

BRYAN **LAWSON**

**DESIGN
EXPERTISE**

KEES **DORST**



ELSEVIER

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UNDERSTANDING DESIGN

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Everyone designs who devises courses of action aimed at changing existing situations into preferred ones. The intellectual activity that produces material artefacts is no different fundamentally from the one that prescribes remedies for a sick patient or the one that devises a new sales plan for a company or a social welfare policy for a state.

HERBERT SIMON (THE SCIENCES OF THE ARTIFICIAL)

”

We can't solve problems by using the same kind of thinking we used when we created them.

ALBERT EINSTEIN

INTRODUCTION

'Design' is a fundamental human activity, as well as the name of a number of quite specific professions. Since we suppose that most of our readers are practicing designers, design students or educators already involved in the field of design, we do not need to dwell on the vexed question of what would be a good definition of design. Nevertheless, we need a few words to explain what we see as the salient features of the design activity, to avoid confusion, set the stage for developing models of design and prepare to explore the creation design expertise.

DESIGN UNDEFINED

The fact that 'design' is such a confusing term, widely used and misused in common parlance, has been problematic in the development of the design professions. If we are not careful, the mere use of the word makes any discussions about design in general flawed, muddled and unproductive. We will use this chapter to put words to our understanding of what design is, and thus steer clear of this trap.

We need to establish what we mean when we say 'design'. But how can we do that? Often we tend to clarify things by defining them; that is by naming their constituent parts. But this will not do for design which is an activity and a way of thinking that is spread across many professional fields. Perhaps looking at what these fields have in common will give us an inkling of the kernel of design expertise? Yet when we look closely we see that the work of these professional fields does not necessarily exhibit one single common trait.

Their range and diversity are huge. However, these various design activities do display what Wittgenstein would call a 'family resemblance' (Wittgenstein, 1953, pp 31-32); there is a variable series of traits that some members of the family will have in common to a varying extent. Thus, within the wide range of activities one could validly call design we might see that the extremes hardly resemble each other at all, but lurking under the surface there are indeed common and characteristic traits.

To confound our problems, we have to admit that design not only encompasses a broad range of activities across many professional fields, but that these activities are also very complicated; perhaps designing is one of the most complicated things we humans do. Since we have just relied on the philosopher Wittgenstein it is worth remembering that he became very interested in architecture and expressed this complexity in a conversation in

THE FAMILY OF DESIGN

In his classic treatise, 'The Concept of Mind', Gilbert Ryle compared thinking with farming (Ryle, 1949). They are both what he called 'polymorphous concepts'. Any two farmers we meet may share almost nothing in common; one may rear sheep for wool while another may grow crops for food. And yet we have no problem seeing them both as 'farmers'. Since design is an advanced form of thinking we should not be surprised that it shares this polymorphous characteristic.

1930: 'You think philosophy is difficult enough, but I tell you it is nothing to the difficulty of being a good architect' (Wilson, 1986).

← If we abandon the attempt at a direct definition of design, but we still want to distinguish some different kinds of design, we end up in trouble too. If we split design up along the lines of professional fields we might think of the fields of architecture, engineering, interior design, interaction design, software design, graphic design and product design. But if we think of these as separate categories of design practice, we miss the way the boundaries between these design disciplines are vague and tending to become more so.

For instance, in all the main design disciplines, there are branches that look very much like product design; in architecture it is the design of building systems, in mechanical engineering it is the development of small, mass-produced machines and in graphic design, the development of company logos and house styles. So, the various seemingly different strands of design just have too much in common to make a clear distinction. Often it is precisely the people who work at these crossovers in design thinking that yield the most interesting results. It is vital that any single description of design should do justice to this phenomenon. We had better leave design undefined, at least for now.

DESIGN AS...

One of the difficulties in understanding design, is its multifaceted nature. There is no one single way of looking at design that captures the 'essence' without missing some other salient aspects. Moreover, what aspects would be salient of course depends on your point of view, and your goal in trying to describe and understand design. To cater for many different points of view we will resort to describing design through a series of short paragraphs that suggest how we could see design from different viewpoints. In doing so we will be using a characteristically 'designerly' way of thinking. Conceptual design has been described as the art of seeing the design situation in multiple ways or 'seeing as'. Designers are used to performing this little dance around a problem, taking stabs at it from different sides. This may sound chaotic but if done well it allows one to build up an integrated picture in the end. So in this chapter we will be taking multiple stabs at describing design itself, and hope to end up with an integrated image of design in our minds that is strong enough to carry this understanding into the next chapters, and avoid confusion in the discussions later on.

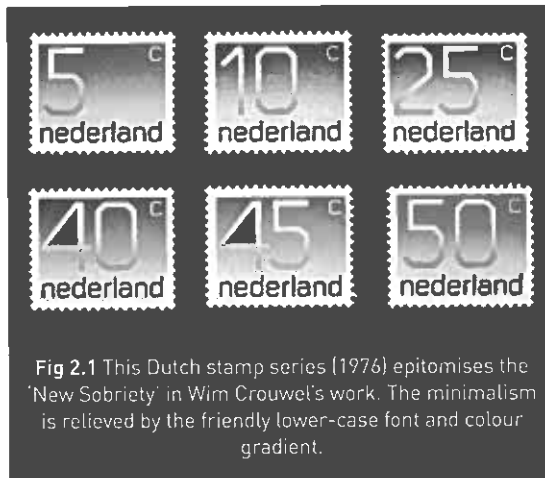


Fig 2.1 This Dutch stamp series (1976) epitomises the 'New Sobriety' in Wim Crowwel's work. The minimalism is relieved by the friendly lower-case font and colour gradient.

WIM CROUWEL

“

I have to say that for me feeling and rationality are very close together. Unexplainably close. And that can bother you. I have discovered this dualism over the years. In the beginning I did not know. At the end of 1960 I was so completely convinced, that I only had one single way of working. The real discovery of dualism happened later. As I grow older, I get a sharper eye for the things I would like to do all over again, and the things I would never redo. I become more selective about my work.

”

WIM CROUWEL

Wim Crowwel (1928) was trained in Groningen and Amsterdam. In his long and distinguished career he was one of the founders of Total Design (1963), the leading Dutch design firm in the modernist era of the 1960s and 70s—with a portfolio that stretched from graphic design and jewelry design to product design. He is generally regarded as a leading exponent of the 'Nieuwe Zakelijkheid' (an heir to the De Stijl movement of the 1920s and 30s—the name translates as 'New Sobriety'). In all his design work he seriously pursues the adage 'Less is more', almost taking this to extremes. He integrates form and message, graphic elements and typography in subtle, deceptively simple designs of the utmost clarity. Any unnecessary elements were rigorously removed, giving his design an unassailable puritanical beauty. In addition to his work for Total Design, Wim Crowwel has been Dean and Professor of design at the Faculty of Industrial Design at Delft University of Technology, before becoming the director of the modern art museum Boymans van Beuningen in Rotterdam.

DESIGN AS...

A MIXTURE OF CREATIVITY AND ANALYSIS

It seems sensible to begin our picture gallery by describing design from the inside, as a way of thinking. In fact this is where it gets complicated straight away; design is not one way of thinking, but several. In particular it is a mix of rational, analytical thinking and creativity. This inherent schizophrenia is a defining characteristic of design, and it directly leads to the peculiar way of working that is a common trait of practice throughout the design professions. ← Wim Crowel is surely alluding to this precious characteristic of designing.

This combination of thinking modes can best be illustrated in an experiment by Bryan Lawson (1979). To investigate how designers and non-designers would tackle a design-like problem, he set a series of puzzles to two groups of advanced students. One group studied science, and the others were designers (architects). And what happened? The scientists started by analysing the structure of the problem, and once they understood it, they set about solving it.

The designers, on the other hand, began by laying out high-scoring solutions and to see if they were allowed; a completely different approach. If they were not successful they modified the solutions until they found one that was permitted. Apparently, the designers were used to problems that did not lend themselves to exhaustive analysis. They were accustomed to dealing with the chaotic problems of their profession by creating high-scoring solutions, analysing those and evaluating them. Their creativity and analytical skills were focused on the solution, not on the problem. This strategy can be recognised in all design professions. In many design situations, the generation of possible solutions and their gradual improvement is the only way forward.

In the case of this experiment, the bad news is that of course there was a structure to the problem, and the way the science students went about it was far more effective and efficient if you wanted to understand that structure. Maybe one could say that designers are defined by the way they treat a problem as if it has no structure; as if it is a design problem. This does unearth a real dilemma often keenly felt in design practice; confronted with a design problem one might tackle it in either a problem-focused (analytical) or a solution-focused (creative) way. This can be a hard choice for a designer; being too analytical can lead to an unnecessary limitation of the solution space, while being too creative and generative can launch a journey into nothingness. Experienced designers often introduce constraints of their own (their own personal 'style', or their 'way of doing things') to avoid the

BRYAN LAWSON'S BLOCKS EXPERIMENT

Subjects were given a set of blocks coloured red and blue on the vertical faces and white and black on the horizontal ones. They were asked to arrange some of the blocks on a grid to create a surrounding wall that was either as blue or red as possible. But there were some hidden rules about which combinations of blocks would be allowed. The only information available was from a computer that would say whether a submitted design conformed to the rules or not.

