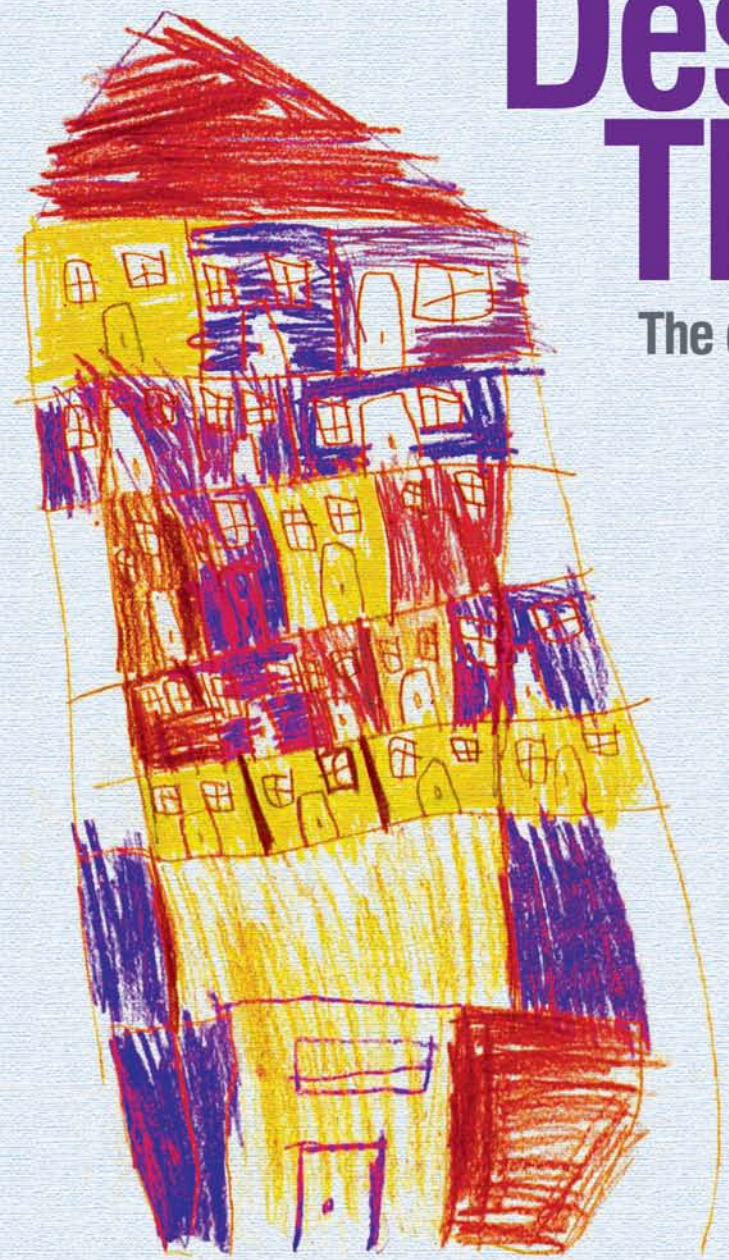
Fourth Edition

How Designers Think

The design process demystified



Bryan Lawson

Architectural Press

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To Rosie

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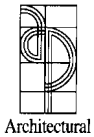

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Preface

This book now has far too long a history for my liking. It is frightening to think that it was first published now nearly a quarter of a century ago. It has been in continuous print ever since and many people have been kind enough to say how it has helped them with their studies, research or just developing their design process. Needless to say there are many others who have been rather more critical of some of the ideas and most of their arguments have been taken into account as the book has progressed through previous editions to this fourth one.

The book was not originally intended to be prescriptive and that continues to be the case. It is an attempt to draw together much of what I know about designing. That understanding has, of course, come from many years' research. But this understanding also comes from teaching designers from a wide range of backgrounds. I have taught students of architecture, interior design, product and industrial design, urban design and town planning, landscape, graphics as well as those who develop virtual worlds such as websites and animated films. I have also taught in the areas of ergonomics, systems design and computer programming. These students have repeatedly amused, surprised and entertained me. They have always taught me new things and occasionally astonished me. That they do not realise some things are thought to be difficult is often the charm and advantage of such novice students and every now and then they show that it is possible to make the complex simple and to resolve the intractable. This is why design is such a drug, so fascinating and yet of course so frequently frustrating and infuriating. I have been privileged to meet many wonderful designers, some of them very well known and others less so. We have discussed the ideas in this book. Often highly successful designers warn me at the start of these discussions that they can more easily describe their designs than their processes. Actually, it usually turns out that they can say a great deal more about their processes than they had previously realised they could. It may

seem odd to some readers that I say relatively little about the finished work of some of these successful designers. The fact is that much more has been written about their designs than their processes so I make no apology for saying very little about product here and concentrating on process.

If I were to start writing this book from scratch now I would probably do it differently. Since I first published this book I have written two others on related matters, *Design in Mind* and *What Designers Know*. The latter is actually a companion book to this one. I have revised this fourth edition in the light of more recent research but also in the knowledge that *What Designers Know* is now also published. Effectively both books taken together represent my latest thinking. This fourth edition has two totally new chapters at the end. The chapters in the third edition on designing with drawings and designing with computers have been removed. Both of those essentially looked at the way design knowledge is transferred between the human mind and some external representation. The main ideas that grow out of that study can now be found in a much more developed form in *What Designers Know*. The first new chapter here discusses the idea of design as conversation. Not only has this view of design grown in popularity over the time this book has been in print, but it now offers a way of thinking about many of the important issues concerning the ways the designers work in teams, with drawings and with computers. The second new chapter rather rashly tries to summarise the range of activities that I believe make up the design process. It also incorporates and summarises some of the lessons only recently available to us about how really expert designers work and how this might be different from the way novice designers work.

