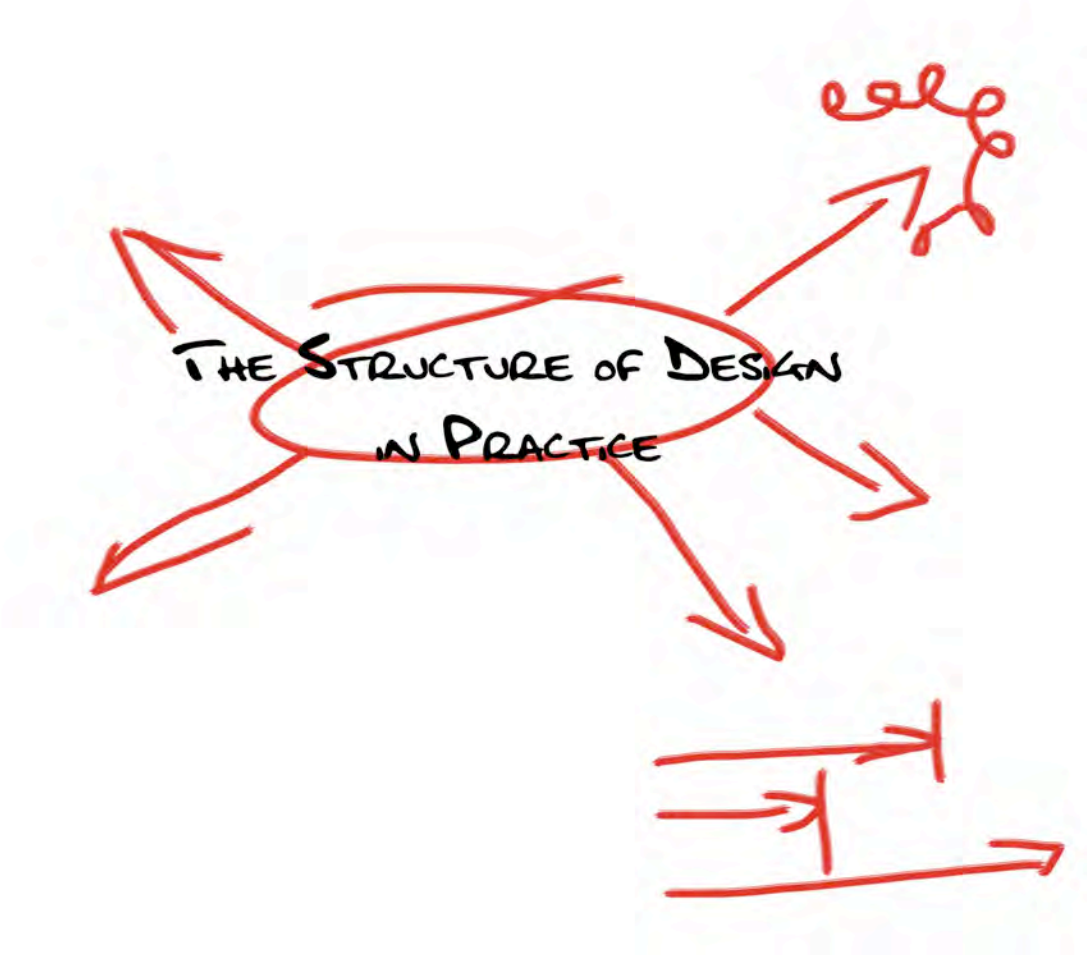

Robert Maslin
BA (Hons) Product Design

Submitted to the University of Hertfordshire in partial fulfilment of the requirements for the Degree of bachelor of Art (Honours)
Thursday 3rd February 2005

Abstract

In order to develop and evolve their own process designers need a model of the design process around which there is a high level of consensus and one that they can relate to. Understanding design in practice and knowing when and how to apply design methodology is a necessary precursor to improving individual design work. When we pose the question: "How does or, should design work in practice? " we access a debate, which has argued between the intuitive understanding of designers used to deal with problems, which are often for various reasons indefinable, and the more definable and controlled problems where various methodologies can in theory be rigorously applied. This debate finds it origins in the early decades of the 20th century and intensifies from the 1960s to 1990s in the form of comparisons between the polarities of the designer as creative artist and the designer as functionary of a scientifically driven industrial process. This essay focuses on a number of theorists central to the development of research on design.

Contents

Acknowledgements

I wish to acknowledge the assistance of Richard Barrett who discussed Schön ideas and introduced me to Empathic Design. Michael Biggs gave me valuable feedback after an earlier draft and Andrew Robinson, my dyslexia tutor, helped me with redrafting and editing. James Bassant gave me valuable insights into design practice in a real world situation.

Introduction

The discipline of design lies at the interface between art and science, where the designer is required to respond both logically and creatively. The result is that an element of subjective interpretation and an element of logical development The nature of design is that it is not as predictable as science but has a more practical application in society than art.

It is in the interest of the student and practitioner that they learn how to use design as a process. Students can no longer afford to learn static knowledge such as in the old craft model, that are only relevant to their present situation as they will probably be quickly outdated. Instead, designers must learn how to exploit the changes in culture and advances in technology.

There have been many attempts to construct a definition of design as a discipline and as a professional practice and many of these have involved the production of visual representations or maps of the design process. This essay explores some of these attempts and examines their limitations as seen by theorists and by practitioners.

In the period after the second world war there were several attempts to present design as essentially a scientific discipline with similar aspirations to technical and mathematical rigour. I look at some of these attempts and how Donald Schön developed a rationale for design practice which did not have to rely on the procedures of science but did have its own rigour.

I examine and critique Nigel Cross' ideas which point out how in practice designers do not follow design theories in the sense that they generate test and examine many possibilities but rather they develop intuitive understandings of the problem and pursue a single solution which they have focussed on early on in the process. I contrast this a wider view of design practice as developed by consultancies like IDEO.