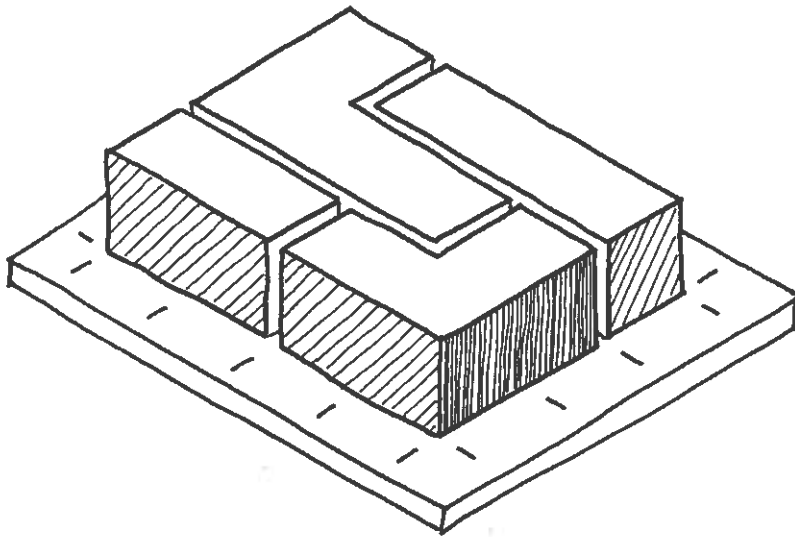


FIG 2.2 Bryan Lawson's blocks experiment

latter. Being lost in a sea of solutions is very unproductive—it is almost as bad as being stuck in a corner.

In design, we are rarely either completely free or completely bound by the problem. Designers have creatively to develop a design, but this creativity is not unrestricted. Achieving a good design is the challenge, one that solves the problems and creates value for the client and prospective user. Combining the two fundamentally different thinking styles of problem solving and creativity means that design is somewhat at odds with the normal ways in which we classify and understand the world. Traditional universities often do not have faculty structures that easily and logically accommodate design. National research funding councils are often either science or arts based. Design is an oddity. We might say it is the 'platypus' of the cognitive world. But like the platypus it is here and we had better learn to deal with it (Pirsig, 1991).

This blend of different thinking styles makes it difficult for many people to understand design. But to designers, these thinking styles are so intimately connected in a design project that they seem almost merged into one way of thinking. When steeped deeply in your design activity you just keep switching between analysis and creativity, between 'problem' and 'solution' without any effort. In practice it is often devilishly hard to distinguish between them.

This is where we should be careful not to descend into such a theoretical description and modelling of design that we lose all contact with the daily reality of life for designers. If designers do not feel a rift between these ways of thinking, then it does not help them much when the theoreticians tell them there is. The real issue resides with those of us who study design, based on the normal paradigms of science; the frameworks we normally use to describe and analyse human activities and cognitive processes ('creativity', 'problem solving', 'decision making', etc.) do not fit cleanly or easily with design.

DESIGN AS... PROBLEM SOLVING

A recurring and dominant model of design used in design education relies on seeing design as a problem solving process. How does this work? In classical problem solving you pose the problem, search for a good solution by generating (perhaps all) possible next moves, explore the consequences, evaluate them and then choose. This process of pose-search-generate-evaluate-choose can clearly be recognised in design practice. If we observe designers working we can sometimes see them doing something remarkably similar to this. So

BREAKING OUT OF THE CONVENTIONAL STRUCTURES OF KNOWLEDGE

The Duckbilled Platypus created a real stir in the biological world when it was first discovered. It can only be found in a very small part of the world mainly along the east coast of Australia. A specimen was sent by Captain John Hunter, the second Governor of New South Wales, back to the British Museum in 1799. George Shaw, the keeper of the natural history section was suspicious. Quite simply this creature ought not to exist at all, he thought, since it did not fit into any of the existing structures of knowledge. It looked very odd with its duck-like beak, mole-like furry body and flat beaver-like tail. Its behaviour was even odder. Like a mammal it has a furry body and suckles its young, like a bird, it lays eggs, and it has almost reptilian venomous spurs on its legs.

Shaw wrote that it was 'impossible not to entertain some doubts as to the genuine nature of the animal, and to surmise that there might have been practiced some arts of deception in its structure'. Suspicions were heightened since the specimen had crossed the Indian Ocean and Chinese sailors were known for their ability in taxidermy.

The platypus was finally accepted not as a hoax but as a challenge to science when more specimens arrived. Yet the platypus was only an anomaly because the biologists made it so. It is only strange because it does not fit neatly into their preconceived view of what a mammal should be. Luckily, the duckbilled platypuses themselves do not seem to be particularly bothered by this. From their perspective, there is nothing wrong. They delight us by going about their business, happily paddling from pool to pool, in tune with their ecological niche.

Today the platypus is classified as one of only three species known as Monotremes.

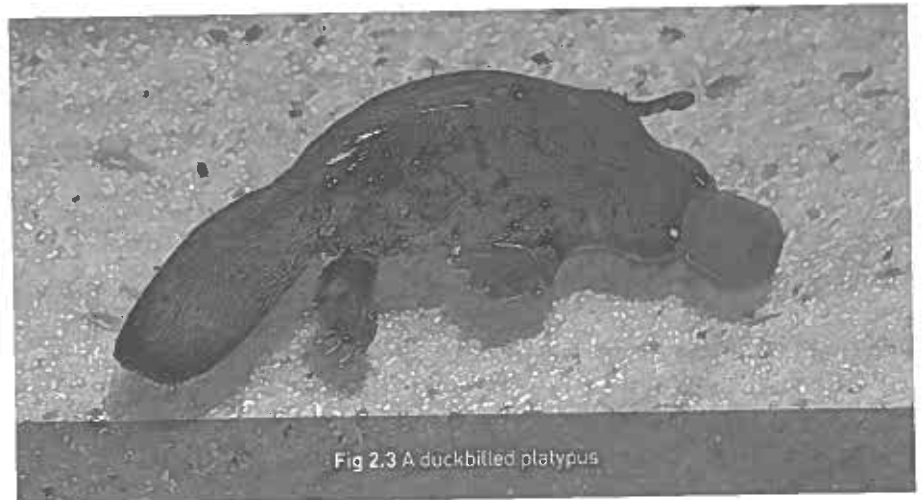


Fig 2.3 A duckbilled platypus

seeing design as problem solving does capture some aspects of design. It may not be describing all of design, all the time, but capturing half of design in a model already represents some progress.

The idea that design is problem solving has led to the development of phase models of the design process, in which you first define the problem, analyse it to formulate requirements and then generate solutions. You choose between these solutions with the help of your requirements, and then implement the chosen solution. This model of design has worked tolerably well in many design professions, although it has also been criticised. Like any model, it highlights some aspects of design while neglecting others. Yet, it seems that as long as the design goals are explicit, clear and stable, and a set of comparable solutions can be generated, design can be treated very much like problem solving. This seems to occur more often in the technically-oriented design professions, like engineering, and also more in the latter parts of a design project, when many of the conceptual decisions have been taken. The sturdy problem solving model and its many accompanying methods then help to structure design work, allowing designers to tackle very complicated design problems. It also enables non-designers to understand design, albeit in a limited way, by relating to a common activity (problem solving is, after all, an incessant universal human activity).

But there is danger in thinking that we have captured all design activity in this model. There is no way in which all of design can be reduced to a problem solving activity. There are many factors in design situations that take us away from the rational high ground of 'normal' problem solving, into a much more marshy and murky area of design practice.

DESIGN AS... LEARNING

When people first started modelling design, they tended to use the problem solving model of design as a clear and concise starting point for organising their thoughts and observations. Thus many of the early books about design tried to understand design in this manner. But the designers on the ground soon revolted against these abstractions, saying that while the problem solving models of design are particularly helpful for controlling and managing design projects, they remain remarkably silent when we want to know more about design than just how to control and structure it. This relative 'distance' from everyday experience has been a criticism voiced by practitioners of the problem solving view of design. Nigel Cross quotes Christopher Alexander, one of the early architectural design theo-

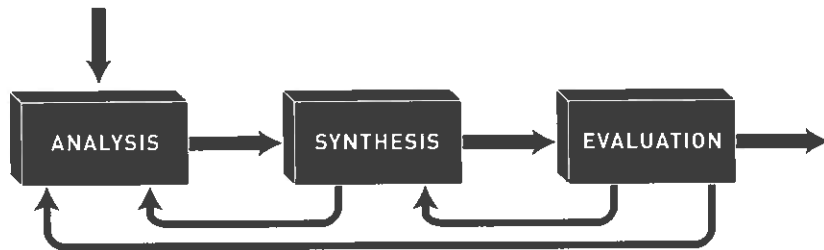


FIG 2.4 The conventional analysis synthesis evaluation model of designing

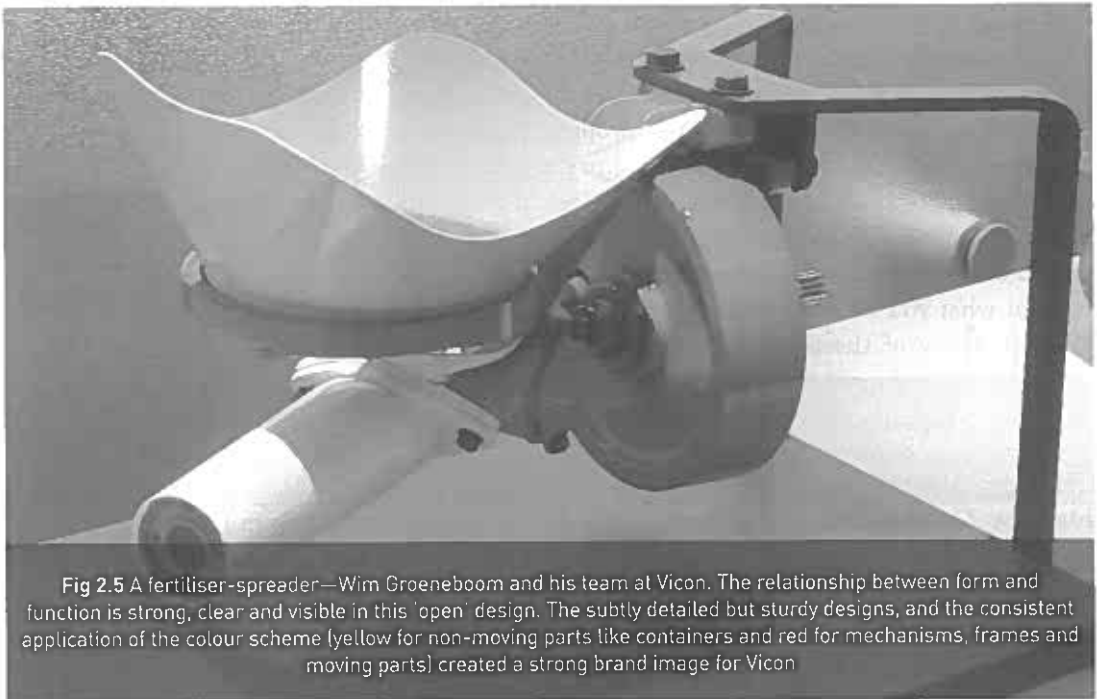


Fig 2.5 A fertiliser-spreader—Wim Groeneboom and his team at Vicon. The relationship between form and function is strong, clear and visible in this 'open' design. The subtly detailed but sturdy designs, and the consistent application of the colour scheme (yellow for non-moving parts like containers and red for mechanisms, frames and moving parts) created a strong brand image for Vicon

LEARNING FROM UNCERTAINTY

WIM GROENEBOOM

“ The big disadvantage (of design methods) is that through this kind of teaching we take away the insecurity of the students. It is a way of quickly and efficiently explaining design but that is deadly. Students have to learn to deal with uncertainty, and we take that away by this kind of teaching... In the end, I would say that dealing with uncertainties is the core of our design profession.

