far. We will now use it to evaluate a number of different methods, so that in a sense, it is both the framework and the methods that we are evaluating against each other.

5.1.3 Because of the nature of the field it is difficult to conduct a systematic literature search. It is possible that other methods than those reviewed have been published, but not to the knowledge of the author. It is amazing that many of the methods are published without reference to comparative or similar methods which may have evolved elsewhere.

5.2 The Ulm Tradition

5.2.1 The Hochschule fur Gestalburg at Ulm, was founded after the second world war. It was the designated successor of the Bauhaus, the German design school of the twenties which had such a profound influence on twentieth century design. The Ulm school, following in the footsteps of its predecessor has in its short life (closed 1968) given those involved in design education a singular lead in the breadth and depth of its approach to the field. We shall look here at three methods which emanate from the Hochschule. In some respects they are similar, as one might expect. Unfortunately, the documentation available to the author on these is scant and in English, and it may be that some of the criticisms are unwarranted.

5.2.2 The first of these, 'Sign System Designs for Operative Communication' by Maldonado and Bonsiepe (1961) is based on principles derived from semiotics and linguistics and upon a method called 'synchronous observation' which is defined in the Glossary of Semiotics (Maldonado, 1961) as a "research method which analyses signs with respect

to their function on a social group in a certain historical dimension". The particular case study through which they develop the method is a "sign system for control and display panels of an electronic digital computer".

The principles which they invoke are as follows:

a) The principle of combinability. Though not explicitly stated here, it seems to suggest a limited number of units which, using certain rules, can be combined to form composite meanings. The prime example is phonogrammatic signs i.e., "Writing, the signs of which stand for speech sounds" (Maldonado, 1961). By way of giving validity to this principle they suggest that "....the principle of combinability makes a sign system into a flexible one, capable of development, open and easily adapted to new requirements". It can be seen that this is a syntactical consideration in the sense in which Morris uses the term. It is a principle of ENCODING. The first question we must raise is, to what extent does an ENCODING principle developed by a designer, come to be interpreted by a DECODING RECEIVER? A PREDICTION is involved here that the ENCODING rules used by a DESIGNER will be similarly used by a RECEIVER, that the same 'logic' will operate. Studies in linguistics would seem to suggest that this is possible but it would be of interest to subject a sign system, particularly an 'artificial' one, to empirical testing. Is the 'flexibility' of the system for the designer or the receiver? The studies we have reported in this enquiry deal with the PREDICTION of denotative and connotative meaning. It will fall to a further study to look at PREDICTION of the use of syntactical rules. This criticism is not directed at the principle of combinability as such, but at the behavioural implications which derive from it. Is a sign system more easily learnt when the principle is applied? What sort of rules of combination are most easily learnt? Does such a system help or hinder the discrimination between different signs within the system?

b) They then suggest a further ENCODING principle by advocating the use of Logograms i.e., "visual language sign for a referent, without taking account of the speech sound dimension" (Maldonado, 1961). They do so on the following basis:

"(1) Logograms, if suitably designed, generally serve the purpose better as regards recognisability, identifiability and readability than a phonogram".

"(2) Logograms, because they are of a non-spoken character, surpass the respective national language and have an international character. True, they must be learned by means of a language, but they are not tied to any particular language".

The latter argument would seem to be analytically defensible and require no further justification. However, the former argument would seem to entail an empirical justification. What can we gather from the phrases "if suitably designed" and "generally"? Presumably a "suitable design" of a logogram would be more recognisable, identifiable and readable than its phonographic equivalent. In part, this would seem to be a self fulfilling prophecy but at a deeper level it is suggesting OBJECTIVES of SUCCESSFUL design, all of which are capable of being subjected to empirical testing. Therefore contained within the phrase "suitably designed" is the implication of successful PREDICTION of RECEIVER response. As we have shown from our own limited study, this is by no means guaranteed. Thus the phrase "suitably designed " contains a multitude of uncertainties.

As an aid to developing suitable signs within the system, they advocate the method of synchronous observation. This is spelled out in the following way: "a certain referent e.g. the action 'stop' is not only designated in pedestrian or motor traffic, but also in

time and motion studies, in telegraphy, and in medico-diagnostic apparatus. Identical or similar referents operate in different sign systems. Possible common features of different signs for the same referent can be distilled by comparing the signs. In this way, under certain circumstances, associative constants appear; taking note of these in designing a sign system makes it easier for it to be learnt". There are three assumptions, for which empirical evidence is by no means unequivocal, upon which this method rests: firstly, that it is possible to 'distil' common features of different signs with the same referent: secondly, that there are such things as 'associative constants', and finally, that using these 'associative constants', signs are more easily learnt.