Chapter 1: Attempts to define design as a process

The attempt to define and formulate design and design strategies goes back at least to the beginnings of Modernism with the work of De Stijl and Le Corbusier. For a number of reasons the 1960s an increase in the publication of systematic attempts by design theorists to describe and document the varied process of designers. Christopher Jones, a pioneer in the design methods movements of this era states that:

> A common feature of both the criticisms of traditional methods and the proposals for new ones is the attempt to isolate the essence of design, to write it down as a standard method, or recipe that can be relied upon in all situations.[1]

He goes on to list examples of these descriptions of design approaches but he also claims that none of the attempts to describe and define the work of designers share an underlying definitive process.[2] He asserts that the attempts to make a definitive description of the design process only tend to work in the context of particular disciplines. For example, one view of design stated in his *Seeds of Human Future is* "'the optimum solution to the true needs of a particular set of circumstances.' (Matchett, 1968)"[3]. This view was later revisited by Lawson more recently and supports Jones' writing on the subject:

> Matchett's use of 'optimum' indicates that the results of design as he knows it can be measured against established criteria of success. This may well be the case for the design of a machine where the output can be quantified on one or more scales of measurement but it hardly applies to the design of a stage set or building interior.[4]

Many designers and academics, particularly from the 1960's to the present day, have tried to map the design process. These were attempts to produce systems that could repeat innovation and success consistently. They endeavour to rationalise, understand

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[1] Jones C. J., *Design Methods Seeds Of Human Futures*: London *Council of Industrial Design*, 1970 re-issued in 1981, p. 3
[2] Ibid., p. 4
[3] Ibid.
[4] Lawson, B., *How Designers Think: The Design Process Demystified*, London: Architectural Press LTD, revised 1997 p. 30

and explain what designers know intuitively, but also to reduce the risks in design as the financial penalties for error become higher in business and manufacturing. Many of the earliest maps attempted to organise design into a linear process. The view that it is not practical to see design in this way, especially in real life design situations, is exemplified by Lawson's critique of the Markus/Maver map of design below.

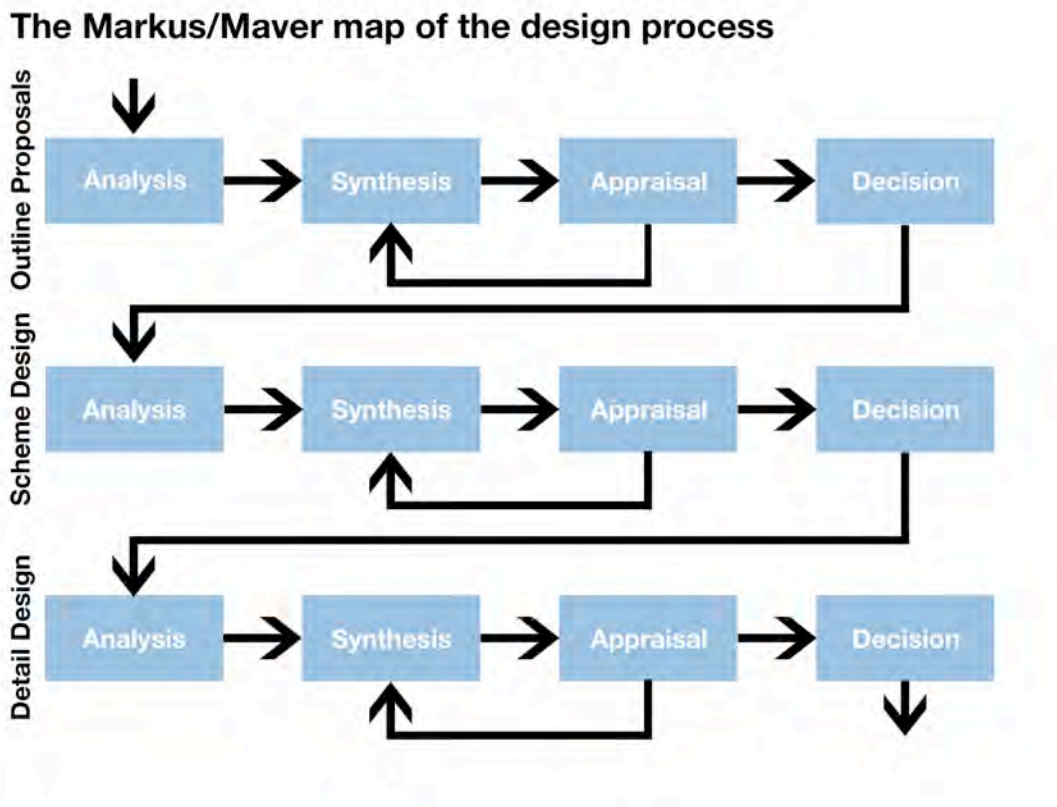

Figure 1. Markus/Maver map of the design process, critiqued by Lawson.

The map looks logical in theory. It starts with researching the issues outlined by the brief, setting the problems and objectives to be achieved by the final solution. It then goes from the general relationship of design elements, mapping out the design on a global level of detail. It then fills in the spaces with detail design. According to Lawson, this map does not have the flexibility required to reframe the brief[5] and overall concept if problems appear further into the process. This means that negotiation needed for interrelation between elements as they change over the course of the project is almost impossible. He also argues that some of the most successful designers use what is not conventionally considered part of the concept stage, as the

[5] Lawson, B., *How Designers Think: The Design Process Demystified*, London: Architectural Press LTD, revised 1997 p. 36

primary driver for the design, in this case he quotes the highly respected architect Eva Jirnica:

> In our office we usually start with full-size detail…if we have for example, some ideas of what we are going to create with different junctions, then we can create a layout which would be good because certain materials only join in a certain way comfortably.[6]

Jirnica's statement supports the idea that, not only are design maps subject to interpretation of meaning, but also that design is highly complex and works in ways that cannot be confidently and comprehensively imagined.

The last design model I have chosen to show is *Lawson's*'. In his book, *How Designers Think* he reviews a number of design maps and concludes that there is no logical linear way through the design process.

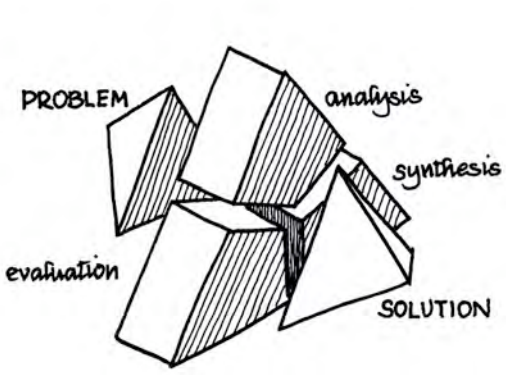

Figure 2. The design process seen as a negotiation between problem and solution through three activities of analysis, synthesis and evaluation.