WIM GROENEBOOM

Wim Groeneboom (1940) started his design career at the Philips Industrial Design Centre in Eindhoven and later developed his own design agency with Willem Rietveld. His major design projects include the complete development of the metro trains for the city of Amsterdam (1971) and the design of the complete product range for Vicon, a highly innovative producer of high-tech farm machinery. In his design work, he combines a classic functionalism with a strong leaning towards research-based and evidence-based design. His work is valued for its ergonomic qualities, as well as for his ability to design complicated technical objects that look elegant and deceptively simple. Wim Groeneboom has also been deeply involved in design education, being one of the founding fathers of the faculty of Industrial Design Engineering at the TUDelft, where he has continued to teach throughout his long career.

rists, as saying that 'design theorists have definitely lost the motivation for making better buildings... there is so little in what is called "design methods" that has anything useful to say about how to design buildings' (Cross, 1984). A damning remark, if there ever was one. What it does signify is that we clearly need alternative models and metaphors to capture the richness of design.

A radically different view, which tries to arrive at a much closer description of design as it is often experienced by designers, concentrates on the learning that takes place during design projects. Design can be seen as learning; as a designer, you gradually gather knowledge about the nature of the design problem and the best routes to take towards a design solution. You do this by trying out different ways of looking at the problem, and experimenting with various solution directions. You propose, experiment, and learn from the results, until you arrive at a satisfactory result. For instance, when you are designing, you sketch an idea and then look at what you have made with a critical eye. This fresh look often immediately shows you what needs changing to improve the design. So you modify and then you again look critically at what you have done. Design can be described as a process of going through many of these 'learning cycles' (propose-experiment-learn) until you have created a solution to the design problem. In this way, you explore different possibilities and learn your way towards a design solution.

This description of design was most clearly articulated by Donald Schön, in his book *The Reflective Practitioner*. He describes design and work in the other professions he studied as a process of 'framing' a problem (a form of 'seeing as'), performing 'moves' towards a solution and the 'evaluation' of these moves, that might lead to new moves or to the seeking of a new frame (Schön, 1983).

Both the problem solving and learning models are valid, in the sense that they capture a part of what design is. Since this book is about the creation of expertise it is intrinsically about learning, so we shall inevitably find ourselves making extensive use of the learning model, although we will also keep connecting to the problem solving literature.

DESIGN AS... EVOLUTION

Creativity in the design process is often characterised by the sudden occurrence of a significant event; the so-called 'creative leap'. Sometimes such an event occurs as a sudden insight, but often it is only in retrospect that

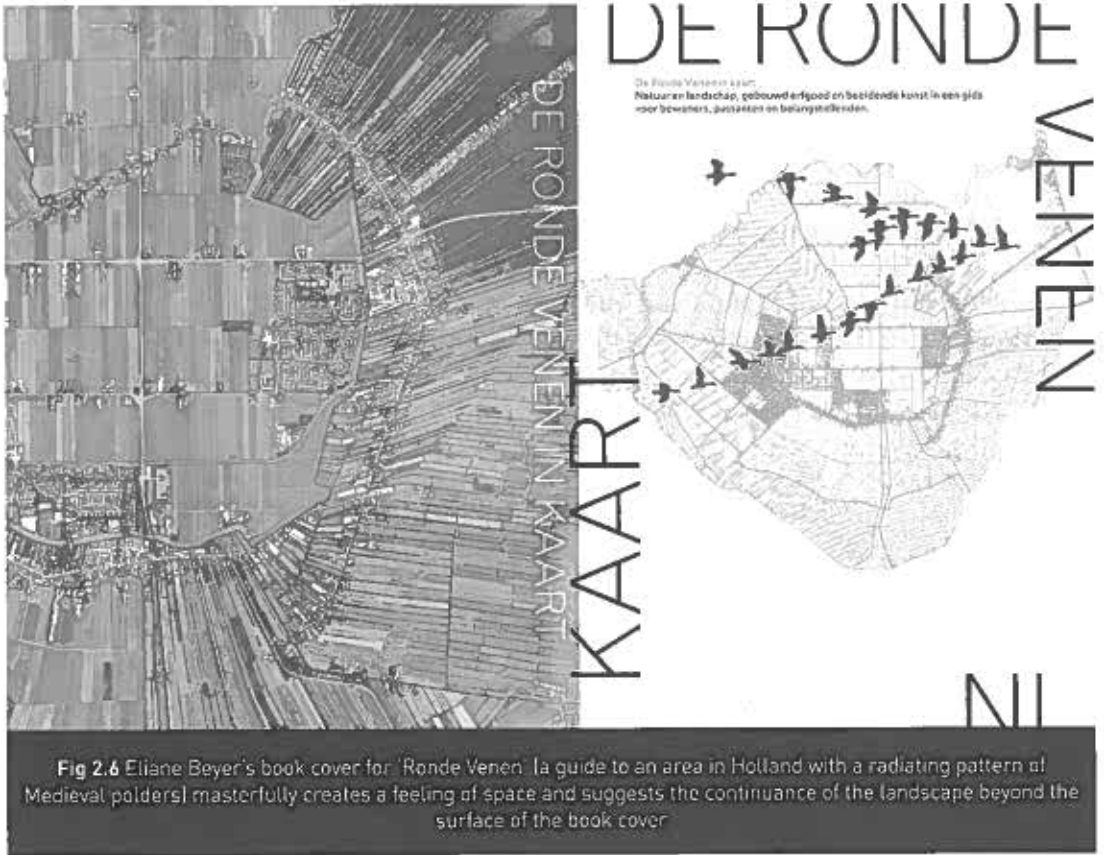


Fig 2.6 Eliane Beyer's book cover for 'Ronde Venen' (a guide to an area in Holland with a radiating pattern of Medieval polders) masterfully creates a feeling of space and suggests the continuance of the landscape beyond the surface of the book cover

ELIANE BEYER



Although most [of my designs] I come to intuitively, I don't just 'do something'. I start with my feeling, but then I introduce a theory. It is very hard to say how this works, but the reasoning emerges on the way. And then, when you look back, you think 'Oh, is that so?'

ELIANE BEYER

Eliane Beyer (1963) trained as a graphic designer at the Rietveld Academy in Amsterdam. She is part of the 'Joseph Plateau' graphic designers' collective, based in Amsterdam. She has designed several series of stamps, agendas and yearly reports for KPN Royal Dutch Post, and other major clients such as the Rijksmuseum and the Mondriaan Foundation. She has designed books and other publications for Droog Design. Joseph Plateau has received several prestigious 'best designed book of the year' awards in the last decade.

REFLECTIVE PRACTICE

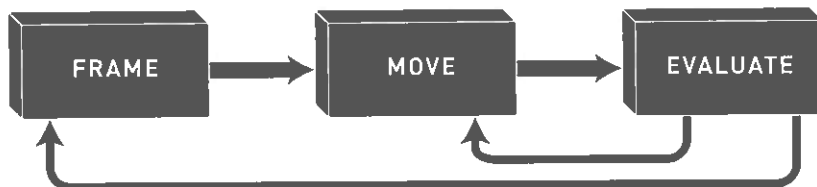


FIG 2.7 The Schönian frame-move-evaluate model of designing

a designer is able to identify a point during the design process at which the key concept began to emerge. Such reports after the fact may not be completely reliable. The idea of the creative leap suddenly illuminating the mind of its inventor dates from the middle of the nineteenth century. Of course, it is hard to say if this is truly how creativity works. There seem to be vague moments at the birth of ideas, which could be described and explained in a number of different ways. The most magical of all, the Eureka experience, is a folk psychology favourite. In retrospect, it often seems easy to imagine that an idea came to light in this sudden and unpredictable way thus confirming the theory. Often though, the evidence is either very sketchy or indeed unsupportive of the mysterious creative leap. Perhaps we are just rather attached to this romantic notion.

Observational research of designers at work has also shown that their process of solution development seldom relies on the 'Eureka' moment, but that it often is much more gradual, like an evolution. The initial ideas can be seen as the first primitive objects, evolving and becoming more subtly tuned to the design problem over the generations. But design problems are a moving target too. They are often nebulous at the beginning of the design project and as the designer acquires more knowledge about the problem and about the possibilities for solving it, the design problems become more concrete.

Jane Darke studied the way a number of architects had gone about designing award-winning public housing schemes in the UK. She noticed a common characteristic which seemed a little perverse on first examination. These architects seemed to come up with a major design idea very early in the process and certainly long before they could have really fully understood what were very complex problems. Working with Bryan Lawson for her doctorate, she was aware of his more laboratory-based research mentioned earlier which suggested that designers tended to use solution-based approaches. Together they named this phenomenon the 'primary generator', a concept which is now well embedded in the literature (Darke, 1978). These primary generators are basic ideas about how the solution might look. They are generally pretty strategic and not very detailed. They allow the designer to create a sort of hypothesis; 'what if the solution looked a bit like this?' What seemed to be happening, in the case of Darke's architects, was that in trying to develop the design along the lines suggested by the primary generator they actually discovered more about the problem. They would find ways in which this type of solution created difficulties, worked poorly or even created more problems than it solved. To use our previous way of describing design, this was truly design as learning.