To look at the first assumption we must try and discover what is meant by 'distil' in this context. The signs collected for observation are classified into a number of categories, related to their function, form and origin. Having established a similar function, the forms are compared for similar visual properties. At this point there is an implication which goes outside the confines of the immediate study and suggests that similar shapes have similar meanings to different social groups. The implications of this assumption relate to theories of pattern recognition, innate arousal mechanisms and some aspects of Freudian and Jungian theory. There is some evidence for the assumption, as we have already suggested (2.3.9, 2.4.4), but the relationship between form and meaning is by no means established. This is not to deny such a relationship. The whole notion of 'PREDICTION' as we have explored it must hinge on some such link, but its precise nature must await further enquiry. The idea of 'distilling' the common features of

different signs must be based on some knowledge of the equivalent formal and semantic 'units' involved. It is quite likely that such 'units' do exist and that designers intuitively manipulate them and receivers intuitively read them, but in order to apply them in a rigorous logical and functional context we need more than the term 'distil' to guide us.

Having considered the first assumption, we can see more clearly what is meant by associative constants. It is a reasonable assumption that if such constants exist, whether due to innate or learned factors, they will aid learning of new signs. However, it is something which could be subjected to empirical testing and therefore it is not necessary to make an assumption about their effect on learning, however reasonable.

One further problem, which relates to the use of a classification system for determining common elements, arises from our discussion of classification systems in 2.4.4. Most 'artificial' sign systems are prescribed, not derived. There may be a discrepancy between intended and actual use. Further, the unsuitability of a sign for a particular use may be masked by learning, however difficult, which will have taken place. To then use such a sign as a basis for deriving a new sign may result in further, not less confusion.

5.2.3 Whereas the previous method related to the design of sign systems, the method which we shall now consider relates to the design of single signs for use as a trademark. Describing the overall intention Müller (1961) in 'A Working Procedure in Trade-Mark Design' says:

"In the following example we shall investigate experimentally to what extent we can establish principles for the design of trade marks which permit a methodical and systematic working procedure. At the same time we must discover criteria by means of which results can

be tested and described".

The example chosen is the design of a trade-mark for 'Deutsche Buchgemeinschaft' (German Book Association).

"The trademark is to appear on books, letter heads, envelopes, posters, announcements, prospectuses and on walls. In addition, the trade mark is to be capable of use in the form of a revolving neon sign. The trade mark is to be capable of being produced by all known processes of reproduction, printing and duplicating".

Up to this point it would seem an impressive display of well-considered intentions in the development of method and a comprehensive set of OBJECTIVES. What follows is not so clear. We are first shown the development of the trademark using the initials d and b. There is at this point no indication as to why this particular Logotype development is used. One is tempted to ask what alternative ideas were rejected, if any, before this one was adopted and on what basis?

We are then shown a series of images in which the trade-mark is subjected to various kinds of visual 'noise' after which it is concluded that "A square trademark shows up to the greatest advantage in a screen which is not parallel to the sides of the square. Circular trade marks show up best in a screen with angles and straight lines. In a highly structural background, figures with a simple closed outline show up better than figures with a complicated, open outline". It would seem from the way in which we are led through the demonstrations that we are being asked to observe certain self evident truths. At a personal level, I find the demonstration convincing. In that sense, the designer has SUCCESSFULLY PREDICTED my response. Can we then call this a 'test'

or an 'experimental investigation'? It would seem that the use of these terms in this context differs from standard scientific usage. In many art journals we find the term 'experimental' used as a synonym for 'exploratory' activity of a free-wheeling nature. However, considering the appeals by the Ulm school to authorities from psychology, sociology and linguistics, it would seem that the term 'experimental' does apply in the normal scientific sense, but unfortunately the experimental methods and results are not given and thus the conclusions given cannot be critically evaluated.

Nowhere in the paper are we shown whether modifications were made as a result of testing and it seems unlikely that SUCCESSFUL PREDICTION occurred with the first and only version of the symbol under all conditions. Finally, the paper concludes with a description of the trademark in semiotic terms which once again is offered to us as a self evident truth with no empirical justifications.

In what sense therefore is this a method? There would seem to be the suggestion, that having designed a trademark, it should be tested in a variety of contexts to establish those contexts in which it operates to the best advantage. Therefore, its claims to being a method would seem to be rather weak.

5.2.4 The final method to emerge from Ulm uses a more empirically based kind of 'synchronous observation' which Krampen (1969) calls the 'Production Method in Sign Design Research'. It addresses itself to answering empirically the question "...which signs people are actually using for themselves and among themselves". Krampen explains the value of this as follows:

"From the material envelope of the signs which people produce in the form of sketches and 'pictures' on paper, one can

draw conclusions as to the kinds of categories they use to depict the material world in their thoughts. In learning about these categories, one acquires the power to predict whether a sign is 'understood' with a certain degree of probability or not. 'Understanding' takes place if the parties in the communication process share a common stock of signs. The material existence of the signs makes their physical exchange between the parties possible. Once a sign has been materially delivered, the receiver can infer from it the thought categories of the sender if by comparison with his own signs the sender's signs turns out to belong to a common stock".