There are therefore now three points of summary in the book. The model of design problems which is developed in Chapter 6, the intermediate conclusions of Chapter 7 and the final summary of design activities in Chapter 16. I very much doubt that this is the end of the story. I am sure that many people will tell me that it is not and that we shall continue to have the same interesting and fascinating debates that I have been lucky to be part of for so many years.

I have researched the design process for over four decades now and met with most of those who contribute significantly and repeatedly to the field and I have greatly benefited from discussion with all the people involved. The Design Thinking Research Symposia and the Creativity and Cognition Conferences have offered particular inspirations. I have supervised many research

students and benefited from collaborating with them. I am greatly indebted to all those who have helped me to form these fumbling ideas as we grope towards an understanding of that most magical of all human cognitive endeavours, designing.

Bryan Lawson

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I am greatly indebted to the many design students I have taught over the years who frequently challenge their tutor's own ideas through their creative imagination. In particular I am grateful for the many discussions and debates we have had over many years in my research group and with other colleagues. There are too many who have contributed in this way to name but if they remain interested enough to read this, then I hope they will know who they are!

I must thank the designers who have allowed themselves to be subjected to my investigation. Many of them have substantial reputations and have been brave enough to open up their minds to me. I hope they will feel I have done their talents justice here.

I am also indebted to the following for supplying illustrations:

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PART ONE

WHAT IS DESIGN?

1
Introduction

> Put a group of architects, urban designers and planners in a sightseeing bus and their actions will define the limits of their concerns. The architects will take photographs of buildings, or highways or bridges. The urban designers will wait for that moment when all three are juxtaposed. The planners will be too busy talking to look out of the window.
>
> Denise Scott Brown, *AD Urban Concepts*

> To regard thinking as a skill rather than a gift is the first step towards doing something to improve that skill.
>
> Edward de Bono, *Practical Thinking*

Design

The very word 'design' is the first problem we must confront in this book since it is in everyday use and yet given quite specific and different meanings by particular groups of people. We might begin by noting that 'design' is both a noun and a verb and can refer either to the end product or to the process. Relatively recently the word 'designer' has even become an adjective rather than a noun. Although on the one hand this can be seen to trivialise design to the status of mere fashion, this adjectival use implies something that will be important to us in this book. It implies that not all design is equally valuable and that perhaps the work of some designers is regarded as more important. In this book we shall not be studying how design can offer us the fashion accessory. In fact we shall not be much concerned directly with the end products of design. This book is primarily about design as a process. We shall be concerned with how that process works, what we understand about it and do not, and how it is learned and performed by professionals and experts. We shall be interested in how the process can be supported with computers and by working in groups. We

shall be interested in how all the various stakeholders can make their voice heard.

To some extent we can see design as a generic activity, and yet there appear to be real differences between the end products created by designers in various domains. One of the questions running throughout the book then will be the extent to which designers have common processes and the extent to which these might vary both between domains and between individuals. A structural engineer may describe the process of calculating the dimensions of a beam in a building as design. In truth such a process is almost entirely mechanical. You apply several mathematical formulae and insert the appropriate values for various loads known to act on the beam and the required size results. It is quite understandable that an engineer might use the word 'design' here since this process is quite different from the task of 'analysis', by which the loads are properly determined. However, a fashion designer creating a new collection might be slightly puzzled by the engineer's use of the word 'design'. The engineer's process seems to us to be relatively precise, systematic and even mechanical, whereas fashion design seems more imaginative, unpredictable and spontaneous. The engineer knows more or less what is required from the outset. In this case a beam that has the properties of being able to span the required distance and hold up the known loads. The fashion designer's knowledge of what is required is likely to be much vaguer. The collection should attract attention and sell well and probably enhance the reputation of the design company. However, this information tells us much less about the nature of the end product of the design process than that available to the engineer designing a beam.

Actually both these descriptions are to some extent caricatures since good engineering requires considerable imagination and can often be unpredictable in its outcome, and good fashion is unlikely to be achieved without considerable technical knowledge. Many forms of design then, deal with both precise and vague ideas, call for systematic and chaotic thinking, need both imaginative thought and mechanical calculation. However, a group of design fields seem to lie near the middle of this spectrum of design activity. The three-dimensional and environmental design fields of architecture, interior design, product and industrial design, urban and landscape design, all require the designer to produce beautiful and also practically useful and well functioning end products. In most cases realising designs in these fields is likely to require very considerable

technical knowledge and expertise, as well as being visually imaginative and ability to design. Designers in these fields generate objects or places which may have a major impact on the quality of life of many people. Mistakes can seriously inconvenience, may well be expensive and can even be dangerous. On the other hand, very good design can approach the power of art and music to lift the spirit and enrich our lives.

Architecture is one of the most centrally placed fields in this spectrum of design, and is probably the most frequently written about. Since the author is an architect, there will be many architectural examples in this book. However, this is not a book about architecture, or indeed about any of the products of design. It is a book about design problems, what makes them so special and how to understand them, and it is about the processes of design and how to learn, develop and practise them.