THE MYSTERIOUS CREATIVE LEAP

A nice example of this mystification of the creative leap can be found in one of the greatest ideas in the history of science: Darwin's idea of natural selection as a driver for evolution. In his autobiography, Darwin claims to have created his theory of evolution and natural selection in a creative flash. He writes that the idea suddenly hit him when he was reading a treatise on human population by Malthus. Luckily for us, we can trace this moment of glory in his original diary of that time, where he dutifully reports having read Malthus. But no Eureka; just a brief entry. The next day he wrote a much longer piece on the sexual curiosity of primates. Reading Malthus was lost in a host of other books that he was browsing through at the time, and he developed many different ideas to explain the diversity of species that he had encountered in his voyage on the Beagle. If we read the diary carefully we can see that the idea of natural selection slowly dawned upon him. Darwin's creation of the theories of evolution and natural selection was a gigantic creative step. But there never was that one Eureka moment. (After Gould, 1992)

In many cases, of course, several primary generators might be tried and sometimes abandoned or eventually combined. Subsequent research has found that designers often struggle with their primary generators later on in the design project; they may be useful in the beginning, but there is a tendency to stick to them for too long, and trying to make them work no matter what. Then these primary generators can become real blockers to the development of better ideas, leading to tunnel vision and what is called 'design fixation'. Anyone extensively involved in teaching design students will be very familiar with this danger. More flexible and skilled designers, however, can often use the failings of a primary generator to enable them to reframe the problem.

Creative design then is not a matter of first fixing the problem and afterwards performing a 'creative leap' to a solution. Creative design seems more to be a matter of developing and evolving together both the formulation of a problem and ideas for a solution, with constant shuttling to-and-fro between the problem and solution. The aim of the designer is to generate a matching problem-solution pair. Design thus involves a period of exploration in which problem and solution are evolving and are very unstable, until they are (temporarily) fixed by an emergent idea which identifies a problem-solution pairing (Dorst and Cross, 2001).

The creative event in design then may not be so much a 'creative leap' from problem to solution as the building of a 'bridge' between the problem and the solution by an idea. A creative event occurs as the moment of insight at which a problem-solution pair comes together. This can be such a triumphant feeling that it overshadows all the slow and laborious evolution that went before it. Perhaps that is the origin of the myth of the creative leap.

In the conversational, co-evolution view of design we might be less inclined to make the distinction between problem and solution at all. Indeed, we might see frames and primary generators as ways of negotiating between a problem and solution view of the situation in order to bring about some resolution between what is required and what can be made. But maybe that is going too far: the terms 'problem' and 'solution' are so widely used in common parlance that we cannot ignore them here. And in some design domains the problem may be very clearly stated and success easily measured and thus the process may be more one of moving from a problem to a solution in a fairly linear motion. At the other end of the spectrum of design domains, the formulation of the design problem may only emerge from an extensive exploration of solution possibilities.

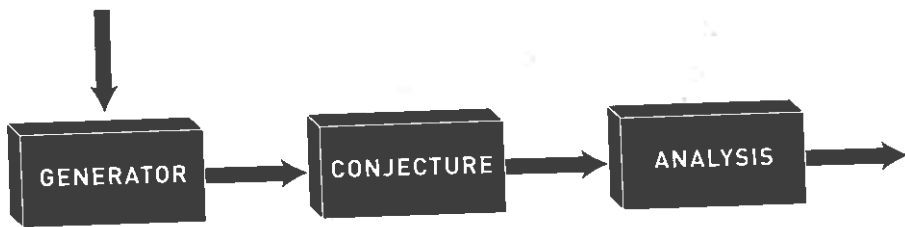


FIG 2.8 Jane Darke's primary generator model of designing

DESIGN AS...

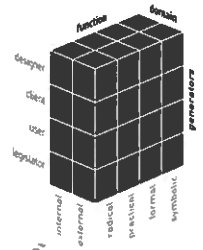
THE CREATION OF SOLUTIONS TO PROBLEMS

Several times in the discussion so far we have seen hints that there is something very special about design problems. In fact, they are so special that we do not really like using the word 'problem' to describe them. This word suggests that they can be solved and therefore by implication that the problem solving view of design is adequate. This is plainly not the case. At times during any design project there may be well-defined problems to solve, perhaps even puzzles with an optimal answer, but overall design is not like this.

In his many perceptive publications Donald Schön claimed that every design problem is unique. Every problem has its own specific situation either in space or time or both. Even tackling the same design problem again is different because it has been changed by our knowledge of the earlier solution. Design problems of the kind we are interested in here are never fully defined. The fact that they are not amenable to the 'classic' problem solving methods has driven the proponents of those methods to call them 'ill-structured' (Simon, 1973) or even 'wicked' (Rittel and Webber, 1973). Perhaps these rather negative descriptions reveal a hint of frustration at the failure of the problem solving methods in tackling design.

More positively, Cross has pointed out that what you need to know about design problems depends upon the approach you are taking to solve them (Cross, 1982). This effectively pulls the rug from under any attempt to describe them in an objective way. What constitutes a problem depends on the abilities of the problem solver so the problem is inherently subjective!

However, we need not despair. It is possible to build some sort of typology of design problems. Lawson used a constraint-based approach to this to create a three-dimensional model showing the generators, domains and functions of constraints (Lawson, 1997). He suggested that design situations differ from each other by the way they are distributed within this model. (This model can be seen with a more detailed discussion in Chapter 4.)



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Dorst showed that design problems also vary in the extent to which they are determined. He argued that they are neither completely fixed nor completely free (Dorst, 2006). In fact, he suggested three states for this fixity of design problems. Firstly, they can be determined by what he called 'hard and unalterable needs, requirements and intentions'. This would make them more or less amenable to problem solving methods.



BUT, IS IT ART?

Navigating this freedom is the ultimate challenge for the fine artist; there are no 'requirements' for art. While design is always to some extent grounded by functionality, by the obligation to relate to the needs of people and the requirements of stakeholders, art is not functional; it does not need to make 'sense'. Artists are more or less on their own, having to develop a personal and interesting starting point for the production of works.

← But secondly, Dorst argued that a major part of design problems are inevitably under-determined. Perhaps none of the stakeholders have strong constraints, leaving the designer free to make autonomous choices. This is the kind of situation where the work of the designer can touch that of the artist. Such problems need interpretation by the designer. This means that different designers may interpret them differently and that this interpretation is itself part of the creative act of designing. In these aspects of the problem the designer is, to a large extent, free to work according to personal taste, style, interests and abilities. This links nicely with Lawson's model which includes the generation of constraints by designers alongside those created by clients, users and legislators. This designer generation of constraints becomes a vital activity in under-determined design situations.

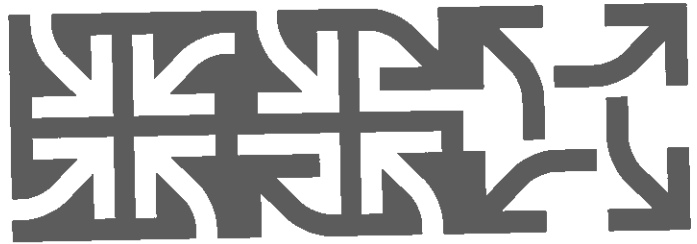
Finally, some design problems are over-determined according to Dorst. In such situations there are so many constraints that quite simply cannot all be satisfied and there are many irreconcilable conflicts. Paradoxically, there is some freedom of choice in the design process for the designer who has to judge which of the conflicting constraints are going to prevail. This again requires a subjective interpretation step before the design situation can be tackled.

One of the challenges then of design is to be able to spot the kind of situation you are in. It will simply be no good taking a tight problem solving approach to a largely under-determined design problem and vice versa. Expert designers understand this and adjust their approach to the situation. The description by Richard MacCormac of his work at Bristol University in England is a remarkably sensitive evocation of these issues. The project consisted of working with a number of existing houses already used for academic purposes and linking them to create faculty accommodation.

DESIGN AS... INTEGRATING INTO A COHERENT WHOLE

All of the various demands of the project's stakeholders have to be reconciled within a design. The difficulty here is one of mapping. One cannot design by simply creating individual partial solutions for all the issues that the stakeholders might have and then building together all of these sub-solutions. To arrive at a good solution, the designer needs to create a design in which all the issues and demands of the stakeholders are addressed in an integrated manner. There is no one-on-one mapping from problem to solution. The features of the design are created in such a way that they address many problems at the same time.

DETERMINATION



DETERMINED ——— UNDETERMINED

The design that is thus produced must be 'good' as seen from all these different perspectives. These stakeholders all come with viewpoints, knowledge and values from their own world. The designer creates a solution in which all these different worlds must be combined. Attaining a well-integrated design, then, is all about getting the balance right. After concentrating on one stakeholder or perspective on the design, the designer must compensate for the inevitable limitations and bias of that approach by making further moves that balance the first. For instance, if a product has been designed while focusing on form, the designer will have to compensate for this bias by investigating whether the design is technically possible, producible, ergonomically sound, economically feasible and so on. Integration-loops like these are made constantly while designing. To achieve integration, the parts of a design have to be developed more or less in parallel.

Designing sometimes feels like being a Chinese juggler, dashing around frantically keeping a myriad of plates spinning on their poles. Yet from time to time a designer must stop this running around, and create a renewed overview of the design. It is so easy to get much too involved in one pet solution, stakeholder or aspect of the design, and neglect others. Integration is tricky enough to attain in design practice, but the task is severely aggravated by the need simultaneously to reach coherence.