Krampen has applied this method to some very large cross-cultural samples. In detail, it consists of presenting subjects with a list of concepts and asking them to draw pictures which represent these concepts. The results are then analysed in terms of the frequency with which particular pictorial elements occurred related to each concept and on the basis of this: "Clear cut recommendations for the design of iconic signs can be made if the frequency of occurrence of a pictorial item is statistically significant. In fact, on the basis of such data, the probability of a sign being understood by a public can be actually expressed in percentages".

The basis of this method would seem to have a certain common sense validity and may in fact work. Armed with data of this kind, a designer may be in a position to PREDICT RECEIVER response. There is, however, a serious gap in the logic of this method. The data is essentially the attempts of non-designers to design signs. We do not know for certain whether the signs so produced would convey the same meaning to others in the same group.

In a loose sense this is 'design by democracy' but there is no guarantee that majority decisions are necessarily the right decisions. The only way to establish this would be to test the particular sign derived in this way against an audience. The hypothesis would be that if a given percentage of a population depict a sign for a concept with a particular pictorial representation then when presented with the pictorial representation, that same percentage will 'understand' the concept.

If we can establish the generality of the above hypothesis, then the 'method of production' would be a valuable way of providing KNOWLEDGE OF RESULTS as an influence on the design process.

5.2.5 The achievement of Ulm is considerable in the world of sign design. It is a very real attempt to bring sign design out into the open and give it theoretical as well as empirical content. In general, one could say that it is over-preoccupied with syntactic and semantic, at the expense of pragmatic considerations. In relation to design methods, at a superficial level it would seem to be a view of designing as a self organising system (1.3.7). However, terms such as 'distil', the lack of information in the second method on how the design was selected, and the absence of any discussion in the final method as to how a designer 'distills' the most frequent pictorial representation, suggest a certain 'black box' approach. The most important question of all is left unanswered, i.e., if we use these methods, will the result be a more 'SUCCESSFUL' design?

5.3 Induced Creativity in Design

5.3.1 The black box methods such as synectics, brainstorming and lateral thinking have been used widely in problem solving situations, particularly in management. Their use in design is discussed by Jones (1970). Of particular interest to this enquiry is the adaptation of this approach to visual symbol design by Bedno (1972). He starts from the assumption that ".....most designers tend to follow a more or less similar procedure without either knowing or being able to describe it". This vague assumption is followed by another of no greater precision. "Many studies of the creative act recognise that it usually, or often, involves the steps of problem definition, analysis, generation, synthesis, development, refinement and presentation". On the basis of the above he developed a ".....structured procedure to guide the user through these steps". The procedure involves an initial amplification in verbal terms of the function of the symbol. At no point is the designer asked to consider whether a symbol is or is not the most appropriate end result. A checklist of concepts related to the function of the symbol is developed in two ways, firstly, by using words which relate to the concept which the symbol represents, and secondly, by drawing up a list of suitable visual images related to the concept. From there, twelve are selected on the basis of 'personal appeal'. Using a six by six matrix these are then cast into thirty-six possibilities by considering all the possible paired combinations. Out of these, twelve are selected and each is ".....drawn as a single, unified visual image". From these, one is selected for development and refinement. The reason for choosing thirty-six, then twelve, and then one is not made clear and it would seem that the decision is an

arbitrary one. As with the Ulm methods, we are shown the development of symbols and asked to accept their effectiveness as a self-evident truth.

5.3.2 The proof of the pudding would seem to be in the eating. Bedno regards the application of this method as a test of its effectiveness. As he says: "To test this procedure, I assigned a problem to two classes of sixteen students each..... All students were given the same procedure to follow..... The end result should be a simple, clear visual symbol representing the institution". He concludes with the following remarks: "Obviously theory and practice do not always coincide, but the examples shown do indicate a high level of performance considering the absence of an instructor, the unfamiliarity of the subject, and the small amount of time available. Some of these symbols are at about the same level as similar projects previously given that occupied weeks of effort". These subjective judgements are not related to any objective criteria of effectiveness. As the OBJECTIVES were at no point put in OPERATIONAL terms, this is to be expected. The most interesting aspect of this paper is highlighted by Bedno when he says: "Having designed symbols professionally, it is possible for me to work 'backwards' from a goal to a set of procedures that will most likely lead up to the goal". This contains a most interesting statement of the relation between PREDICTION and EXPERIENCE. Can this method, if we can isolate its essential features, be used to short circuit a process of learning by the designer which has obviously taken place over a considerable period of time? The answer to this must await more controlled research. On two counts, a certain degree of scepticism is appropriate. Firstly, there is no evidence to suggest that the methods of 'involved creativity' are more

productive in terms of ideas than unstructured methods. A comparative study by Taylor, (1953) revealed no differences in the output of productive ideas between groups using synectic procedures and those using no established procedure at all. Secondly, the method as Bedno describes it involves the user in making a large number of subjective judgements about the selection and rejection of verbal or visual concepts. Experience is bound to influence this process and the design student may behave differently to a professional designer.