We can see that in this map all the activities have an equal relationship to both the problem and solution. Lawson's conclusion, after analysing many design maps, was that although in practice the activities of analysis, synthesis and evaluation are usually seen as constituent parts of a systematic design process, they are in fact almost inseparable and often relate and influence each other, the brief and solution in unforeseen ways. The biggest problem with the map is that it has limited value.

[6] Lawson, B., *How Designers Think: The Design Process Demystified*, London: Architectural Press LTD, revised 1997 p. 36

Lawson himself described it as being too vague and unstructured to help understand how design is actually practised. However the model does have one noteworthy feature. As Lawson says, 'the design process can be seen as a negotiation between problem and solution through the three activities, analysis synthesis and evaluation'[7]. It may be that previous models of design have identified and separated the wrong elements in design development structure.

There are many more design maps and processes many of which are very similar. However, I know of no generic maps that are no universally accepted by designers, who should obviously be the main judges about what they do. It seems that in practice the best designers do not use design maps to tell them where they are in the process and where they may go next. Instead, Schön argued that it is rather a matter of the designers' judgement and ability to improvise learnt in practice that is more valuable than the procedures and static information learnt in some models of education. This led Schön to argue that the education of reflective practices should simulate professional situations, aiming to prepare designers with the skills that can be applied to real situations:

> Knowing-in-practice is exercised in the institutional settings particular to the profession, organised in terms of its characteristic units of activity and its familiar types of practice situations, and constrained or facilitated by its common body of professional knowledge and its appreciative system.[8]

An example of how professionals come understand their practice came to light when James Bassant, the head of Astro Lighting, was asked what his personal view of the design process was. Bassant replied to the effect that he had not previously thought about trying to apply logic to the design process, so out of the two design processes that I showed him it is understandable that he could most relate Lawson's and felt the IDEO's model (Figure 3.) was too linear:

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[7] Lawson, B., *How Designers Think: The Design Process Demystified*, London: Architectural Press LTD, revised 1997 p 47

[8] Schön, D., *Educating The Reflective Practitioner: Toward a New Design for Teaching and learning in the Professions*, California: Jossey-Bass, 1987 p. 33

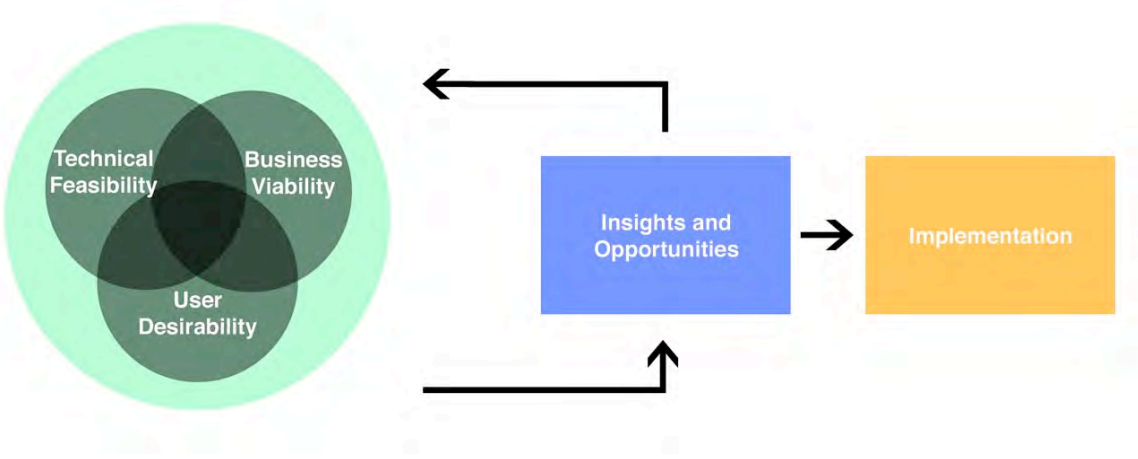

Figure 3. IDEOs' model of design found on their website.

> It would be nice to be like this and aspire to have a nice linear process where everything happens in sequence. The time to market is really being squeezed. The client says 'I like that product and want it on the shops on in four months.' When it exists only in a computer how do you get it prototyped and engineered bearing mind that two months are for shipping.[9]

Bassant's knowledge of design methodology may be considered by some as over simplistic, as Astro employ only a very basic form of brainstorming to facilitate thinking and communication. Nevertheless, because of Astros' small size and niche market they do not require the sophisticated techniques that might be used by multidisciplinary design companies that have large design teams doing a wide range of products and styles which might be considered radically innovative. Instead Astro have a small product range, which is very coherently stylised. In such niche markets it is more important for individuals to develop the right understanding of their discipline, as the solutions are often quite simple and follow the style of the consultancy.

Although only a small company, Astro Lighting are very successful business, designing lights for Habitat and Heals, among other design outlets, so how they go about development deserves to be considered seriously as a design 'process'. However because the small range of products they design and of their somewhat formulaic style (Figure 3.) they limit themselves to incremental innovation, not deviating from the overall design approach or style.

[9] Maslin, R., *Interview with Head of Astro, James Bassant*, Harlow: 2004

Figure 4. A sample of Astro Lighting's 2004-05 product range.

Like many designers, Bassant did not put into words what he knows about his design methods. His design development is dominated by what he knows intuitively and he makes decisions based on what he has learned in practice.

Chapter 2: Design culture has its own rigour

To explain why design is a non-linear or reflective process it is best to try to understand how the design practices has evolved from craft discipline. When discussing the relationship between a design discipline which uses drawings and craft processes which Jones argues the discipline evolved from, he suggests that there are two ways of developing solutions

> The essential difference between this, (design using drawings) the normal method of evolving the shapes of machine-made-things, and the earlier method of craft evolution, is that trial-and-error is separated from production by using scale drawing in place of the product as a medium for experiment and change.[10]

Despite both design and craft share the characteristic that each move or adjustment to the design results in number of unintended consequences, causing the need to re-appraise the situation, it is harder to do this in design. This is because the evolution of design concepts are disconnected from the real world situation they are designed for, because of the division of labour used in manufacture. Subsequently is harder to identify the problems that are present, as the new design often only exist in the designer's universe.