Coherence describes the extent a design is 'unified', free from inner contradictions and can be perceived as a whole; a single entity. The need for coherence effectively limits the amount of compromise a designer can build into a design. Well-integrated and coherent designs are characteristically simple, elegant and give the feeling that everything has been taken into consideration, and is as it should be. There is a glimpse of perfection in an integrated design.

DESIGN AS... A FUNDAMENTAL HUMAN ACTIVITY

Designers are convinced that 'design' is a special way of thinking, and in their battle for recognition, they spend a lot of time trying to convince the rest of the world of this. But surprisingly seventeen or eighteen-year-old students, new to design school, seem to just start designing. At a simple, basic level of course, but they manage. It does not seem as if they first have to learn an alien, fundamentally different thought process. This tells us that, no matter what designers may claim, apparently there is a certain level of design that can be approached by common sense.



RICHARD MACCORMAC

I know we live in a very un-visual culture and a lot of our problems come from that, but... the sense I have that architecture is a kind of analogical or metaphorical way of thinking and I think architects try and translate the stuff of briefs into some kind of structure as soon as possible and the most one of the most vivid experiences of that was in the Bristol University Faculty of Arts scheme, where one sensed that the scheme could be a kind of model of a very, of a complex large university department and that's what it came out really... the real problem is concealed in the way it is written about as a brief often. And the real problem is some kind of structural problem, I don't mean in an engineering sense, I mean in the sense of relationships, in this Bristol case—the problem which the brief couldn't describe was really the problem of trying to attach new buildings to listed existing buildings in such a way that it would be acceptable to the conservation lobby, and would get planning consent, and yet would give a continuity of accommodation that would allow a lot of flexibility of re-naming and different territorial arrangements between existing buildings and new ones, and so there had to be some kind of a network and it was in fact a kind of grid if you like, of relationships.

There was another I suppose which could only be hinted at in the brief which is what physical arrangements tend to produce the idea of a faculty—and we felt very strongly under these conditions, apart from this continuity of fabric and social continuity that would allow the circulation system, which was going to be pretty meagre in terms of UGC funding, would be amplified if we could string all the departmental common rooms out along the circulation system and use them as expansion chambers for lecture theatres, which otherwise would have caused terrific congestion. Now those issues don't appear in briefs often, they are the stuff of the thing which only comes out when you try and solve, when you try and produce a scheme and therefore the design process defines objectives in a way in which a brief could never do.



Perhaps this sounds disappointing and we designers would rather be something special, but there it is. But just what is common sense, anyway? This deceptively unassuming name actually stands for an extremely complicated set of thinking strategies that we use to navigate through the world; the things you never explicitly learn, but that you absorb as you grow up. Although expert systems have been built that can, to some extent, deal with large amounts of explicit knowledge, only the most avid artificial intelligence enthusiast would claim that we are ever going to get common sense into a computer. Common sense is just too context-dependent, complex and subtle that we need the human mind to do it. So there is no shame in having a profession that can contain a generous helping of common sense thinking.

The real difficulty in design is not in reaching that very first level of apparent competence; it is in attaining the higher levels. And that is where the design profession sits. Most expert designers certainly employ many more sophisticated cognitive skills, as we shall discover on our journey through this book.

In passing it is worth noting a trend in many other professions, to describe their work as 'designing'. For instance, managers now 'design' company policies, teachers 'design' a curriculum and care models are 'designed' in medical circles. Using this design metaphor appears to suggest the adoption of an open, creative, solution-focused way of working, perhaps unusual in the field, and this may offer new freer ways of working. Some of the tricks and methods that designers use can probably benefit people in many professions. Though it is likely that the way these professions deal with design is probably only just emerging from the 'common sense' level. Designers, with all their experiences of the ins and outs of designing, can play an important role in professionalising design in these disciplines. This is beginning to happen; in fact, designers are spreading throughout society. These days, you encounter people with a design background in all kinds of jobs. These people use their design thinking to create solutions to the problems they face in areas that are far beyond the confines of the 'traditional' design professions.

Many more things can be said about this subject; the second author of this book has published a book that contains 175 mini-essays, all of them stabs at understanding our incredibly complex design profession (Dorst, 2006). But for now, this rough characterisation of design is enough to get a feeling for the field, and provide a basis for some more serious modelling of the design activity in the next sections.

However, we still cannot find a single all-encompassing model of design. Instead we present three models of design or ways of thinking about design,

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CONVERSATIONS WITH DRAWINGS

DENISE SCOTT BROWN

Sometimes the hand does something that the eye then re-interprets and gets an idea from and that kind of drawing for yourself and a few other people around the table is Bob's (Venturi) great specialty and those drawings have a nervousness to them and a tension, some of them are just wonderful but they are never done as a piece of art, they are done as a communication with self and with people around the table.

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each of which have something useful to say about this most enigmatic and fascinating area of human cognition.

DESIGN MODEL #1: THE NATURE OF DESIGN ACTIVITIES

In a seminal paper Nigel Cross summarised the scientific knowledge about the activities that make up designing (Cross, 1999). He listed many of the things that designers typically do. According to Cross, designers typically 'produce novel unexpected solutions, tolerate uncertainty, work with incomplete information, apply imagination and constructive forethought to practical problems and use drawings and other modelling media as a means of problem solving'.

Cross then goes on to produce an accompanying list of the abilities designers must have to carry out these activities, and do them well. They need to be able to deal with uncertainty and decision making on the basis of limited information, resolve ill-defined, 'wicked' problems by adopting solution-focusing strategies, employing productive/creative thinking and using graphic or spatial modelling media.

This is an impressive list with a wide range of necessary skills. They do spark immediate recognition in designers, but their very closeness to design practice might also explain an apparent lack of structure in this list. It does not present an overarching model of design, and there does not seem to be one hidden behind it; perhaps there can never be. But in an attempt to impose some sort of order on all this, it may be useful to think of these design skills and group the corresponding design activities under some headings.

The most obvious set of skills employed by all designers are those to do with making design propositions. These are sometimes developed and sometimes abandoned. We might see this whole group of skills as to do with making moves and we shall therefore refer to them as 'moving'. These moves are most often made through some form of representation. They may be described in words or put into computers or, most common of all, visualised through drawings of one kind or another. We shall call these skills 'representing'. Another set of skills are clearly those to do with understanding problems and describing them. We shall refer to these as 'formulating'. The way moves are regulated is most obviously by an evaluation of them against some set of criteria however precisely or vaguely understood. So there is clearly a whole range of skills which we shall refer to as 'evaluating'. In addition to all this there is some group of activities that oversee the whole



Fig 2.10 Extension to National Gallery, London by Venturi, Scott Brown showing a characteristic sense of humour as the building copies the original less and less accurately as it moves further away from it

ROBERT VENTURI AND DENISE SCOTT BROWN

Robert Venturi studied architecture at Princeton University and the American Academy in Rome. His early architectural career included periods with Louis Kahn and Eero Saarinen. Denise Scott Brown studied at the Architectural Association in London and at the University of Pennsylvania. She has taught at the Universities of Pennsylvania, California at Berkeley, UCLA, Yale and Harvard. They have collaborated since 1950.

Their work includes the decorative arts, furniture, architecture, urban design and planning. They are at least as well known for their writing as for their design. Robert Venturi's book **Complexity and Contradiction in Architecture** is arguably one of the most significant contributions to the debate about the post-modern movement. Robert Venturi and Denise Scott Brown, together with their associate Steven Izenour, followed this with their equally influential treatise on 'Learning from Las Vegas'.

In 1991 Robert Venturi joined a very select band of recipients of the Pritzker Architecture Prize. The jury said 'He has expanded and redefined the limits of the art of architecture in this century, as perhaps no other has, through his theories and built works'.

process and provide support for it. A more or less conscious effort is needed to keep the design activity on course towards its target. We shall refer to these skills as 'managing'.

A model of design skills and activities is beginning to appear. We have groups of activities and skills that are all needed and are commonly found in successful design. They are 'formulating', 'representing', 'moving', 'evaluating' and 'managing'. In the next few pages, each of these activities will be explained briefly, and some first comments will be made that elucidate their application in design practice. If we want to understand the creation of design expertise then we had better have an appreciation of the nature of these constituent skills.

FORMULATING

The design process is a sequence of activities. Logically it would seem that getting a brief and analysing the problem comes before the synthesis of solutions but we have already questioned that assumption. However, there can be no argument that designers must be skilled in finding and stating problems and in understanding and exploring them—maybe not all at the beginning of a project, but as a recurring activity.

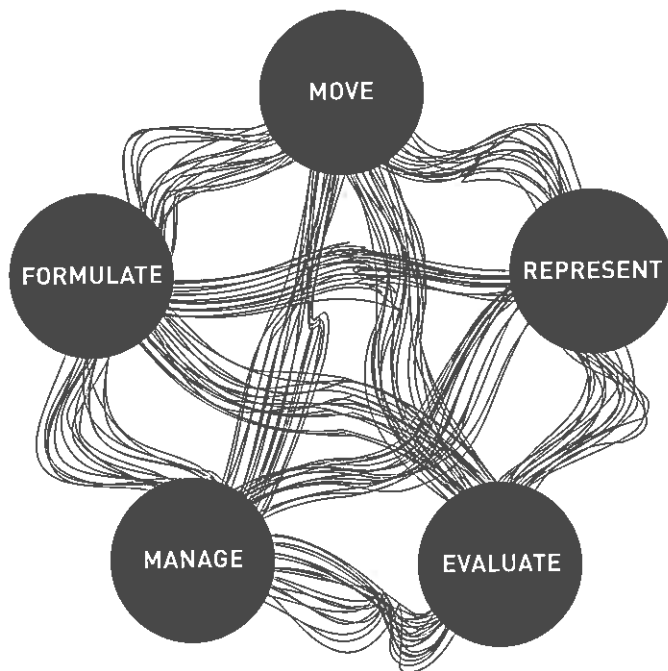
IDENTIFYING

In the problem solving view of design these skills include the ability to reformulate and organise ill-structured or wicked problems. In the conversational and learning view of the process designers are said to identify, or as Schön would put it, 'name' elements in the design situation. It is almost as if characters are being introduced in a story and their roles and personalities are being explored in order to understand how they will react to events and behave as the story unfolds. Whether we think of it as the reformulation of problems or the identification of elements, making them explicit and developing their characteristics is not a clear-cut thing but very much part of the design project. This is clearly an important and central design skill.