5.3.3 This approach to design problems has been heavily criticised elsewhere (1.3.2). The usefulness of heuristics of any sort in this area is justified more on the basis of an appeal to elaborated common sense rather than empirical proof. It would be possible to subject it to such proof using the framework we have developed in this study. It would involve studying the relationship between methods of ENCODING and SUCCESSFUL PREDICTION. One aspect of the above method which would seem to place limitations on its use is that it favours those situations in which a single symbol rather than a family of symbols is required. Further, the matrix only allows the amalgamation of two concepts at any one time. This implies a particular visual syntactics which may not be justified.

5.4 An Approach from Ergonomics

5.4.1 Not all those involved in symbol design regard the activity as necessarily stemming from a visually based expertise. Easterby (1970) proposes a method based on the application of findings from fundamental research to design problems. It contains the assumption that KNOWLEDGE OF RESULTS makes

PREDICTION easier. As he suggests: "An intuitive design approach guesses at a good symbol while an experimental approach, which is advocated here, attempts to define a symbol stereotype and then, further, to validate this stereotype by experiment". The first assumption that we can question here is Easterby's use of the term 'intuitive'. It is not clear what he means by this except in a very loose sense to suggest an absence of any reasoning or systematic procedure. Perhaps he is contrasting 'black box' and 'glass box' methods. Further, he implies that an 'experimental approach' is better than an intuitive approach. After a symbol has been designed, an experimental attempt to validate its effectiveness is certainly desirable, but of critical significance is the process by which the 'stereotype' is evolved. In this respect Easterby claims that: "There is, for example, a basic meaning associated with a particular shape....". This assumption which is prevalent throughout the methods we have discussed, but referred to differently by different authors, is supported partially by some findings, as we have already discussed. The outstanding question is how good a 'guess' can a designer make and given that, how can we improve his guess. Easterby cites a study by Krash and Mudd (1962) in which subjects assigned meanings to a group of symbols using only prior experience and the relative success in doing so was used as a basis for modifying the symbols. This is only indicative of the fact that the original 'guess' was partially successful and we must ask, how, from an infinity of forms, did the designer select the original symbols to test?

5.4.2 The next assumption of the method is: "The more we can match the characteristics of the visual image to the idealised process of discrimination and perception, the more rapidly and

unambiguously will the symbol be perceived". The 'idealised process' is based on the conclusions of Gestalt Psychology and a number of principles such as unity, simplicity, symmetry, all of which require subjective evaluation. Easterby does not take account of more recent work on Pattern Recognition and Information Theory. We are thus back to 'guessing', or in our own terminology, trying to PREDICT.

5.4.3 The over-riding value of Easterby's approach is that it does not assume that the procedure is foolproof and relies finally on empirical validation. This is in sharp contrast to all the other methods reviewed.

5.5 Conclusions

5.5.1 Two conclusions emerge from the methods reviewed. They all indicate that we need to know a greater amount about design behaviour, before we are in a position to discuss design methods.

5.5.2 They all raise a large question about the relationship between form and meaning. This must form the subject of a great deal of further enquiry.

5.5.3 It has been possible to show that the framework developed in this study can be usefully and critically applied to design methods.

CHAPTER VI

Conclusion

It remains for us now to look back at what has been achieved and point towards future avenues of enquiry. Possibilities abound and it would take a great deal of space to do full justice to the potential for future research. Accordingly, I will limit myself to a summary of the main areas and those aspects which are most important or which I find most interesting.

6.1 The Framework for Design Research

6.1.1 The framework which we developed in the first three chapters and applied in Chapters IV and V was shown to have a wide area of application. This can be its only ultimate justification. It is a framework around which a systematic body of knowledge about design behaviour can be developed. It is not a theory of design behaviour. This should develop as more research is conducted.

6.1.2 One of the most important issues to emerge from design methods is the problem of complexity. How much complexity can a designer cope with? By using the number of scales on a S.D. test as the variable, it should be possible to shed some light on this vexing issue.

6.1.3 So far we have only used the behavioural manifestations of denotative and connotative meaning as OBJECTIVES. These are extremely important aspects of communication design and they, to some extent, form the core of any encoding of messages. There are however, other important objectives which could be similarly

treated, for example, legibility. Can a designer estimate the distance at which an image would be legible? How accurate is his estimate? The limiting factor here will always be the extent to which OBJECTIVES can be translated into BEHAVIOURAL terms. However, even allowing for that the scope is considerable.