Already here we have begun to concentrate on professional designers such as architects, fashion designers and engineers. But there is a paradox here about design. Design is now clearly a highly professional activity for some people, and the very best designers are greatly valued and we admire what they do enormously. And yet design is also an everyday activity that we all do. We design our own rooms, we decide how to arrange things on shelves or in storage systems, we design our own appearance every morning, we plant, cultivate and maintain our gardens, we select food and prepare our meals, we plan our holidays. All these everyday domestic jobs can be seen as design tasks or at least design-like tasks. When we are at work we are still designing by planning our time, arranging the desktops of our computers, arranging rooms for meetings, and so we could go on. We may not aggrandise these humble tasks with the word 'design', but they share many of the characteristics of professional design tasks.

We can see, however, that these tasks vary in a number of ways that begin to give us some clues about the nature of designing. Some of these tasks are really a matter of selection and combination of predetermined items. In some cases we might also create these items. Occasionally we might create something so new and special that others may wish to copy what we have done. Professional designers are generally much more likely to do this. But professional designers also design for other people rather than just themselves. They have to learn to understand problems that other people may find it hard to describe and create good solutions for them. Such work requires more than just a 'feeling'

for materials, forms, shapes or colours; it requires a wide range of skills. Today then professional designers are highly educated and trained.

Design education

Design education in the form we know it today is a relatively recent phenomenon. That a designer needs formal instruction and periods of academic study and that this should be conducted in an educational institution are now commonly accepted ideas. The history of design education shows a progressive move from the workplace into the college and university studio. In a recent attempt to interpret the history of architectural education linked to establishment of the Prince of Wales Institute of Architecture, this change is interpreted as a series of political conspiracies (Crinson and Lubbock 1994). Certainly it is possible to argue that academically based design education lacks contact with the makers of things, but then as we shall see in the next chapter this reflects practice. The designers of today can no longer be trained to follow a set of procedures since the rate of change of the world in which they must work would soon leave them behind. We can no longer afford to immerse the student of architecture or product design in a few traditional crafts. Rather they must learn to appreciate and exploit new technology as it develops.

We are also seeing quite new design domains springing up as a result of technology. I have been lucky enough to spend some time working in the design faculty of a university entirely devoted to multi-media. Designers there learn to animate, to create web-sites, to design virtual worlds and to create new ways for people to relate to, and use, highly complex technology. Such design domains were unimaginable when the first edition of this book was published and yet today they are extremely popular with students. Even further along the spectrum of design fields we find the system designers and software designers who create the applications that we all use to write books, manipulate images and give lectures. Many contemporary products have in them hardware and software that are combined and integrated in a manner that makes the distinction increasingly irrelevant. Mobile phones, MP3 players and handheld personal computers are not only appearing, but converging and transforming into new kinds of devices. Such areas of design are changing our lives not only physically but socially. Until recently we would have thought of software and system designers as lying

outside the scope of a book like this. However increasingly I am finding that people who work in those fields are seeing relevance in the ideas here and as a consequence are beginning to question the traditional ways in which such designers have been educated.

In the twentieth century technology began to develop so quickly that, for the first time in our history, the change was palpable within a single lifetime. Design has always been connected with our contemporary intellectual endeavour including art, science and philosophy. During that period we saw a change in design that was at the time thought to be more profound and fundamental than any of the stylistic periods that had preceded it. It was even known by its direct connection to the contemporary, 'modernism'. This name implied that it provided a full stop at the end of design history and I was taught by tutors who genuinely believed that. This set of ideas has so profoundly influenced the way that we think about design that sometimes it is hard to disentangle. Only now are we beginning to see that it is possible for design to move on from modernism. We shall not here be primarily concerned with design as style, but nor can we think about process in isolation.

Design education has recently emerged from a period of treating history as deserving academic study but making little connection with the present. Thankfully those notions of modernism as the last word in design have been largely rejected and the design student of today is expected not only to appreciate historical work in its own right but to use it to inform contemporary design.

Design education has some very common features that transcend countries and design domains. Design schools characteristically use both the physical and conceptual studio as their central educational device. Conceptually the studio is a process of learning by doing, in which students are set a series of design problems to solve. They thus learn how to design largely by doing it, rather than by studying it or analysing it. It seems almost impossible to learn design without actually doing it. However the ideas in this book may offer a complementary resource. One of the weaknesses of the traditional studio is that students, in paying so much attention to the end product of their labours, fail to reflect sufficiently on their process. Physically the studio is a place where students gather and work under the supervision of their tutors. The studio is often assumed to replicate the offices of professional designers in the domain. However, one of the perennial problems here is that so much of the real professional world is very difficult to replicate in the college or university. In particular there is usually an absence of clients with real problems, doubts, budgets and time constraints.

It is often difficult therefore for design students to develop a process which enables them to relate appropriately to the other stakeholders in design. Rather it is easier for them to develop very personally self-reflective processes aimed chiefly at satisfying themselves and possibly their tutors. Thus, the educational studio can easily become a place of fantasy removed from the needs of the real world in which the students will work when they graduate. Not only does this tend to distort the skill balance in the process, but also the sets of values which the students acquire. Hubbard showed for example that town planners tend to acquire a different set of values about architecture to the public they represent and serve (Hubbard 1996). Similarly Wilson showed that architects use different evaluative systems to others about buildings (Wilson 1996). She also showed that this tendency is acquired during education. More disturbingly this work also revealed a strong correlation between preferences within each school of architecture and that these preferences are linked to style. Almost certainly design schools do not intend these effects so perhaps this indicates some significant problems with the studio concept of design education.

Throughout this book we shall see how many influences a designer must be open to and how many arguments there are about their relative importance in practice. Design education, like design itself, will probably always be controversial. Traditions have grown up which show structural variations not only between countries but also between the various design fields.