FRAMING

Perhaps the most important contribution made by Schön and his followers to the debate about design is the idea of 'framing'. This activity involves selectively viewing the design situation in a particular way ('seeing as...') for a period or phase of activity. This selective focus enables the design to handle the massive complexity and the inevitable contradictions in design by giving structure and direction to thinking while simultaneously temporarily suspending some issues. The skill to create and manipulate frames is a central one in determining how the process will unfold. As we will see later in this book, the high-level skill of framing is crucial in the development

DESIGN ACTIVITIES



of design expertise, and often the central activity in the working lives of top-designers and architects. The quality of design work produced depends as much on the ability of the designer to frame the problem relevantly and productively, as on the ability to arrive at an interesting solution from this standpoint; maybe even more so.

REPRESENTING

Although it is perfectly possible to imagine design taking place without any externalisation at all, in practice designers almost always externalise their thoughts prolifically. Indeed designers are often characterised by their habitual use of these activities. They draw, write, model, make and compute representations of their inchoate ideas for the design they are working towards. They also shuffle and represent to themselves information about the brief or problem. This extensive use of representation relies on texts, sketches, models and indeed the whole environment as a type of 'external short-term memory'. Design offices are always full of stuff that can spark ideas, feed the intuition or relates more directly to the projects at hand. Designers more or less live within their projects!

CONVERSATIONS WITH REPRESENTATIONS

As Schön has so eloquently put it designers interact with these representations in a conversational way (Schön, 1983). The representations are thus far from being incidental outputs but are rather central inputs to the thought process. Clearly then the ability to execute these representations and manage them is one of the central skills in designing. A designer who cannot sketch is likely not to be able to 'converse' freely with the situation. Drawings are undoubtedly amongst the most central and important of all these forms of representation and those drawings come in several types including most crucially design drawings, diagrams, and visionary drawings. In design practice, some time is spent on managing what can be an avalanche of material around a project, and professional designs can often be seen making periodic overviews of the materials gathered and produced. They see this as a natural and vital part of their professional practice—often to the surprise of design students, who often assume there is some kind of inherent creativity of messiness.

WORKING WITH MULTIPLE REPRESENTATIONS

Most designers do not actually make their designs, but rather they make representations of their designs. They make drawings, computer models, textual descriptions, physical models and so on. In a way the whole point of such a process is that it enables change and experimentation at much lower cost than would be incurred by making the designs themselves. Such a process then is based on the reduction of risk to the designer. Unfortunately,

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THE PENCIL AS SPOKESMAN

RICHARD MACCORMAC

Whenever we have a kind of design session or crit review session in the office I cannot say anything until I've got a pencil or pen in my hand and one covers across, well we have these rolls of paper and you get through them at a fantastic rate. I feel the pencil to be my spokesman as it were, nowadays I suppose most of what I do is freehand... mostly I'm using drawing as a process of criticism and discovery and tweaking and direction finding.

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what we have often seen is that the risk can be transferred to the client who pays for the representations to be made real. The skills of choosing and making representations that minimise this risk and that represent the finished design as accurately as possible to the client and to users may also be ones which are critical in the success of real design processes.

This story does not always hold true for some of the new design disciplines. If you look at web design, for instance, quite a different pattern emerges. In developing a website or an interactive system for a computer, you work on designs that are easy to replicate, and that will be used in the same medium through which they are made. You make things that are going to run on a computer, and you make them on a computer. So you have a realistic 'prototype' at almost any moment during the design process. This allows the designer to do user testing at all times. Designing then changes from a vaguely linear process which leads from small sketches to bigger sketches to presentations to computer models and then on to a prototype, into a process of continuous testing and learning. In these new design professions, design could become a more continuous and evolutionary process; the designer is able to test many generations of the design before delivery (although we would agree with any reader that the above grand opportunities for testing designs have not prevented the proliferation of maddeningly confusing websites).

MOVING

So central to design is the activity of solution generation that the word 'design' is sometimes only used to relate to this group of activities. What we have seen now is that there are several activities under this general heading of making design moves. Firstly and most obviously, a new move may be made which has not been seen before in this process. A feature of the solution is placed, or given some shape or some relation to some other element or given some characteristics. Secondly, a move may alter or develop the existing state of the solution. Where do such ideas come from? We shall develop answers to that question under the section on reflecting.

INTERPRETIVE AND DEVELOPMENTAL MOVES

Not all moves in design are entirely original to the process. Margaret Boden's distinction of 'h' and 'p' creativity is partially helpful here (Boden, 1990). We have four possibilities in a design process. An idea may be entirely novel in all of history (h). Actually such events are relatively rare in our developed and sophisticated world. It might be entirely novel as far as the designer or design team are concerned (p), it might be entirely novel as far as this particular process is concerned, and finally it might derive from another idea that has already appeared in this process.



EVALUATING

OBJECTIVE AND SUBJECTIVE EVALUATIONS

Not only do designers generate alternatives between which choices must be made but also they must know, rather like an artist, when to stop. Clearly then, designers must have evaluative abilities. In some aspects of design this can be considerably aided by technology when numerical criteria can be set, for example the energy consumption of a building. Characteristically though, design involves making judgements between alternatives along many dimensions that cannot be reduced to a common metric. Designers must then have a very particular evaluative skill enabling them to feel comfortable about arriving at such tricky judgements. Designers must be able to perform both objective and subjective evaluations and to be able to make judgements about the relative benefits of alternatives even though they may rely on incompatible methods of measurement. Indeed, designers may develop their own particular tools for evaluating designs against the criteria that are often important to them either because of the kinds of objects they frequently design or because of the guiding principles they have developed.



pg. 181

THREE QUALITIES


But evaluation in design is much more than just a straight choice between alternatives, on the basis of a more or less clear list of criteria. It is much more of a process of deliberation; because the design discipline implicitly contains many incommensurable viewpoints about what is 'good' and 'bad'. Here we explore three fundamentally different ways of defining quality.

1. Some designers and critics tend to be utilitarian; they would say that a design that people want and buy is, by definition, good.
2. Others would argue that a design can be intrinsically good, regardless of the reaction of the public. They say that quality is deeply engrained in the things we make, and not dependent on the whims of public opinion.
3. Still others argue that designs that are made in correspondence with certain principles which they would hold to be virtues (like simplicity, honesty, care, 'showing the hand of the maker'), and that designs derive their real quality from this.

Discussions about designs often touch upon two or more of these frameworks. Evaluating design then usually involves weighing the relative importance of such incommensurate value systems and building bridges between them.



BEAUTY AND COMFORT



The famous American architect Philip Johnson is reported to have said that: some people find chairs beautiful to look at because they are comfortable to sit in, others find chairs comfortable to sit in because they are beautiful to look at.

SUSPENDING JUDGEMENT

Undoubtedly one of the skills that a designer must have here is to also be able to suspend judgement to allow creative thought to flow and ideas to mature before they are subjected to the harsh light of penetrating criticism. Extremely talented and creative designers are not always very helpful when teaching students as they sometimes fail to appreciate just when and how to do this.

MANAGING

REFLECTION ON ACTION

Since Schön introduced the idea of the 'reflective practitioner' there has been much more recognition of the importance of this concept of reflecting upon actions. In design at least this seems to be capable of two interpretations which we might call 'reflection in action' and 'reflection on action'. The concept of reflection in action is already covered here by combining our formulation, moving and evaluation activities. With such a model the designer is more or less continually reflecting on the current understanding of the problem and the validity of the emerging solution or solutions. As in the example of the idea-sketching activity: the designer fluently moves from making a proposal towards stepping back and reflecting upon it, and deciding on a modification, all in one flow. This can happen on a split-second timescale, as well as in design sessions spanning days or weeks. Reflection on action can be seen as a higher level activity in which the process is monitored rather than the state of the design. Such a concept clearly involves the creation of an overview and a stepping out of the 'flow' of the design activity. It involves a mental 'standing back' and asking if the process is going well or might be steered differently.

BRIEFING IS A CONTINUOUS PROCESS

Contrary to the wishes of many who have tried to establish route maps of the design process, briefing appears to be a continuous process. It is certainly not something that happens exclusively at the beginning but rather represents the problem formulation aspects of designing which are often greatly influenced by the emerging potential solutions. In design, problems do not even necessarily precede solutions in the way normally expected in conventional problem solving. Thinking about solutions and thinking about problems seem inextricably interwoven in the design process. This may well offer us one useful way to distinguish between different design fields. Some design fields have very clearly defined problems that can be quite well described and understood at the beginning of the process or very early in it. Others may characteristically have more open-ended problems that can only be very loosely described and only vaguely understood at the outset.

● **PARALLEL LINES OF THOUGHT**



PARALLEL LINES OF THOUGHT

Designers appear to be able to develop parallel lines of thought about the problem-solution situation. Each line of thought seems to respond to a frame in order to restrict the view of the problem and to rely on a primary generator to develop ideas about the solution. It seems probable that highly creative designers may be able to sustain several of these parallel lines of thought and allow them to be incompatible or even apparently irreconcilable for extended periods during the design project. Judging when to drop some of them or try to resolve the conflicts between them seems to be one of the key skills required for creative design. Indeed, it may even be the case that a creative reframing of the situation allows for a new view in which the various lines of thought can be incorporated into one single higher level set of ideas. The ability to think along parallel lines, deliberately maintain a sense of ambiguity and uncertainty and not to get too concerned to get to a single answer too quickly seems to be essential design skills. This also sheds some light on the decision process that accompanies a design project; clients are often surprised that the design is subject to many changes after the choice of a concept. This is because the choice of a design concept may represent a freezing of a way of describing the problem but not necessarily the solution.