6.1.4 The concept of 'SOCIAL DISTANCE', would seem to be an important issue. The difference from one audience to another is bound to affect responses to communication. This in turn will influence the very subtle relationship between designer and audience, about which we know very little. There are many questions one would wish to ask. For example, how much and what quality of information does a designer need to know about an audience?

6.1.5 The designer offers the most challenging focus of research in this study. So far we have not considered any psychological variables in the designer which may affect the process. The pioneer work of Simon and Newell (1972) in using protocols in studying problem solving behaviour could yield a rich source of information. Eastman's study which we criticised in Chapter I used this method in studying design behaviour and despite the lack of resolution in their approach, their use of protocols can be seen to be applicable to design behaviour.

There is a possibility that variables of personality and ability will play a role in whether any individual will make a successful designer. It would be possible in a future study to try and correlate personality and aptitude tests with levels of performance at design tasks.

We have already suggested that the role of experience may be important. In this study we have not looked at professional

designers except in Chapter V. We need in a future study to look at a fully grown member of the species, as it were.

6.2 The Development of Design Ability

6.2.1

At the opposite end of the scale to the professional designer is the infant scribbling. Where does the ability to become a visual communicator begin and can we help this ability to develop? The Schools Council in 1972 held a conference on the subject. The term used was 'GRAPHICACY', which was coined by Balchin and Coleman (1965) and defined by them as ".....the educated counterpart of the inherent visual-spatial ability that we all possess and was thought of as being analogous to literacy, numeracy and articulacy as a means of communication". Unfortunately, the conference did not achieve its objective in persuading the Governing Body of the Schools Council to support research in the area but it did succeed in persuading those who attended that a real problem existed. Research into children's art has been conducted for many years, notably the work of Kellog (1969). However, all studies start from the art objects and work backwards to intention and forward to meaning. The framework used here begins with intention and takes it through from there. In this respect the approach to studying children's developing ability is firmly rooted to a purpose. This is an area with fascinating possibilities which could be pursued at some length and depth.

The importance of this research cannot be over-stated. Our means of communication in society are becoming more visual. The child, whether he becomes a designer or not, is faced with an increasing need to express ideas in visual form. The use of charts, graphs and diagrams are all aspects of this. Further, the child is bombarded with visual material in books, magazines, films and

television. He has very little guidance in evaluating these. Our culture has a strong literary tradition and as a matter of course children are taught to evaluate what they read but they are seldom taught how to evaluate a picture or a television programme. Thus there is a need for us to conduct research in this area and understand how we can develop the visual ability of a child.

6.2.2 Of more immediate relevance to my own occupation is the development of ability in design students. We have seen from the experiments that communication is a difficult skill which requires experience to develop. We have also shown that knowledge of results, as we have used the term, positively influences the ability. This in itself is a significant finding in terms of design education. In many schools, the students' work is regarded as finished when the art work is complete. Little attempt is made to evaluate the effectiveness of the work in terms of communication. We can see this as implicit in the Ulm approach and that suggested by Bedno. Not only is this inconclusive in a large sense but it denies the student a valuable experience in the development of his ability.

There are many aspects of design education which would benefit from further research. The present study only scratches the surface but it does demonstrate the feasibility of such research.

6.3 Meaning and Shape

6.3.1 A recurrent issue throughout this study has been the implied relationship between the form of a symbol and its meaning. This is particularly in evidence in Chapter II and V. We have

discussed at length the possible causes of this either in terms of biological determinants or cultural stereotypes. To look at this in depth we need to cast our net much wider and draw from knowledge and concepts in related fields particularly linguistics and pattern recognition. If a definite relationship can be demonstrated to exist, then this can provide valuable information for designers.

6.3.2 A possible avenue into this would be to try and look more directly at the way in which the visual system collects its information. By studying eye movements in relation to meaning valuable insight may be gained. If a relationship exists we might postulate that a designer may guide eye movements by the use of visual forms and thereby influence meaning. Further the onset of 'set' which was apparent in pilot study II and which influenced the designer's ability may be related to the scanning pattern employed by the designer.

6.3.3 Another aspect of the use of eye movements in design research is that it widens the scope of design theory to encompass aspects of information processing which are central to communication.

6.4 Visual Images and Explanation

6.4.1 I would like to end on a purely speculative note which has much wider implications than anything we have so far considered. In Chapter II we were confronted with the problem of explaining 'Process' (2.2.8). Scientific theory is always limited by the tools at its disposal but these tools are not only the hardware which technology makes available, they are also the mathematical, linguistic and pictorial modes we use in analysis and by way of models.