Craft based production is typically not capital intensive. Mass production, on the other hand is highly capital intensive and although the design process required is more efficient the costs of mistakes is correspondingly greater. Jones implies that in order to cope with the expectations and responsibilities put on designers by society they need to be educated in design disciplines:

> The up shot of all this is to take away much of the intellectual difficulty and fun from manufacture and give them to a new class of persons who make the drawings. Designing comes into being.[11]

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[10] Jones C. J., *Design Methods Seeds Of Human Futures*: London *Council of Industrial Design*, 1970 re-issued in 1981, p 20
[11] Ibid., p 22

Once design came into being as a discipline, it became desirable to be able to break, the processes down in their constituent parts and create procedures, which would ensure efficient repeatability. Therefore, it was logical to look at science as a model that was accredited and already established. Jones, in mapping the development of this tendency makes reference to the 'design methods movement' and points out that the 1960's were characterised as the 'design science decade'. However, these developments caused much controversy as they undermined the credibility of the proficiencies of the practitioner who used a type of rigour, which Schön was later to characterise as 'reflective practice'

According to Schön, the catalyst for seeing design as a linear or logical activity comes from what he described as a *crisis of confidence in professional knowledge*[12] originating in the 1960s. This view shared by Jones as indicated earlier. This crisis of confidence essentially questioned whether professional knowledge was adequate to fulfil the espoused purposes of the professions? Was it sufficient to meet the societal demands, which the professions have helped create?'[13]. Even today, designers face a level of respect in the popular press which *Design Week* recently described as being 'scant at best sneering and stereotyping at worst'[14] Schön argued that back in the sixties and seventies this crisis in confidence caused a reassessment of the professions on whom society had become increasingly reliant, as people become less self-sufficient, leading to the aim of developing a new stable and rigorous model of scholarship, which would make professionals more reliable. This led to an increasing reliance on the notion of technical rationality as a guarantor of professional competence. Schön directly challenged this paradigm, in *Reflective Practitioner*. He states that:

> Technical rationality is the positivist epistemology of practice. It became institutionalised in the modern university, founded in the late nineteenth century when positivism was at its height, and in the professional schools, which secured their place in the university in the early decades of the twentieth century.[15]

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[12] Schön, D. A., *The Reflective Practitioner: How Professionals think in action,* London: Ashgate publishing, 1983 p 3-21
[13] Ibid., p. 13
[14] Davis, J., 'Build a Sustainable Future' *Design Week*, volume 19, December 16, 2004, p.12
[15] Schön, D. A., *The Reflective Practitioner: How Professionals think in action,* London: Ashgate publishing, 1983 p. 31

It was also argued that design, lacking a long tradition as a discrete field of intellectual endeavour, could profitably draw on the traditions and procedures of other disciplines. It was widely accepted that design required skills used in a number of professions and is as described by Jones as a hybrid activity[16]; a combination of maths, art and science where the design is 'unlikely to succeed if it is exclusively identified with any one'[17]. For example costing is one domain that would require a good understanding of mathematics and would have an impact on 'construction technology', which in turn requires an understanding of science. Both science and mathematics would impinge of the aesthetic possibilities of a building.

The point of view that design could be divided into a set of procedures that used a combination of these disciplines and retained the discrete characteristics of the constituent disciplines became very influential at the at the height of the 'Methods Movement, but became less convincing, particularly when abandoned by some of its adherents, including Jones himself.

Cross, who is one of the central contemporary figures in design theory, acknowledges that design involves problems that do have the characteristics of these other disciplines. But he feels that in design practice they are inseparable, and that it is precisely the fact that a number of different disciplinary elements which have to be manipulated and combined which gives design its own distinct culture. He recently proposed that design should seek to create what he calls an 'interdisciplinary discipline'[18].

> This does not mean that we completely ignore other cultures. On the contrary, they have much stronger histories of enquiry, scholarship and research than we have in design. We need to draw upon those histories and traditions where appropriate, whilst building our own intellectual culture, acceptable and defensible in the world on its own terms.[19]

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[16] Jones C. J., *Design Methods Seeds Of Human Futures*: London *Council of Industrial Design*, 1970 re-issued in 1981, p 10
[17] Ibid.
[18] Cross, N., *Design as a Discipline* the inter-disciplinary design quandary' conference; De Montford University, 2002 p. 3
[19] Cross, N., *Designerly ways of knowing: design discipline versus design science,* Department of Industrial Design, Politecnico di Milano, Milano: Design (plus) research proceedings, 18-20th May, p. 46

One of Cross's primary influences in coming to this argument for design having its own distinct culture, which is essentially interdisciplinary, was the work of Donald Schön. Schön not only aimed to find the fundamental principles that underlies all design, but also made comparisons with all practitioners from a wide range of disciplines. He argued that practitioners use experiments controlled by a certain type of rigour which he called 'reflection in action', in order to solve the problems posed by their profession, which are typically 'indefinable' and need to be understood and shaped or changed in order to be solved. He separated and defined the types of experimenting used in design by contrasting them with the well-recognized type of rigour exercised in classic scientific method.

Schön notes that the scientist uses only two types of experiment, whereas he observed three types of experiment used by the reflective practitioners. 'In the most generic sense, to experiment is to act in order to see what the action leads to. The fundamental questions is "what if?"'[20].

The key to differentiating the type of experiments used involves looking at the variations in the nature of problems faced and the conditions in which they are to be solved. Any solution arrived at is only meaningful in relation to the way the experiment has been framed. The basis of the scientific method is the notion of *hypothesis testing*:

> The method of experimental hypothesis testing follows a process of elimination, the experimenter tries to produce conditions that disconfirm each of the competing hypotheses, by showing that each of the conditions that would follow from each hypothesis are not the ones observed ones.[21]

In order to refute or confirm a hypothesis with assurance, a set of conditions must be put in place to make sure it is a fair test. For this reason it is vital that there is control of the recognized variable elements that are put forward in each hypothesis, so each elements effect can be measured individually. The scientist must exercise absolute control over the situation created, meaning that 'he must also be able to isolate the

[20] Schön, D. A., *The Reflective Practitioner: How Professionals think in action,* London: Ashgate publishing, 1983 p. 145
[21] Ibid., p. 143

experimental situation from confounding changes in the environment'[22] so that they do not have an unintended influence on the experiments. This means that such experiments often need to be done in artificial environments. However the hypothesis that comes out as being the most successful must be confirmed tentatively as a new variable element may make a new hypothesis may be more successful still.[23]

Criteria by which the solutions are judged need to be clearly defined so that their success can be measured as accurately as possible, which could be otherwise be recorded inaccurately due to subjective interpretation:

> In association with this model of controlled experiment there is also a requirement for a particular kind of stance toward inquiry. The experimenter is expected to adhere to the norms of control objectivity and distance. By controlling the experimental process, he is to achieve objectivity, seeing to it that other inquirers who employ the same results. And to this end, he is expected to preserve his distance from experimental phenomena keeping his bias and interests from affecting the object of the study.[24]

The other two are what he called *exploratory experimenting*[25] where moves are made with no preconceptions of what the consequences will be as the designer moves purely to understand instead of control the situation. Both practitioners and scientists use this type of experiment at the earliest stages although its use is not always stated:

> 'Exploratory experiment is essential to the sort of experiment that does not appear in scientific journals, because it has been screened out of the scientists' account of the experimental results.'[26]

The type of experimenting, which Schön argues is unique to reflective practitioners, is what he called *move testing*. This experiment is a move to make intended changes, but also to see what happens, as unintended consequences are produced and form part of the outcome[27]. Otherwise there would be no need to try to gain an understanding and control of the situation as the designer could move straight into calculating the

[22] Schön, D. A., *The Reflective Practitioner: How Professionals think in action,* London: Ashgate publishing, 1983 p. 143
[23] Ibid.
[24] Ibid., p. 144
[25] Ibid., p. 145
[26] Ibid.
[27] Ibid., p. 146

solution in the same way that a mathematician solves equation when he has a defined problem. In the context of design, *move testing* is evolving a single design concept through iterations, as the designer moves, he evaluates the consequences and makes further moves which are intended to improve the design.

In reflective practice the situation's 'talk-back' is not always clearly defined and it is important that the data is not made to conform giving false results. 'His primary interest is in changing the situation but if he ignores its resistance to change, he falls into mere self-fulfilling prophecy.'[28] The cause of this is that design, as the evolution of a concept, is separated from its manufacture, meaning that it is harder to base the situation in the context of reality.

Instead of identifying reflective practice primarily with any one-type experiment Schön claims that reflective practitioners use all of the three experiment types at as a way of fully exploring a unique situation in order to change it at the same time. "The three functions are fulfilled by the very same actions. And from this fact follows the distinctive character of experimenting in practice."[29] Thus design is not characterised by the hypothesis testing used in science, as the problems are open ended and the conditions needed to regulate and control the experiments, in order to measure the outcomes, are not subject to the realistic restriction of parameters. The real situation, that is the finished product in the real world, cannot be feasibly be experimented with.

For this reason designers have developed a number of ways in which to carry out experiments where the designer can control the variable elements and experiment rigorously, as close to reality as possible. The 'universes' created by the designer are re-interpretations of the real situation concerning the aspects that the designer wishes to experiment with although in some cases they are only extensions of his imagination. These universes or domains include drawing, prototyping, and other ways of experimenting with situations and provoking new ideas some of which can be seen below.

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[28] Schön, D. A., *The Reflective Practitioner: How Professionals think in action,* London: Ashgate publishing, 1983 p. 153
[29] Ibid., p. 147

This crude prototyping medium helped IDEO to communicate and explore ideas with its client. It is very rough but does not need to be any more sophisticated at this stage exploration. This activity is more concerned with generating many ideas in a short time.

Figure 5. Initial Prototyping helped design precision medical instruments

IDEO method cards were developed as a list of 51 methods through various mediums to explore and develop situations. These techniques are still being added to as IDEO improvise more methods through which to explore situations.

Far Left: Word-Concept Association (Method) 'WHY: clustering users' perceptions helps to evaluate and prioritize design features and concepts.' Left: Body Storming (Method) 'WHY: this method helps to quickly generate and test many context- and behaviour based concepts.'