The extent to which the various design fields share a common process is a matter for considerable debate. That designers educated in each of these fields tend to take a different view of problems is less contentious. Furniture designers will tell you that they can spot furniture designed by an architect as opposed to someone trained in furniture design. Some say that architects design furniture to sit in space and not obstruct it; others will tell you that architects simply do not understand the nature of the materials used in furniture and consequently assemble it as they would a building. It is now commonly accepted that the United Kingdom construction industry is too divided and confrontational and that the various consultants and contractors involved tend to be combative when the client would like them to be co-operative. A recent report suggested a solution to all this would be to educate them all through some kind of common university degree only allowing specialisation later (Bill 1990). Such an idea, while well meaning, is fundamentally flawed. It assumes that there is a pool of 18-year-old students with more or less blank minds and personalities who might be attracted to take

such a degree. In fact we know the truth to be very different. Very few students applying to university apply for courses in more than one area of the construction industry. Similarly, very few students apply to study more than one design field. Thus, although architecture and product design seem very closely related there is little contact between the fields. The internationally acclaimed British product designer Richard Seymour is not surprised by this.

> Although some architecture and some product designs look very close it is really the extreme end of the bow of the architecture tree rubbing up against a leaf at the extremity of the product design tree. We tend to think that they are very similar, but they are not. Fundamentally their roots are completely different.
>
> Lawson (1994)

For Richard Seymour, the separation between these professions begins very early and crucially before the period of tertiary education which might be held responsible for the divide. His view is that these 'roots' are put down much earlier in life and that by the time we come to select our profession, the choice is effectively already made. Richard Seymour observes that most product designers come from a background of achievement in practical crafts like metalwork and woodwork.

> The product designer is used to working with physical entities and the nature of materials and experiences them through seeing and feeling.

The English system of upper school education may aggravate these difficulties since pupils must choose to study only about four subjects. The universities then demand particular subjects before granting admission to each degree. Thus you might well be offered a place to study for a degree in architecture even if you had not studied mathematics, but almost certainly the same university would not grant you a place to study civil engineering. So the specialisation of students has already begun at school.

Whether it is the education system or the very nature of the students who select themselves, the atmosphere and social norms in the lecture theatres, studios and laboratories in the university departments of architecture, civil engineering and product design are different from the very beginning. The students speak differently, dress differently and have different images of themselves and the lives ahead of them. We must be cautious therefore in assuming that all design fields can be considered to share common ground. What is certain is that design is a distinctive mental activity, and we shall progressively explore its characteristics through this book.

However, we shall also discover that design can be extremely varied and we shall see that successful designers can employ quite different processes whatever their educational background.

Design technologies

This chapter began with a brief look at some of the differences between the way fashion designers and civil engineers might design. Another very important difference between them is the technology they must understand and use to achieve their ends. Designers must not only decide what effects they wish to achieve, they must also know how to achieve them. So our civil engineer must understand the structural properties of concrete and steel, whereas our fashion designer must appreciate the characteristics of different fabrics. Again this a simple caricature since both must know far more than this, but the point is made to demonstrate that their grasp of technology has to be relevant to their design field. Traditionally we tend to use the end products of design to differentiate between designers. Thus a client may go to one kind of designer for a bridge, another for a building, yet another for a chair and so on.

Many designers dabble in fields other than those in which they were trained, such as the famous architect Mies van der Rohe who designed a chair for his German Pavilion at the Barcelona International Exhibition of 1929, which to this day appears in the lobbies of banks and hotels all over the world. Very few designers are actually trained in more than one field such as the highly acclaimed architect/engineer Santiago Calatrava. Some designers are even difficult to classify such as Philippe Starck who designs buildings, interiors, furniture and household items. It is interesting that some of the most famous inventions of modern times were made by people who had not been specifically trained to work in the field in which they made their contribution (Clegg 1969):

Invention	*Inventor*
Safety razor	Traveller in corks
Kodachrome films	Musician
Ball-point pen	Sculptor
Automatic telephone	Undertaker
Parking meter	Journalist
Pneumatic tyre	Veterinary surgeon
Long-playing record	Television engineer

Classifying design by its end product seems to be rather putting the cart before the horse, for the solution is something which is formed by the design process and has not existed in advance of it. The real reason for classifying design in this way has less to do with the design process but is instead a reflection of our increasingly specialised technologies. Engineers are different from architects not just because they may use a different design process but more importantly because they understand about different materials and requirements. Unfortunately this sort of specialisation can easily become a strait-jacket for designers, directing their mental processes towards a predefined goal. It is thus too easy for the architect to assume that the solution to a client's problem is a new building. Often it is not! If we are not careful then design education might restrict rather than enhance the ability of the students to think creatively.

The cautionary tale of the scientist, the engineer, the architect and the church tower illustrates this phenomenon. These three were standing outside the church arguing about the height of the tower when a local shopkeeper who was passing by suggested a competition. He was very proud of a new barometer which he now stocked in his shop and in order to advertise it he offered a prize to the one who could most accurately discover the height of the tower using one of his barometers. The scientist carefully measured the barometric pressure at the foot of the tower and again at the top, and from the difference he calculated the height. The engineer, scorning this technique, climbed to the top, dropped the barometer and timed the period of its fall. However, it was the architect who, to the surprise of all, was the most accurate. He simply went inside the church and offered the barometer to the verger in exchange for allowing him to examine the original drawings of the church!

Many design problems are equally amenable to such varied treatment but seldom do clients have the foresight of our shopkeeper. Let us briefly examine such a situation. Imagine that a railway company has for many years been offering catering facilities on selected trains and has now discovered that this part of the business is making a financial loss. What should be done? An advertising agency might suggest that they should design a completely new image with the food repackaged and differently advertised. An industrial designer might well suggest that the real problem is with the design of the buffet car. Perhaps if passengers were able to obtain and consume food in every coach they would buy more than if they had to walk down the train. An operations

research consultant would probably concentrate on whether the buffet cars were on the right trains and so on.