DESIGN MODEL #2: LEVELS OF DESIGN ACTIVITY

Most readers will recognise many, if not all, of these activities and the accompanying skills from their own work as designers, educators or students of design. This first modelling of design already goes a long way towards capturing design practice. But design is much more complicated than this. We should be aware that 'formulating', 'representing', 'moving', 'evaluating', and 'managing' all take place within design on four distinct levels which we shall call 'project', 'process', 'practice' and 'profession'.

The Malaysian architect Ken Yeang shows an awareness of the 'project', 'process', and 'practice' levels in his comments quoted here and his body of work contributes substantially to the development of our fourth level, the architectural profession itself. Yeang has become known not only for his designs but for consistently pushing forward an agenda about sustainable high rise buildings in the tropics. Through this he has developed an approach to regionalism based not on copying slavishly from the past but on understanding the sound principles behind traditional architecture. He has published these ideas and arguments in many books and clearly sees an interaction between our four levels.

● DESIGN LEVELS

PROFESSION
PRACTICE
PROCESS
PROJECT

1. THE DESIGN PROJECT

Most of the design activities that have been described in our first model drive the design work within a design project (for instance, describing the reflection on the state of the design problem or solution as *Reflection in Action*). Projects are the locus of design work for a client, and they are the main economic element in any design organisation. In a design practice the projects represent income streams, resource needs, timescale and many other features of managing the organisation. Therefore, designers and design researchers alike tend to focus almost exclusively on optimising design performance within the context of the concrete design project.

The training that designers receive is also very much project-oriented; the majority of university design curriculum takes place in 'project work' in 'the studio' (see Chapter 6 for a much more extended coverage of studio-based education). This is almost considered to be 'learning on the job'—and indeed, an important part of design practice is mimicked in the educational environment. Students can even graduate from design school with the impression that being in projects is all that there is. But there is much more to a design existence than project work; many activities in a design practice have to do with the preparation of offers to clients, doing research to support the general development of the office, feeding the inspiration and continuous professional training. There is often a stream of self-initiated design activities that does not fall within the 'classical' project format.

2. THE DESIGN PROCESS

We have already discussed the activities of the design process in detail in our previous mode. We need a brief linguistic intermission here; this is where describing design becomes slippery again. Please note that we use the word 'process' here in a very general sense. By 'process' we mean the methods, ways of working of a designer, and *not* as describing the concrete sequence of steps within a design project. Designers do not just work in (inside) a design project, they also create overviews of the design project to monitor its progress; they have to step back from the hands-on level of working within the project to reflect on what they are doing. This reflection *on action* can lead to devising new 'frames' or 'moves' (or series of moves, patterns of which can be captured in more or less formal 'design methods') to develop the design project.

This process level is an important one; it is here that, through their reflective moments, designers learn from their projects and develop their own approaches to design problems. This is crucial for developing a more

KEN YEANG



Any architect with a mind of his own, whether by design or default will produce an architecture which is identifiable to that architect. Sometimes that's more apparent or evident in the work and sometimes it is more internalised... I had to study ecology, I had to study biology; that was the basis for most of my design work. I'm trying to develop a new form of architecture. We have this climatically responsive tropical skyscraper agenda and each project we try to see whether we can push an idea a little bit further... I give every new member of staff the practice manual to read when they join. They can see not just past designs but study the principles upon which they are based. We work these out over time, over many projects... But in a project I have to be very dependent on my architects and each one of them has their own personal way of doing things, and I try to respect that so they are constantly improving and making things better, there is growth and they get motivated.

I do competitions more as an academic exercise. I treat competitions as research projects... it motivates the office—gets them excited—lets the mind develop new thoughts and themes. I put all the drawings together and publish a book... look in this book, these were our competition drawings for Kuala Lumpur and people said 'how can you spend so much time doing drawings and so on' and I say 'it's research, it develops ideas'.



Fig 2.11 One of Ken Yeang's recent projects illustrating one of his recurring themes—integrating landscape with buildings

KEN YEANG

Ken Yeang was born on the beautiful Malaysian island of Penang in 1948. He studied at the Architectural Association in London and the Department of Landscape Architecture at the University of Pennsylvania. Finally he studied for his doctorate at Cambridge University, which was concerned with the role of ecological considerations in the design of the built environment. He has practiced mainly from Kuala Lumpur and is now also in partnership in London.

In particular Ken Yeang has developed a reputation for designing climatically responsive tall buildings. Dr Yeang himself has also continued to write and lecture on his search for a new form of architectural expression which both has a regional identity and is ecologically sound. He has published many books as well as articles in both Asian and European journals.

Ken Yeang has taught and examined at universities in Malaysia, as well as other schools of architecture in Europe, the United States of America, and Asia. He has been Vice-President of the Commonwealth Association of Architects, and chairman of the Architects Regional Council of Asia (ARCASIA), president of the Malaysian Society of Architects and on the RIBA Council.

strategic view of design, and possibly a distinctive 'style' of designing. This reflection is a vital part of creating design expertise.

3. THE DESIGN PRACTICE

The same basic activities of 'formulating', 'representing', 'moving', 'evaluating' and 'managing' are used again at a level that is a step removed from the concrete project level, that of the development of the professional practice. This can be seen to include the style and assumed role of the designer. This professional stance or personal position is something we shall discuss in detail in later chapters. Suffice it to say here that all designers gradually begin to acquire some attitudes, interests and even principles that govern their work. Along with this comes a set of knowledge and particular experiences which may lead to specialisation. In any case, such awareness must surely change the design process as Theo Groothuizen points out. Experienced designers become familiar with certain kinds of problems or ranges of solutions, technology or groups of users. However, many design practices are not managed by a single individual but may be a partnership employing junior designers. The creation of collective practice design expertise will interest us in a later chapter.

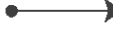
Many recent developments in design have impacted upon this practice level. The increasing complexity of design problems and the growing number of parties involved have led to the development of what is called 'participatory design' or 'co-design'. In these new ways of dealing with design practice, there is a much more active engagement by the designer with the prospective user. In participatory design the user is asked to help evaluate developing design ideas during the design project. In co-design the user is actually part of the design team, actively co-creating the design with the professionals. Each of these new ways of embodying the design profession requires the designer to leave the ivory tower of the studio and to engage with the design situation in a new way. There is as yet no definitive role for the designer in such processes and it is unclear how these trends are going to be developing in the coming years.

The changing nature of business structures in many Western design firms, brought about by the forces of globalisation, is also impacting on design practice. Product design firms, in particular, seem to suffer from a loss of the profitable embodiment (engineering) part of their design projects. That tends to move closer to the countries where the production takes place, leaving the design agencies in the West with a much reduced economic base just consisting of the comparatively few hours of conceptual design; hours that tend to be rather high-risk requiring the more experienced and expensive staff members. But the picture is not all gloomy; other design firms have



THEO GROOTHUIZEN

When you have a lot of knowledge in a field, that is comfortable; but is also limiting. I notice that when I design telephone booths I know so much about telephone booths that designing one becomes more and more difficult. Because if you did a good job on the last one, then that contains many of the optimal solutions, or the optimal choices, or the choices that fit me as a designer... this reminds me of playing chess: it always surprises me how easily a beginner can play. We call that beginner's luck, they are not hampered by too much knowledge. The more you know about chess, it does not become easier or more difficult, but you are able to make many more combinations...



thrived in the same years. Most of them have followed a strategy of self-initiating projects, and selling their design concepts (with intellectual property) to companies. This does require a different, much more entrepreneurial stance from these designers. Perhaps a new business model for design practices is emerging.

Architects too have seen their traditional central role in the project decline. More often than not these days, large developer corporations may initiate projects hiring architects only for design phases and using professional project managers to supervise the process.

4. THE DESIGN PROFESSION

These are just two examples to show that design practice is changing quite rapidly, and that designers might find themselves in the position that they have to re-invent the very core of their professional life. This is the fourth level on which designers work, together defining and redefining the very nature of their profession within what is commonly called in sociology a 'community of practice'. Just as there are collections of individual designers inside a practice then, there are collections of practices that make up the profession. There is then some creation of expertise at this professional level as members come together to develop techniques, publish solutions and exchange ideas. We shall explore this notion of design expertise at the professional level in Chapter 7.

With the introduction of these four levels of activities that are part and parcel of being a designer, we mean to step beyond the overriding focus in design practice, design theory and design education on the design project. Through this fixation on design projects, there are many activities that are an integral part of 'being a designer' that have been neglected by designers, under-funded and unorganised in design agencies and missed by design researchers. They involve vital (but non-project related) activities like the gathering of inspiration, the building up of a stock of useful or admired precedents, and the self-education that is needed to stay abreast of an ever developing field. And most importantly perhaps, they include the critical reflection across projects, through which a designer develops. We need to deal with all of these levels when we want to describe the development of design expertise.



Fig 2.12 Triangular telephone booth—Theo Groothuizen at Landmark. The original model is shown. Colour (an informal bright green) and detailing of the design (with its frameless glass) were developed according to the latest design research insights into what triggers vandalism

THEO GROOTHUIZEN

Theo Groothuizen (1949) started his academic career by studying Architecture, but he was to graduate as an industrial designer from Delft University of Technology in 1978. His major project was the design of a cleverly constructed new triangular telephone booth that was further developed into the new Dutch standard design and also being very influential internationally. This gave him the chance to begin his professional career as a design consultant at PTT, the Dutch telecom company.

After a spell as an independent designer he became the co-founder, with four other experienced designers, of Landmark Design. This firm grew to be one of the biggest and most important product design agencies in the 1980s and early 90s, making a name for itself by creating products for the public domain, with a strong social and ergonomic orientation. Theo has also been very active in national and international designers' associations (BNO, BEDA, ICSID) and has taught at various schools throughout the world.

DESIGN MODEL #3: TYPES OF THINKING IN DESIGN

This third model of design looks at three types of thinking that can be usefully employed in the process. They represent different approaches that a designer can take to developing the design problem and creating a solution. We can think about effecting a change in the world in a purely rule-based manner, by concentrating the specific problem situation, or by actively creating a new situation through strategic thinking.