Figure 6. Examples of IDEO Method Cards

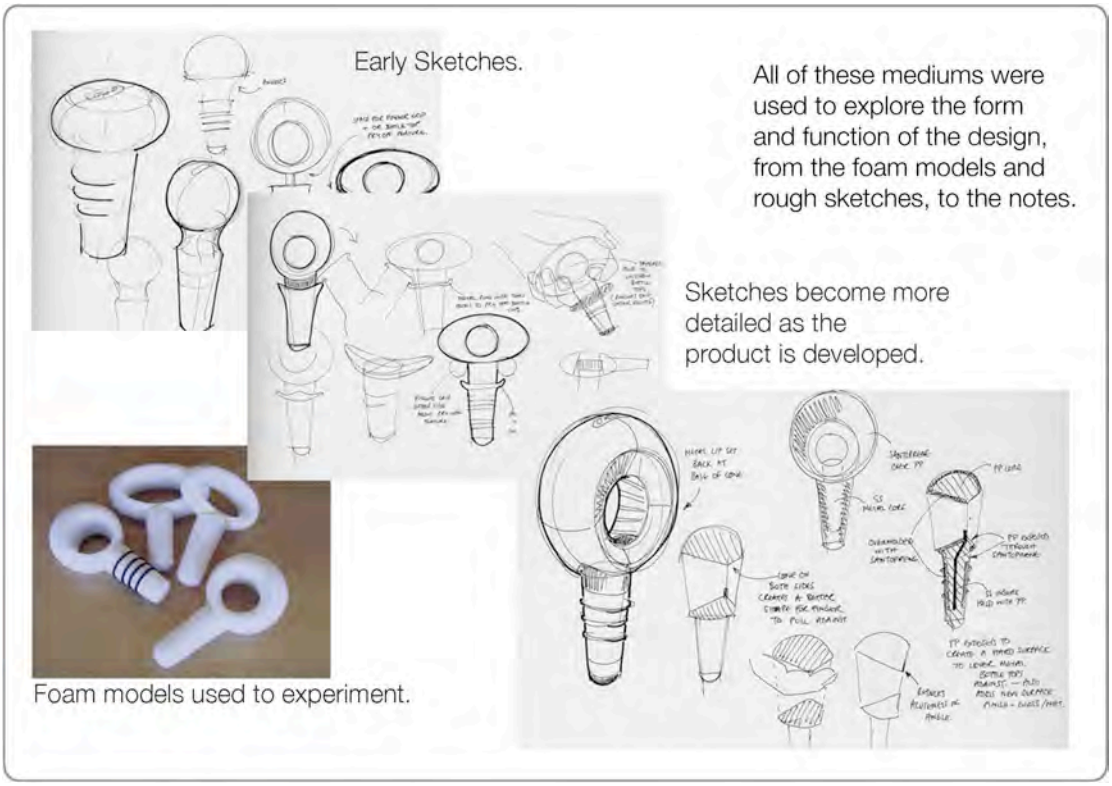

Figure 7. Working Development Sketches and Prototype

Figure 8. Experiments with different materials

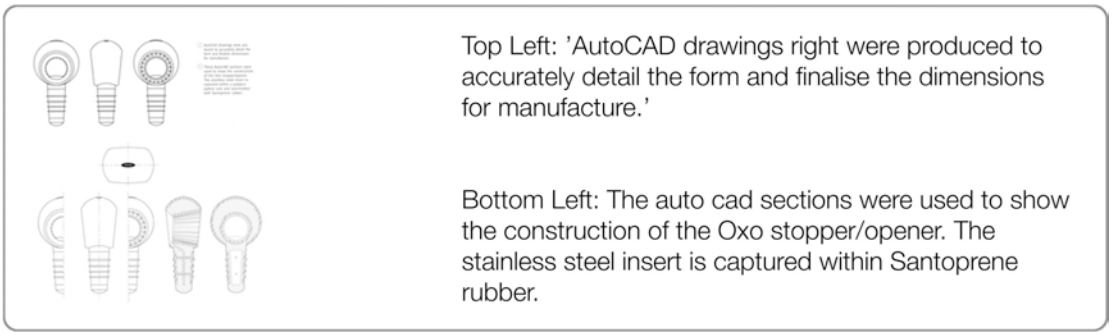

Figure 9. Technical drawings for manufacture

It is widely acknowledged that drawing is the main form of experimenting for the designer. This can be seen in the illustration in the case study example of the Oxo bottle opener (above). It is also valued as it can be done quickly enough to help sustain a stream of ideas, but can also be used keep up with conversations, aiding the description of ideas to clients or other designers. Its flexibility as a medium also offers a whole range of ways in which to experiment, especially when combined with the designer's imagination. These include comparing aesthetics, mapping contours, formulating mechanical solutions and to an extent, exploring ergonomics. Schön argues that it is imperative that any understanding of the design process must take into account the fact that designers use drawing as a dynamic instrument to visualise the evolution of a concept. As he explains:

> Any faithful description of designing must take account of the fact that designers work in a medium – in our examples they draw on paper – and literally see the evolving products of their work. Models that treat only of conceptual matters – emphasising, for example, the implementation of ideas, the interplay of variables, the management constraints, or the alternation between proposals and evaluations – are bound to miss crucially important features of the design process, whatever else they may capture.[30]

Lawson also argues, based on his studies of architects, that the action of drawing is instrumental to exploring design situations cognitively and intuitively. The designer's reliance on drawing goes so far that 'the act of making marks on the paper seems to have mediated the flow of thoughts and words.[31] In practice the most experienced designers become so familiar with the media they use, that they can actually go beyond the limitations of the medium and use their imagination to extend the boundaries of rigorous experimentation. Schön observed that in his case study of an architectural tutor and student, the tutor was able to experientially place himself in the setting that he was building, using abstract symbols to describe the situation. Thus:

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[30] Schön, D. A., 'Kinds of seeing and their functions in designing' *Design Studies*, volume 13, Issue 2, April 1992, p. 154

[31] Lawson, B., *Design In Mind*, Oxford: Architectural Press, 1994 revised 1997, p. 142

> Quist has also learned to use graphic languages transparently. When he represents a contour of the site by a set of concentric lines, he sees through it to the actual shapes of the slope, just as practiced readers can see through the letter on the page to meanings.[32]

Another reasons that the design process cannot conform to the full rigour of scientific method is the fact that solutions generated in design need to negotiate between conflicting criteria that inform and constrain the design. More often than not the best solution to single problem that makes up part of the whole design cannot be implemented, as it could compromise the solution to another problem. A very obvious example of this would be that if a product uses the best technology available to meet the user's requirements, although it might be the best known possible solution to the usability criteria, because the user might not be willing or able afford the cost of the technology. So, the best solution to a problem is found not by trying to find the optimum solution to each problem individually. It is instead found by developing all the parts of the design in relation to each other in order to find the most relevant solution.

One solution or feature of a design may be the answer to many problems and is accepted as one of the fundamental characteristics of design. The idea of design as a negotiation of solutions and problems was identified by the craftsman, George Sturt, Jones points out that Sturt's[33] work represents an early example of the recognition of this feature of design solutions by a literate craftsman. Sturt set out to explain why the customary expectation that the wheels for a horse-drawn carriage should be dish shaped and is unable to present any one specific answer to the problem, rather that it was the feature which provided a solution to a whole range of other problems. Sturts' explanation has since been revisited and added to by many design theorist including Cross and Lawson, who stress the strong grounding of the modern practice of design in the craft tradition.

The craft model would involve problem solving only being possible in terms of a finished product. The designer on the other hand must simulate experiments that represent variables in clusters as he/she needs to see the implications of experiments

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[32] Schön, D. A., *The Reflective Practitioner: How Professionals think in action,* London: Ashgate publishing, 1983 p. 159

[33] Jones C. J., *Design Methods Seeds Of Human Futures*: London *Council of Industrial Design*, 1970 re-issued in 1981, p. 17

that cross domains and mediums to create a whole picture. Drawing facilitates the negotiation of problems and solutions which is exercised by designers as they work through the many variables which cannot all be fully represented. It is also required of the designer that he/she is able to consider a range of possible moves as he/she explores the situation in response to new problems that arise. These will be caused, not only by the designer's lack of understanding of finite or domain specific experiences that might be present in a situation, but more importantly there may be problems that are concealed from the designer's vision by the user or client.

Objectives and problems in design are often hidden from view by, amongst other things the preconceptions, hidden agendas or tacit and latent criteria of users and clients which therefore need probing or provoking. Designers accept that they can never state a list of problems which they can be certain is comprehensive. Therefore they value the process of revelation which works towards the gradual framing of a problem. This view again supports that design practice is not characterised by the kind of hypothesis testing exemplified in scientific method.

The importance of the user's unspoken needs has led to the development of a new discipline called *Empathic Design,* which seeks to gain a better understanding of the unspoken needs of potential users by observing how people behave instead of merely questioning them. An example of an early form of this approach is given by Lenard and Rayport in the Harvard Business Review. Here they outlined how the concept of broadcast radio as a domestic product, which incorporated existing technology but had not yet been imagined by either user or inventor.