It is quite possible that none of our professional experts was right. Perhaps the food was just not very appetising and too expensive? In fact, probably all the experts have something to contribute in designing a solution. The danger is that each may be conditioned by their education and the design technology they understand. Design situations vary not just because the problems are dissimilar but also because designers habitually adopt different approaches. In this book we shall spend some time discussing both design problems and design approaches.

What does design involve?

Barnes Wallis is perhaps most famous for his wartime invention of the bouncing bomb immortalised in the film of the 'dam-busters'. However his career achievements went much further with a whole succession of innovative pieces of aviation design including aircraft, airships and many smaller items. However, at the age of sixteen, Barnes Wallis failed his London matriculation examination (Whitfield 1975). It seems likely that this was a result of undergoing a form of Armstrong's heuristic education at Christ's Hospital, which did little to prepare its pupils for such examinations but rather concentrated on teaching them to think. Barnes Wallis recalls 'I knew nothing, except how to think, how to grapple with a problem and then go on grappling with it until you had solved it'. Later Barnes Wallis was to complete his London University first degree in astonishingly quick time, taking only five months!

Later in life Barnes Wallis was quite prepared to take technical advice, but never accepted help with design itself: 'If I wanted the answer to a question for which I could not do the mathematics I would go to someone who could . . . to that extent I would ask for advice and help . . . never a contribution to a solution'. Even at an early age it was the quality of Barnes Wallis' thinking and his approach to problems as much as his technical expertise which enabled him to produce so many original aeronautical designs.

For many of the kinds of design we are considering, it is important not just to be technically competent but also to have a well developed aesthetic appreciation. Space, form and line, as well as colour and texture, are the very tools of the trade for the environmental,

product or graphic designer. The end product of such design will always be visible to the user who may also move inside or pick up the designer's artefact. The designer must understand our aesthetic experience, particularly of the visual world, and in this sense designers share territory with artists. For these reasons alone, and there are some others we shall come to later, designers also tend to work in a very visual way. Designers almost always draw, often paint and frequently construct models and prototypes. The archetypal image of the designer is of someone sitting at a drawing board. But what is clear is that designers express their ideas and work in a very visual and graphical kind of way. It would be very hard indeed to become a good designer without developing the ability to draw well. Indeed designers' drawings can often be very beautiful.

Sometimes the drawings of designers become art objects in their own right and get exhibited. We must leave until later a discussion of why the practice of designing should not be considered as psychologically equivalent to the creation of art. Suffice it now to say that design demands more than just aesthetic appreciation. How many critics of design, even those with the most penetrating perception, find it easier to design than to criticise?

Perhaps there can be no exhaustive list of the areas of expertise needed by designers, although we shall attempt to get close to this by the end of the book. However, there is one more set of skills that designers need which we should at least introduce here. The vast majority of the artefacts we design are created for particular groups of users. Designers must understand something of the nature of these users and their needs whether it is in terms of the ergonomics of chairs or the semiotics of graphics. Along with a recognition that the design process itself should be studied, design education has more recently included material from the behavioural and social sciences. Yet designers are no more social scientists than they are artists or technologists.

This book is not about science, art or technology, but the designer cannot escape the influences of these three very broad categories of intellectual endeavour. One of the essential difficulties and fascinations of designing is the need to embrace so many different kinds of thought and knowledge. Scientists may be able to do their job perfectly well without even the faintest notion of how artists think, and artists for their part certainly do not depend upon scientific method. For designers life is not so simple, they must appreciate the nature of both art and science and in addition

they must be able to design! What then exactly is this activity of design? That we must leave until the next chapter but we can already see that it involves a sophisticated mental process capable of manipulating many kinds of information, blending them all into a coherent set of ideas and finally generating some realisation of those ideas. Usually this realisation takes the form of a drawing but, as we have seen it could equally well be a new timetable. It is the process rather than the end product of design which chiefly interests us in this book.

Design as a skill

Design is a highly complex and sophisticated skill. It is not a mystical ability given only to those with recondite powers but a skill which, for many, must be learnt and practised rather like the playing of a sport or a musical instrument. Consider then the following two passages:

> Flex the knees slightly and, while your upper body inclines towards the ball, keep from bending over too much at the waist. The arms are extended fully but naturally towards the ball without any great feeling of reaching out for the ball . . . start the club back with that left arm straight letting the right elbow fold itself against the body . . . the head should be held over the ball . . . the head is the fixed pivot about which the body and swing must function.
>
> Lee Trevino (1972) *I Can Help Your Game*

> Keeping the lips gently closed, extend them a little towards the corners as when half smiling, care being taken not to turn them inwards at all during the process. The 'smile', rather a sardonic one perhaps, should draw in the cheeks against the teeth at the sides and the muscular action will produce a firmness of the lips towards the corners. Now, on blowing across the embouchure towards its outer edge, the breadth will make a small opening in the middle of the lips and, when the jet of air thus formed strikes the outer edge the flute head will sound.
>
> F. B. Chapman (1973) *Flute Technique*

These two passages come from books about skills. Both are skills which I have spent a lifetime miserably failing to perfect; playing golf and playing the flute. My well-thumbed copies of these books offer me a series of suggestions as to where I should direct my attention. Both authors concentrate on telling their readers how it feels to be doing it right. A few people may pick up a golf club and swing it naturally or make a beautiful sound on a flute. For them these books may be of little help, but for the vast majority, the

skills must be acquired initially by attention to detail. It is in the very nature of highly developed skills that we can perform them unconsciously. The expert golfer is not thinking about the golf swing but about the golf course, the weather and the opponents. To perform well the flautist must forget the techniques of embouchure and breath control and fingering systems, and concentrate on interpreting the music as the composer intended. You could not possibly give expression to music with your head full of Chapman's advice about the lips. So it is with design. We probably work best when we think least about our technique. Beginners however must first analyse and practise all the elements of their skill and we should remember that even the most talented of professional golfers or musicians still benefit from lessons all the way through their careers.