6.4.2 One of the most powerful models available to science is mathematics and yet mathematics is limited in a very simple and direct way which is often unnoticed. Mathematicians also use tools: paper, pencil, slide rule, computers. These tools in turn limit the scope of mathematics. Progress in mathematics has as much to do with the development of these tools as the individual ability of mathematicians. Developments in the tools available will inevitably pave the way for richer and more comprehensive models.

6.4.3 It occurred to me while struggling through the pages of 'Principia Mathematica', that a large part of the difficulty was typographical. In the opening chapter Whitehead and Russell spell out their elaborate notation system which is complicated by the fact that they could only represent concepts by using type which was available to a printer. By the time one gets to the second chapter, one has forgotten the notation and one has to return again and again to the beginning before the body of the text makes sense. It is sad that our appreciation of a work should be inhibited by lumps of metal and one is tempted to ask what ideas Russell and Whitehead may have given us if they were not so confined.

6.4.4 Fortunately, our present reprographic technology is much more advanced. The scope of our tools is considerable. However, mathematicians do not have a visual education and are therefore not in a position to evaluate the full potential of these new tools. The art student has such a background but he lacks an understanding of mathematics. I have begun in a small way to look at this area with a group of students with a visual education.

6.4.4 The above mentioned study is highly speculative. However, there can be little doubt that the framework developed in this thesis can be used as a basis for developing a theory of design behaviour and it is hoped that in its turn it will influence design education and practice for the better.

APPENDIX I

Definitions of Design

The definitions presented below are by no means a comprehensive list of those offered by design theorists and others, rather it is intended as a representative selection.

Oxford Dictionary

1. "A plan or scheme conceived in the mind and intended for subsequent execution, the preliminary conception of an idea that is to be carried into effect by action; a project".

2. Purpose, aim, intention.

3. The thing aimed at; the end in view; the final purpose.

4. Continuance in accordance with a preconceived plan; adaption of means to ends; pre-arranged purpose.

5. In a bad sense; crafty contrivance".

Alexander (1963)

"Finding the right physical components of a physical structure".

Archer (1965)

"A goal-directed problem solving activity".

Asimow (1962)

"Decision making in the face of uncertainty, with high penalties for error".

Booker (1964)

"Simulating what we want to make (or do) before we make (or do) it, as many times as may be necessary to feel confident in the final result".

Eder (1966)

"Engineering design is the use of scientific principles, technical information and imagination in the definition of a mechanical structure, machine or system to perform specified functions with the maximum economy and efficiency".

Farr (1966)

"The conditioning factor for those parts of the product which came into contact with people".

Gregory (1966)

"The design method is a way of solving certain classes of problems; relating product with situation to give satisfaction".

Jones (1966)

"The performing of a very complicated act of faith".

Jones (1970)

"The initiation of change in man-made things".

McCrory (1966)

"Design is considered as the process of applying the total spectrum of science and technology to the attainment of an end result which serves a valuable purpose".

Matchett (1968)

"The optimum solution to the sum of true needs of a particular set of circumstances".

Page (1966)

"The imaginative jump from present facts to future possibilities".

Reswick (1965)

"A creative activity - it involves bringing into being something new and useful that has not existed previously".

APPENDIX II

Instructions Used in Pilot Study 1

The purpose of this study is to measure the meanings of certain symbols to various people by having them judge them against a series of description scales. In taking this test, please make your judgements on the basis of what these symbols mean to you. On each page of this booklet you will find a different symbol to be judged and beneath it a set of scales. You are to rate the symbol on each of these scales in order.

Here is how you are to use these scales:-

If you feel that the concept at the top of the page is very clearly related to one end of the scale, you should place your cross-mark as follows:-

fair : X : ___ : ___ : ___ : ___ : ___ : unfair

or

fair : ___ : ___ : ___ : ___ : ___ : ___ : X : unfair

If you feel that the concept is quite clearly related to one or the other end of the scale (but not extremely), you should place your cross-mark as follows:-

strong : ___ : X : ___ : ___ : ___ : ___ : ___ : weak

or

strong : ___ : ___ : ___ : ___ : ___ : X : ___ : weak

If the symbol seems only slightly related to one side as opposed to the other side (but is not really neutral), then you should cross as follows:

active : ___ : ___ : X : ___ : ___ : ___ : ___ : passive

or

active : ___ : ___ : ___ : ___ : X : ___ : ___ : passive

The direction toward which you cross, of course, depends upon which of the two ends of the scale seem most characteristic of the symbol you're judging.

If you consider the symbol to be neutral on the scale, both sides of the scale equally associated with the symbol, or if the scale is completely irrelevant, unrelated to the symbol then you should place your cross-mark in the middle space:-

safe :___:___:___: X :___:___:___: dangerous

IMPORTANT: (1) Place your cross-marks in the middle of spaces, not on the boundaries:

:___:___:___: X :___:___:___:
THIS NOT THIS

(2) Be sure you cross every scale for every symbol do not omit any.