> Sarnoff had put his knowledge of technology together with what he found when he observed families gathered in their homes to envision a totally different use for the technology. No one had asked for broadcasting because they did not know that it was feasible.[34]

The designer has to meet the challenge of finding ways of uncovering or revealing needs and motivations which potential users do not know how to articulate in words but betray in their actions. These revelation of these unspoken needs signal the need

[34] Leonard, D., Rayport, J. F., *Spark Innovation Through Empathic Design* Harvard Business Review, December 1997 p. 105

for something which goes beyond that which has been laid out in the original client brief. The client may also have taken for granted or not have been sufficiently explicit about his/her understanding of the requirements of the product. The task of the designer is to interrogate the unspoken assumptions of the brief in order to tease out needs, both of client and user, which have not previously been explicit. The perceived and unperceived , problems presented in design has led to Cross describing design as rhetorical:

> What this means is that design is not a search for the optimum solution to the given problem but as a kind of partial map of unknown territory (as Jones suggested), and the designer sets off to explore, to discover something new, rather than return with yet another example of the already familiar.[35]

This chapter has attempted to show that design as discipline has evolved into a number of problems that are unique to the changing situation of practice. The metaphor of design as a map to be explored, seems to be quite accurate up to this point, but needs to be investigated further. As has been pointed out earlier the way that professionals have evolved their discipline is significantly different from the way that design theorists have suggested that design should logically be developed. We have seen that Schön challenged the positivist model of technical rationality used in education resulting in him developing what he has termed an epistemology of practice. In the next chapter we will look towards design in practice to see how designers have responded to the problems which have been outlined.

[35] Cross, N., *Natural Intelligence in Design* Milton Keynes, UK: The Open University 1999, p.28

Chapter 3: Design in practice

The observation of design in practice is usually studied in what is described as protocol studies. Amongst the most important findings taken from protocol studies has been Schöns' description of problem framing as the basis for rigorous reflective practice. A designers is most likely to be successful when he frames the most demanding question which he feels he is most likely to be able to solve. Schön points out that the designer cannot judge the effectiveness of problem framing nor can he know what the solution will be but nevertheless uses a strategy that does in his experience work:

> "Neither practitioner can know at the moment of reframing, what the solution will be nor can he be sure that the problem is soluble at all. But the frame he has imposed on the situation is one that lends itself to a method of inquiry in which he has confidence.
>
> When the practitioner tries to solve the problem he has set, he seeks to understand the situation and change it."

The role and effectiveness of problem framing by expert designers can be seen explicitly in the protocol studies by Cross, when he made studies of three top designers. From these studies it was found that the designers own experience played a very important role in framing the problem. The designer Victor Scheinmann was given the problem of designing a back pack. As there was only a limited amount of time in which to complete the design he was also given a prototype as a physical object to react to, which had been made by previous designers. Scheinmann's experience as a cyclist and as a designer meant he knew the design would have to be considered in the context of use:

> Victor therefore framed the problem as " how to maintain stability " given that a heavy backpack had to be carried over the rear wheel of the bicycle, and given his experience of 'wobbling' that can occur in the riding situation.[36]

[36] Cross, N., *Creative cognitions in design: Process of exceptional Designers* Milton Keynes: The Open University, 2002

However, later in the study he designed the bag with an aesthetic consideration, as a novel feature to sell the product, in addition to the products performance. The first problem that Scheinmann framed was not the whole problem but only the leading question, which provoked a form and concept by which the rest of the design was to be informed. The designer always anticipated that a visually pleasing details would later have to be added but it did not need to be part of his initial framing of the design problem.

One of the limitations with protocol studies is the time factor. Designers might consider a problem over several months and it would be impractical to record their process of a long period of time. In the case we have cited Scheinmann was only given two hours to complete his design. So we do not have the bigger picture of how the designer goes through the whole task, from research to details of manufacture. Cross adds that:

> His design for carrying the device is therefore based on an integrated concept in which user requirements are addressed through the problem frame of stability, leading to the use of triangularity as the guiding first principle, which he then uses to address the client's goal of having a proprietary, unique selling feature to the product.[37]

This showed a loose hierarchy of problems approached by the designer but does not mean that there cannot be negotiation between them. In the small sample of design observed in Cross' study of Scheinmann's working process the stability of the design in use was a rigid criterion. The unintended consequence was the production of a new and interesting shape. If the unintended consequence that occurred had not been satisfactory the solution would have to be made to fit with other parts of the design and if this was not possible then the design problem would have to be reframed. Previous theorists, for example Markus and Maver have proposed a path through the design process which proceeds from the general to the particular, there are defined levels of detail. Cross makes the point that this hierarchy is too rigid and that in practice designers adopt only a loose hierarchy of constraints which they effectively juggle within the early stages of design.

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[37] Cross, N., *Creative cognitions in design: Process of exceptional Designers* Milton Keynes: The Open University, 2002

> We see that designers think about the overall concept and at the same time think about detailed aspects of the implementation of that concept. Obviously not all of the detailed aspects, because if they could do that, they could go straight to the final set of detailed drawings. So they use the sketch to identify and then to reflect upon critical details—details that they realise will hinder, or somehow significantly influence the final implementation of the detailed design.[38]

Because the designer can only experiment with so many elements in one move each small experiment created by the designer also contributes towards understanding, reframing and changing of the global problem. In Schön's study of a design created in an educational setting, he stated that the designers 'attention must oscillate between the "whole" and the "unit," the global and the local.'[39] It is clear that the methods used by designers accept that they cannot make a comprehensive list of problems and can only take a certain number of criteria into account at any one time. Therefore, when the designer makes an experimental move he/she checks to see what the consequences of the actions might be and whether the unintended consequences are undesirable or of benefit to the design. These moves contribute to the designer's understanding of the possible moves and their potential consequences as he/she builds a picture of the problem and looks to see what can be made from the new information. Schön talks of making a web of potential moves. We might think of it as a designer creating a map as he/she progresses through the design which at any point indicates potential points of advance.

In a recent paper, Cross looked for a common pattern in the practice of a range of expert designers in the hope that his findings would assist in the nurture of better designers. His conclusions are potentially controversial. He argued that the best designers develop one design concept from their initial appreciation of the problem. He speculated that they could either have simply had the professional experience to intuitively generate early concept designs that work well or that they are able to fluently and effortlessly adjust their designs over the course of development:

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[38] Cross, N., *Natural Intelligence in Design* Milton Keynes, UK: The Open University 1999, p.35

[39] Schön, D. A., *The Reflective Practitioner: How Professionals think in action,* London: Ashgate publishing, 1983 p. 92

> Either way it seems that designers are reluctant to abandon early concepts, and generate ranges of alternatives. This does seem to conflict with more 'principled' approach to design, as recommended by design theorists…having more than one concept in play should promote a more comprehensive understanding of the problem.