While we are used to the idea that physical skills like riding a bicycle, swimming and playing a musical instrument must be learned and practised, we are less ready to recognise that thinking might need similar attention as was suggested by the famous British philosopher Ryle (1949):

> Thought is very much a matter of drills and skills.

Later the psychologist Bartlett (1958) echoed this sentiment:

> Thinking should be treated as a complex and high level kind of skill.

More recently there have been many writers who have exhorted their readers to practise this skill of thinking. One of the most notable, Edward de Bono (1968) summarises the message of such writers:

> On the whole, it must be more important to be skilful in thinking than to be stuffed with facts.

Before we can properly study how designers think, we need to develop a better understanding of the nature of design and the characteristics of design problems and their solutions. The first two sections of this book will explore this territory before the third main section on design thinking. The book as a whole is devoted to developing the idea that design thinking is a skill. Indeed it is a very complex and sophisticated skill, but still one which can be analysed, taken apart, developed and practised. In the end though, to get the best results, designers must perform like golfers and flautists. They should forget all the stuff they have been taught about technique and just go out and do it!

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2

The changing role of the designer

> A bee puts to shame many an architect in the construction of her cells but what distinguishes the worst of architects from the best of bees is this, that the architect raises his structure in imagination before he erects it in reality. At the end of every labour process we get a result that already existed in the imagination of the labourer at its beginning.
>
> Karl Marx, *Das Capital*

> Architecture offers quite extraordinary opportunities to serve the community, to enhance the landscape, refresh the environment and to advance mankind – the successful architect needs training to overcome these pitfalls however and start earning some serious money.
>
> Stephen Fry, *Paperweight*

Vernacular or craft design

In the industrialised world design has become a professional activity. There is now a whole range of designers each educated and trained to design objects for quite specific purposes. There are graphics designers who arrange the myriad of images we look at, product designers who create the items we use in our everyday lives and architects who design the buildings we live and work in. At university now it is also possible to take courses on interior design, theatre design, urban design, landscape design, fashion and textile design, and of course there are degrees in civil and structural engineering, electrical and electronic engineering, mechanical engineering and chemical and process engineering. So it seems there is a designer with a university degree who has been trained to design every article we buy, consume or inhabit. However, it has not always been so, nor is it so now in many other

societies. Design as we know it in the industrialised world is a relatively recent idea.

Some years ago a group of my first year architecture students at Sheffield University were working on a project devised to get them to think about the design process. This project was specifically set up to get the students to concentrate on process rather than product, and for this reason did not involve buildings. Instead the students had to work in groups to design a machine to process marbles (Fig. 2.1). Nine marbles had to be poured into the machine at one end from a plastic cup and the machine was required to deliver two, three and four marbles respectively into three other plastic cups after a certain period of time. The students were also expected to record and later analyse how they had made decisions and interacted with each other during the design process. During the project, the studio was full of noise, not only from the clacking of marbles as machines were tested and found in need of improvement but also from the arguments which raged as to how the improvements could, or should be made. Inevitably most designs began by being complicated and unreliable,

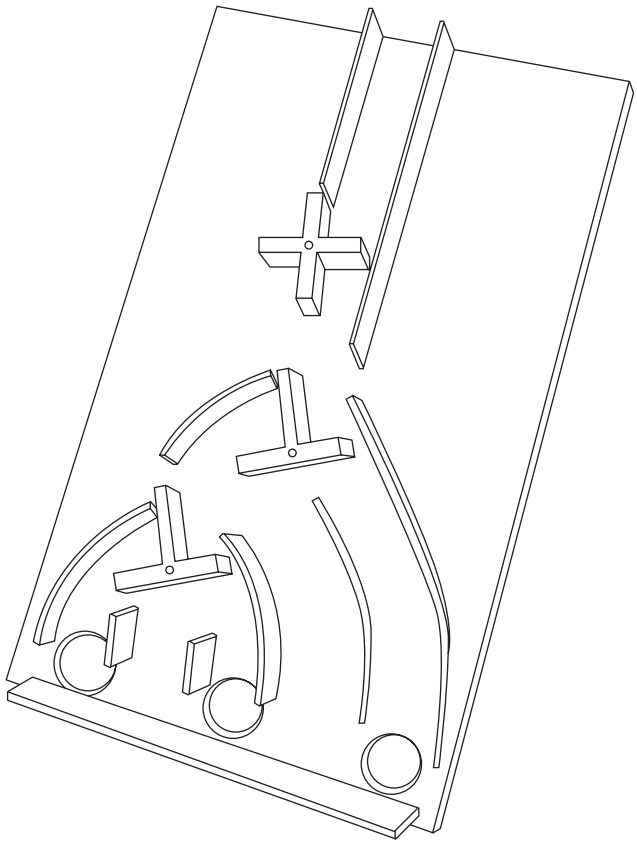

Figure 2.1
Part of a marble machine designed by a group of architecture students using a highly self-conscious process

and the groups gradually moved towards simpler and more reliable machines. The most reliable solutions were generally those which had few moving parts, not many different materials and were easy to construct. As is often the case with design, such solutions also tend to look pleasing and visually explain how they work.