(3) Never put more than one cross-mark on a single scale.

Sometimes you may feel as though you've had the same item before on the test. This will not be the case, so do not look back and forth through the items. Do not try to remember how you chekced similar items earlier in the test. Make each item a separate and independent judgement. Work at a fairly high speed through this test. Do not worry or puzzle over individual items. It is your first impressions, the immediate 'feelings' about the items, that we want. On the other hand, please do not be careless, as we want your impressions.

MEAN RESULTS PILOT STUDY 1

	Newcastle	Sunderland	
hot	-1.1	-0.4	cold
pleasant	-0.3	-0.2	unpleasant
lush	+0.3	0.0	austere
vibrant	-0.7	-1.3	still
repetitive	+0.3	-2.1	varied
happy	+0.3	-0.4	sad
chaotic	+1.8	+1.5	ordered
smooth	-0.9	-0.2	rough
superficial	0.0	-0.3	profound
passive	+0.1	+0.9	active
blatant	-0.8	-1.1	muted
meaningless	+1.4	-0.9	meaningful
simple	-0.6	-0.3	complex
relaxed	+0.8	+1.1	tense
obvious	-0.4	-0.7	subtle
serious	-1.7	-0.3	humorous
violent	-1.1	-0.2	gentle
sweet	+0.8	+0.1	bitter
static	+0.4	+0.6	dynamic
clear	-2.0	-0.4	hazy
unique	-0.8	+0.7	commonplace
emotional	+0.1	+0.4	rational
thick	-0.3	+0.8	thin
ugly	-0.3	-0.6	beautiful
dull	+1.5	+0.2	sharp
sincere	-0.1	0.0	insincere

	Newcastle	Sunderland	
rich	-1.1	-0.1	poor
bad	+0.2	0.0	good
intimate	+0.6	+0.1	remote
masculine	-1.7	0.0	feminine
vague	+1.7	+0.3	precise
ferocious	-1.2	+0.1	peaceful
soft	+1.6	-0.3	hard
usual	+0.2	-0.6	unusual
controlled	-2.0	-1.8	accidental
wet	-0.2	-0.2	dry
strong	-2.3	-1.2	weak
stale	+0.3	-0.2	fresh
formal	-1.6	-0.6	informal
calming	+0.4	+0.4	exciting
full	-0.5	-1.3	empty