The observation that leading designers tend not to generate a wide range of alternative concepts and approaches contrasts sharply with the practices and claims of a number of leading design consultancies, including IDEO, who promote themselves on the basis that their expertise includes the generation of multiple concepts, through the application of team working which in turn leads to radical design innovation.

Cross is mainly concerned with observing the work of individual designers whereas the IDEO methodology is essentially a group based one that has a commitment to the early generation of many ideas and its designers would probably do so whether they worked in groups or not. Tom Kelly explains that:

> Brainstorming is the engine room of IDEO's culture. Its an opportunity for teams to "blue sky" ideas early in a project or to solve a tricky problem that's cropped up later on. The more productive the group the more it brainstorms regularly and effectively.[40]

IDEO put a lot of effort into creating brainstorms that generate a large volume of possible ideas as a way of getting good ideas. So for them quality comes from quantity, rather than relying on the arbitrary selection of one idea early on in the process. They value brainstorming so highly as a way of generating ideas they treat the technique as more of a skill of designing rather than an activity through which design skills are used.

The main problem with Cross' analysis of expert designers may be that he has only selected a small range of disciplines, mainly focused around the fields of engineering and structure based areas of design, rather than perception based areas. For example in *Creative Cognitions in Design* the first 'expert designer' he used was a designer of Formula One cars, where the concern is to make the car with the best performance. The second study was of a designer who was described by Cross as using a

[40] Kelly, T., *The Art Of Innovation: Lessons in Creativity from IDEO Americas Leading Design Firm*, London: Harper Collins Business 2002 p 56

'functional practical approach'[41] as a way of innovating. The third design study was of Scheinmann, who was a design engineer. The individuals on whom Cross based his observations of expert designers, were mainly professionals who specialised in particular narrow fields. On the other hand consultancies such as IDEO undertake a range of tasks and work across disciplines which range from engineering and manufacturing to the more subjective disciplines of branding and aesthetic styling. IDEO therefore, put great emphasis on the process of development as a means of achieving rigorous design and on analysing problems and exploring solutions that aim to result in innovation rather than trying to directly think of innovative concepts.

Cross' conclusions in these two papers on expert designers in practice, puts emphasis on "designing from 'first principles'"[42], which he takes from the work of other engineer theorist 'such as French (1985) and Pahl and Beitz'[43]. It is obviously true that all designers rely on their past experiences, as it informs their design enabling them to see if a solution fits the problem and as a result to predict the future consequences of their actions. However, to what extent does the type of past experience that designers have access to affect the quantity of ideas generated? Our understanding of the world, which is gained through experimenting and comparing our results with past experiences allows us to predict future events. This process has been referred to in the work of developmental psychologists as using schema. The psychologist Piaget suggested ways in which schema are used to develop learning about the world.

> Cognitive abilities developed by means of schemas and changing according to experience. A schema is a mental model of what happens in certain situations. For example, a baby develops a schema for sucking and finding out what happens.[44]

The emphasis put on first principles by Cross means that designers must already have a schema of the rules or principles by which they judge the situation. It is true that the designer can do this when the problem exists where the principles or schemas are already familiar such as in practical or performance based approaches which have

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[41] Cross, N., *Creative Cognitions in Design: Process of exceptional Designers* Milton Keynes: The Open University, 2002
[42] Ibid.
[43] Ibid.
[44] Brain, C., AS Psychology unit 1: cognitive, social and development processes, Oxfordshire: Phillip Allan Updates, 2003, p. 47

more easily measured criteria for success. However when the problems are based on cultural perceptions which are in constant fluctuation, for example in the domain of fashion or semiotics, the designer is required either to investigate the constraints or to already be immersed in the culture. The nature of the problems between the two extremes measurable and the immeasurable may require emphasis on generative ideas to varying degrees. This problem is alluded to by Lawson:

> Since design is rarely an optimisation procedure leading to one correct answer, divergent thinking will be required. However, there are likely to be many steps in any design process which themselves pose convergent tasks. True, such steps may eventually be retraced or even rejected altogether but it would be absurd in the extreme to pretend that there are no parts of design which are themselves amenable to logical processes and have more or less logical solutions.[45]

I have tried to show that the different ways designers go about developing the problems and solutions needed to answer a design brief will vary according to their past experience of similar problems and their understanding of the appropriate methods of developing the situation. This analysis shows us that design is a discipline which has a highly variable spectrum which resists being closely defined in relationship to other disciplines.

[45] Lawson, B., *How Designers Think: The Design Process Demystified*, London: Architectural Press LTD, revised 1997 p. 147

Conclusion

In the light of my research it would be true to say that an optimum design process relevant to all disciplines cannot be represented in the form of a detailed visual model. Many attempts have been made to produce such a representation but the results have all been open to criticism. Not only do designers of different disciplines use different approaches to problems but they also differ in their valuation of problems and solutions in development, which can only be judged through their own experience and frames of reference. It is this variability which means design cannot be considered in terms of the repeatable, rigorous and infallible formula that science and maths aspire to. However, all design practices require a sense of logic and direction in the way that they frame and solve problems, which places design in a different category than related art practices. As a consequence, theorist of design have been engaged in outlining what Schön has called an 'epistemology of practice', which would justify a respect for design as its own discipline with its own culture and rigour.

This essay set out to map the attempts at definition of design as a discrete discipline and as such did not attempt to explore Schön's idea of the 'reflective practitioner' in its wider context. However, it is reasonable to assert that Schön characterisation of design as a conversation with the situation is an accurate representation of the methods designers use to investigate and develop designs. It is apparent that the designer must reflect on his/her moves, playing the role of both gaining a better understanding of the situation in order predict the consequences of moves and attempting to change the situation itself.

The understanding gained from looking briefly at the development of design from its origins in craft practices has shown that one of the fundamental characteristics of design is the necessity to create a solution, which at once solves a number of problems. In all the cases that I have observed, design is consistently iterative and places high value on problem framing.

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Figure 2.

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Figure. 7

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Figure 8.

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Figure 9.

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