One night it snowed very heavily, and the next morning the students quite spontaneously decided to abandon their work and turned their attention to building an igloo in a nearby park (Fig. 2.2). The igloo was very successful. It stood up strongly and could accommodate about ten people with the internal temperature rising well above that of the ambient air. Indeed the igloo was so well made that it attracted the attention of the local radio station who came along and conducted an interview with us inside!

What was even more remarkable however was the change of process. Out in the park the students left behind not only their marble machines but also their arguments on design. The students immediately, and without any deliberation switched from the highly self-conscious and introspective mode of thinking encouraged by their project work to a natural unselfconscious action-based approach.

There were no protracted discussions or disagreements about the form of the igloo, its siting, size or even construction and there were certainly no drawings produced. They simply got on and built it. In fact these students shared a roughly common image of an igloo in

Figure 2.2
The same architecture students designed and built an igloo but used an unselfconscious approach

what we might fancifully describe as their collective consciousness. In this respect their behaviour bears a much greater resemblance to the Eskimo way of providing shelter than to the role of architect for which they were all being trained. Actually the common image of an igloo which these students shared and successfully realised was not entirely accurate in detail, for with their western preconceptions they built up the walls in horizontal courses whereas the Eskimo form of construction is usually a continuous rising spiral ramp (Fig. 2.3).

As the igloo was completed the students' theoretical education began to take over again. There was much discussion about the compressive and tensile strength of compacted snow. The difficulties of building arches and vaulting with a material weak in tension were recognised. It was also realised that snow, even though it may be cold to touch, can be a very effective thermal insulator. You would be very unlikely indeed to overhear such a discussion amongst Eskimos. Under normal conditions igloos are built in a vernacular manner. For the Eskimo there is no design problem but rather a traditional form of solution with variations to suit different circumstances which are selected and constructed without a thought of the principles involved.

In the past many objects have been consistently made to very sophisticated designs with a similar lack of understanding of the theoretical background. This procedure is often referred to as

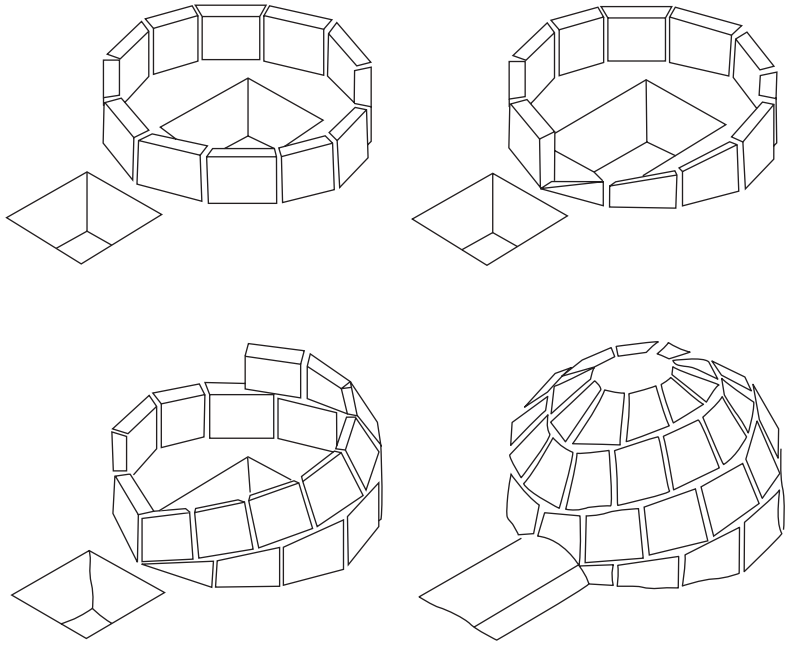

Figure 2.3
The traditional method of igloo construction

'blacksmith design' after the craftsman who traditionally designed objects as he made them, working to undrawn traditional patterns handed down from generation to generation. There is a fascinating account of this kind of design to be found in George Sturt's book *The Wheelwright's Shop* (Sturt 1923). Sturt suddenly found himself in charge of a wheelwright's shop in 1884 on the death of his father. In his book he recalls his struggle to understand what he describes as 'a folk industry carried on in a folk method'.

Of particular interest here is the difficulty which Sturt found with the dishing of cartwheels. He quickly realised that wheels for horse-drawn vehicles were always constructed in a rather elaborate dished shape like that of a saucer, but the reason for this eluded Sturt. (Fig. 2.4) From his description we can see how Sturt's wheelwrights worked all their lives with the curious combination of constructional skill and theoretical ignorance that is so characteristic of such craftsmen. So Sturt continued the tradition of building such wheels for many years without really understanding why. He realised that the dished wheel itself must be much more complex to make than a flat one. However the design necessitated even further complexities resulting in the wheel being tilted outwards and angled in towards the front (Fig. 2.5). Not surprisingly then, he was not content to remain in ignorance of the reasons behind the design.