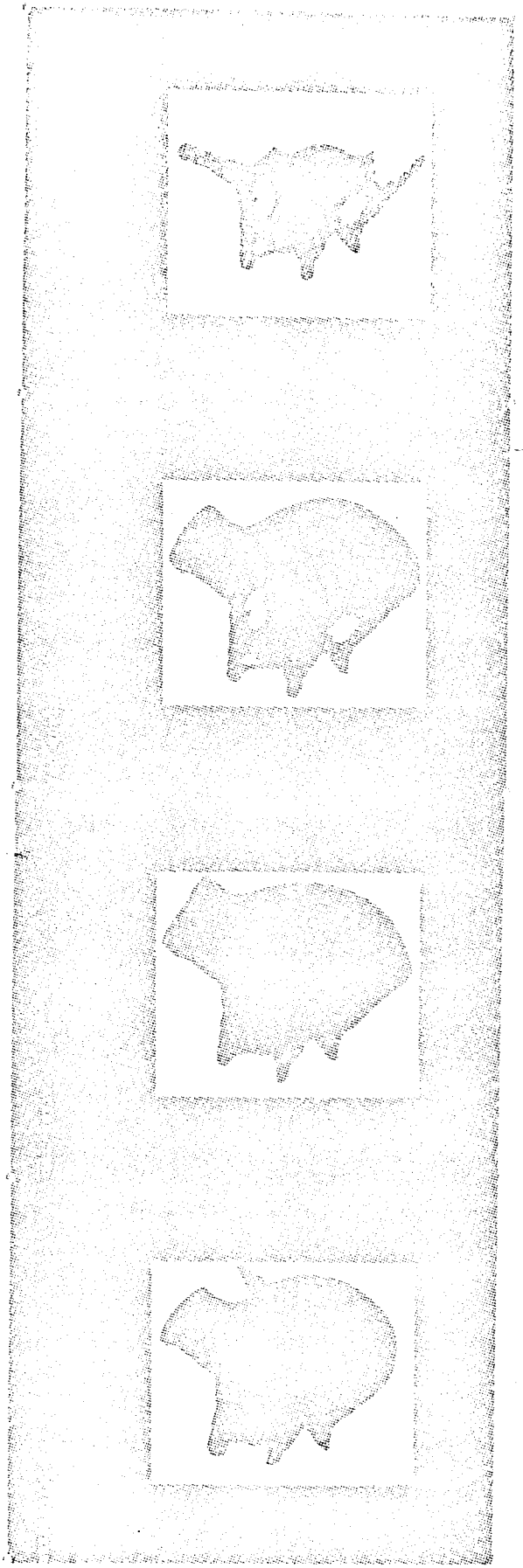
APPENDIX III

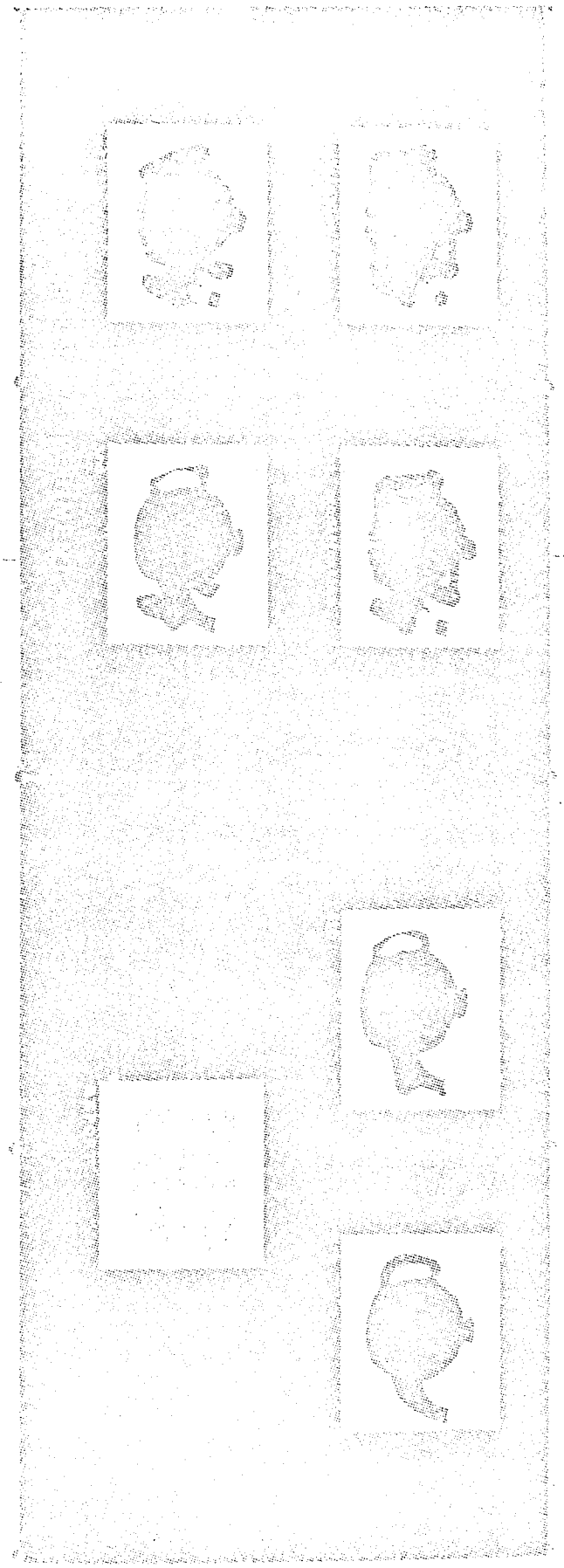
Results (Modes) Pilot Study 2

Differences between Observed and Predicted Modes

	Before	After Modification
Feminine/Masculine	0	0
Obvious/Subtle	0	1
Neat/Untidy	1	0
Clear/Hazy	1	0
Naive/Sophisticated	2	2
Commonplace/Rare	0	0
Soft/Hard	1	3
Usual/Unusual	0	0
Strong/Weak	1	0
Sharp/Dull	0	0
Controlled/Accidental	1	0
Good/Bad	2	1
Thin/Fat	1	0
Vibrant/Still	0	3
Appealing/Revolting	1	0
Pleasant/Unpleasant	1	0
Interesting/Boring	0	1
Ugly/Beautiful	1	1
Calming/Exciting	0	0
Ferocious/Peaceful	2	0
Happy/Sad	2	0
Sincere/Insincere	0	1
Meaningful/Meaningless	0	0
Wise/Foolish	0	0
Tense/Relaxed	1	0
Serious/Humorous	2	0

	Before	After Modification
Cold/Hot	1	1
Passive/Active	2	1
Precise/Vague	1	0
Remote/Intimate	2	0
Superficial/Profound	2	2
Small/Large	1	2
Robust/Delicate	2	0
Biased/Unbiased	2	2
Real/Imaginary	1	0
Modern/Oldfashioned	3	0
Smooth/Rough	3	0
Quiet/Loud	4	0
Simple/Complex	1	0
Informal/Formal	4	0





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