Sturt first suspected that the dish was to give the wheel a direction in which to distort when the hot iron tyre was tightened on by cooling, but Jenkins (1972) has shown that dishing preceded the introduction of iron tyres. One other reason that occurred to Sturt

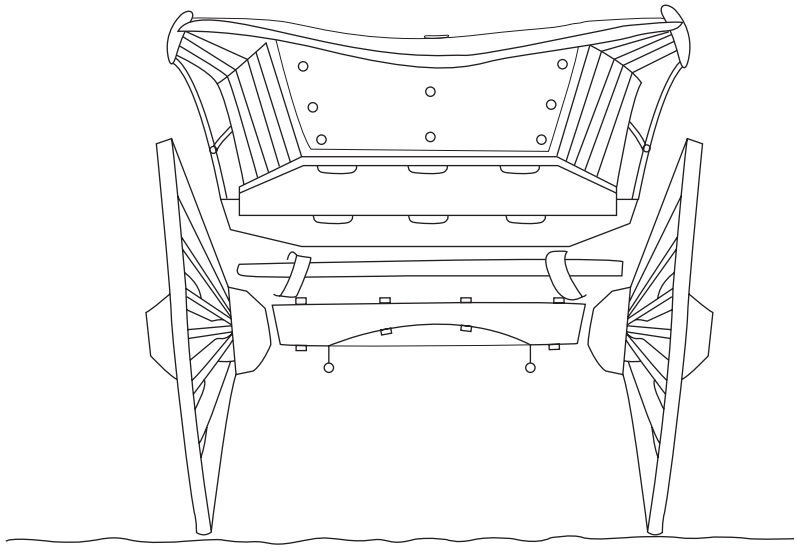

Figure 2.4
The cartwheel for horse-drawn vehicles was constructed in a complex dished shape

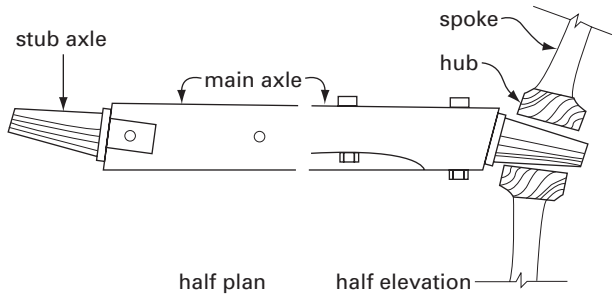

Figure 2.5
The axle had to be tilted down (pitch) to enable the cartwheel to transfer load nearly vertically to the ground, and then angled forward (foreway) to prevent the cartwheel falling off

was the advantage gained from the widening of the cart towards the top thus allowing overhanging loads to be carried. This could be achieved since that part of the dished wheel which transfers the load from axle to road must be vertical, and thus the upper half of the wheel leans outwards. This may have more validity than Sturt realised since legislation in 1773 restricted the track of broad wheeled vehicles to a maximum of 68 inches. Although dished cartwheels were narrow enough to be exempt from this legislation, the roads would have probably got so rutted by the broad wheeled vehicles that a cart with a wider track would have had to ride on rough ground.

Eventually Sturt discovered what he thought to be the 'true' reason for dishing. The convex form of the wheel was capable not just of bearing the downward load but also the lateral thrust caused by the horse's natural gait which tends to throw the cart from side to side with each stride, but this is still by no means the total picture. Several writers have since commented on Sturt's analysis and in particular Cross (1975) has pointed out that the dished wheel also needed foreway. To keep the bottom half of the wheel vertical the axle must slope down towards the wheel. In turn this produces a tendency for the wheel to slide off the axle which has to be countered by also pointing the axle forward slightly thus turning the wheel in at the front. The resultant 'foreway' forces the wheel back down the axle as the cart moves forwards. Cross appears to argue that this is a forerunner of the toe-in used on modern cars to give them better cornering characteristics. This is probably not accurate since, as Clegg (1969) has argued, this modern toe-in is really needed to counter a lateral thrust caused by pneumatic rubber tyres not present in the solid cartwheel.

There probably is no one 'true' reason for the dishing of cartwheels but rather a great number of interrelated advantages. This is very characteristic of the craft-based design process. After many generations of evolution the end product becomes a totally integrated response to the problem. Thus if any part is altered the

complete system may fail in several ways. Such a process served extremely well when the problem remained stable over many years as with the igloo and the cartwheel. Should the problem suddenly change, however, the vernacular or craft process is unlikely to yield suitable results. If Sturt could not understand the principles involved in cartwheel dishing how would he have responded to the challenge of designing a wheel for a steam-driven or even a modern petrol-driven vehicle with pneumatic tyres?

The professionalisation of design

In the vernacular process designing is very closely associated with making. The Eskimos do not require an architect to design the igloo in which they live and George Sturt offered a complete design-and-build service to customers requiring wheels. In the modern western world things are often rather different. An average British house and its contents represent the end products of a whole galaxy of professionalised design processes. The house itself was probably designed by an architect and sited in an area designated as residential by a town planner. Inside, the furnishings and fabrics, the furniture, the machinery and gadgets have all been created by designers who have probably never even once dirtied their hands with the manufacturing of these artefacts. The architect may have got muddy boots on the site when talking to the builder once in a while, but that is about as far as it goes. Why should this be? Does this separation of designing from making promote better design? We shall return to this question soon, but first we must examine the social context of this changed role for designers.

Approximately one in ten of the population of Great Britain may now be described as engaged upon a professional occupation. Most of the professions as we now know them are relatively recent phenomena and only really began to grow to the current proportions during the nineteenth century (Elliot 1972). The Royal Institute of British Architects (RIBA) was founded during this period. As early as 1791 there was an 'Architects' Club' and later a number of Architectural Societies. The inevitable process of professionalisation had begun, and by 1834 the Institute of British Architects was founded. This body was no longer just a club or society but an organisation of like-minded men with aspirations to raise, control and unify standards of practice. The Royal Charter of 1837 began the process of acquiring social status for architects, and eventually