1. CONVENTION-BASED DESIGN THINKING

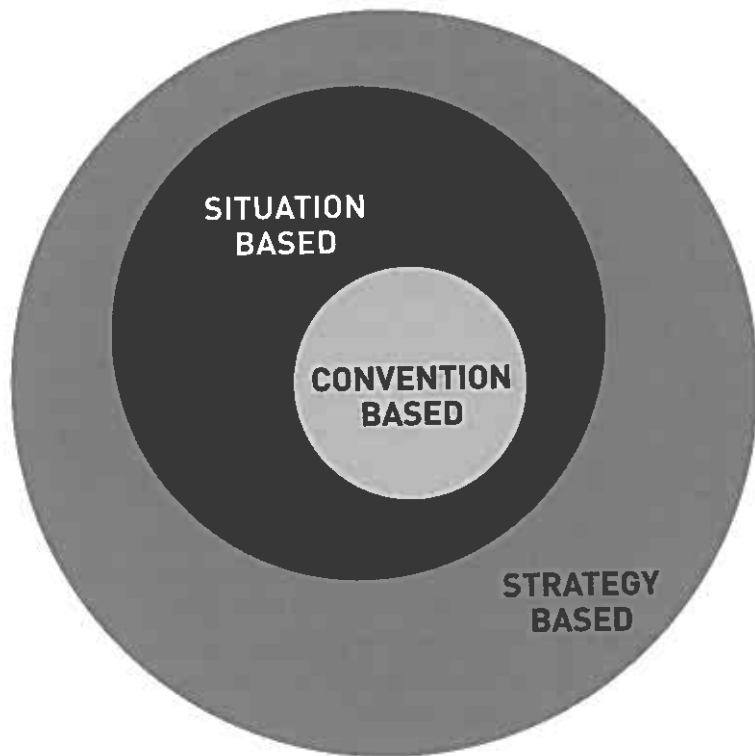
When confronted with a design challenge, one could respond by working according to conventional wisdom, following 'the rules of the game'. This requires some explanation. Firstly, it could be that parts of a design problem can have a very solid knowledge basis that no designer could ignore. When dealing with technical issues, say in the development of a mechanism, anybody will understand that they can only be tackled productively by using the laws of physics and their operationalisation in the fields of statics and mechanics. There are other rules which are much less theoretical in their appearance but nonetheless valuable. Rules-of-thumb, for example, are heuristic ways of getting to a workable solution without employing sophisticated theory. Rule-based thinking allows us to tackle complicated problems with very sophisticated approaches that are often a combination of logic and the experience of many designers before us.

We also find that many of the 'rules' in design are much more tenuous and culturally determined, they are conventions: customs and habits; the set ways of working within a field.

This kind of designing was described by Broadbent as 'canonic' who included planning grids, proportioning systems and other geometrical devices in his canonical rules (Broadbent and Ward, 1969). Perhaps one of the most famous such systems of generating, or at least governing, form was Le Corbusier's Modulor which was based on rules of proportions (Le Corbusier, 1951), but such ideas have a long history in architecture going right back through Alberti to Vitruvius.

These conventions and rules undoubtedly have their uses, and a large part of normal design practice relies on such more or less routine, rule-based behaviour. But an over-reliance on these conventions can lead to standard, run-of-the-mill solutions. Knowing the conventions and successfully applying rule-based thinking is just a first step in becoming literate in the design

DESIGN THINKING STRATEGIES



profession. There are much more sophisticated and interesting kinds of design thinking to come.

2. SITUATION-BASED DESIGN THINKING

When confronted with a design challenge, we could respond by studying the design situation and trying to create a response that is appropriate in this particular setting. This requires a keen eye for the possibilities within a complex environment and a considerable mental flexibility in formulating a response. Designers often have to improvise to get around the most limiting requirements and use their knowledge and skills in innovative ways to create a fitting design solution. This is where the 'rules of the game' become much less mechanical, acting more as guides. This is where design becomes improvisation, where designers have to use all their wits to scramble out of a problematic design situation towards a satisfactory solution.

Some have argued that the very essence of design is that it is a 'situated' activity (Gero, 1998). Remember that Schön claims, for this reason, that every design situation is unique. Certainly it is often the very special and sometimes unique circumstances of a situation that, in the hands of an expert designer, can help to create very special solutions. The famous opera house in Sydney, for example, was an extraordinary response to a very special site. Frank Lloyd Wright's much-admired house at Falling Water owes a huge amount to his enormous skill but the waterfall it sits over must have triggered much of his thinking. These are rather obvious examples but undoubtedly the skill of recognising not only a special situation, but one that is promising is part of advanced design expertise.

3. STRATEGY-BASED DESIGN THINKING

In strategy-based design, designers formulate a planned response; effectively they consciously design the process itself and create the design situations for themselves. This strategy can be rooted in a general knowledge of the dynamics of a design process and an interpretation of the design situation, but it can also be a personally developed way of working, a 'style' that is imposed upon the problem. The introduction of an original strategy in a design situation of course also introduces the possibility of success or failure of this strategy. This makes the strategy an important object for reflection. Often, the development and use of a strategy are accompanied by a very real sense of personal commitment to the course the design project takes, and to its outcome.

USING THE THREE TYPES OF DESIGN THINKING

The differences between these design approaches can perhaps be clarified by an extended example. In one of the first extensive thinking-aloud protocol

SOME SIMPLE ARCHITECTURAL 'RULES OF THUMB'

A simply spanning concrete beam will need to be about as deep in inches as the span is in feet.

To find the depth of timber floor joists take the span in feet, halve it and add 1 for hardwood and 2 for softwood. This gives the depth in inches for 18 inch spaced joists in a domestic floor.

In a staircase the minimum and maximum pitch allowed can be calculated as follows. Take twice the rise (of each step) plus the going (tread of each step) and the result must be between 550 and 700mm.

A project will take twice as long as you think and cost twice as much.

studies in Industrial Design in the early 1990s, Dorst and Christiaans studied the steps of individual designers working on a design task. The subjects were asked to think aloud, so their thought patterns could be captured and analysed. This study has been extensively reported upon in Dorst (1995), Christiaans and Dorst (1992a, 1992b), Cross et al. (1994), and later led to the Delft Protocols Workshop (Cross et al., 1996). What is interesting from our perspective is that this series of protocol studies was performed with different design students and designers; 12 second year design students, 12 fifth year design students and 12 experienced designers (with a minimum of five years experience, and this dozen included some of the best Industrial Designers in Holland at the time). This gives us a rich source of the three different approaches to design thinking.

A bit of background on these protocol studies is necessary to understand the work of these designers: the design challenge was to develop a new 'litter system' for the passenger carriages of a new Dutch train. All information needed to design a solution (e.g. background to the project, stakeholders involved, dimensions of the train, user research on the existing trains, etc.) was provided. The designers had 2.5 hours to tackle this design challenge, working individually in a lab environment at Delft University of Technology.

Many of the second year students displayed 'convention-based design thinking' in their response to the design challenge. One could say that it is a 'rule' in design that in order to create value you should concentrate on the user, and design from their standpoint. This is exactly what many of these young designers did: they analysed the use situation and developed user criteria from the research they found in the information cards. This naturally led to issues like providing litter bins that are within easy reach of the user (the train passenger), and providing a possibility to store newspapers and magazines for the clean and easy re-use by other passengers. The whole litter system was designed from this standpoint. Other design students and some of the experienced designers clearly followed a 'situation-based design thinking' approach. After some initial thinking about the user, they discovered another party in the life of this litter system that should have an equally strong influence on its form and use; the cleaners of the trains. To see this requires some subtlety of thought since these cleaners were not directly represented in the design situation. Migrating to the standpoint of designing for the cleaners meant stepping away from the 'rule' that the main user comes first. The designs produced by this group of designers were compromises between the passenger-related criteria (that the litter collection points should be easy to reach, and the desire to store newspapers separately) and the

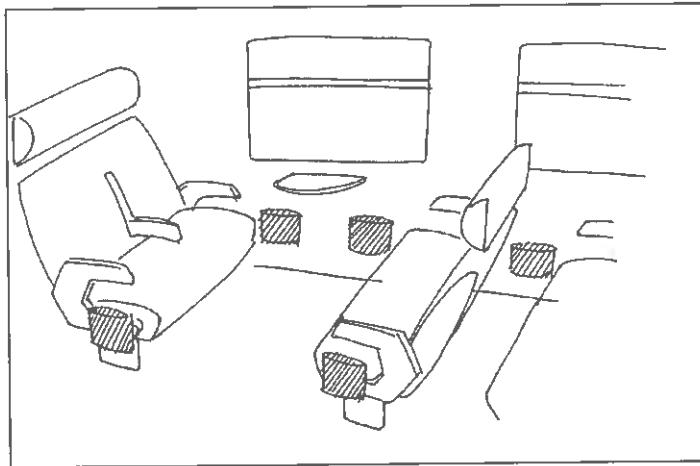


Fig 2.13 Convention-based design thinking in action: the most obvious and immediate stakeholder, the train passenger, is well catered for. The interests of the other important stakeholder, the cleaners, have not been taken into account—in fact, this design creates huge problems for them

criteria of the cleaners (efficient and quick emptying of the bins, no bending, easy cleaning). This clash between different types of users is a common design situation and more experienced designers are likely to be aware of this. For instance, in the design of hospital beds the interests of the nurses (care) and the doctors (the medical process) lead to more stringent and sometimes conflicting criteria for the bed design than the interests of the patient (recovery and quality of life).

Some of the experienced designers took a 'strategy-based design thinking' approach to this problem. In general, they went quickly through most of the information provided to them about the design problem, and they identified what could be called a 'core problem' or 'central paradox' in the problem situation. This paradox was that the requirements of the passengers and the cleaners for the litter system are actually contradictory. We can imagine that an ideal design for the passengers would basically involve a lot of litter collection points spread around the carriage, easily reachable from a sitting position. By contrast the ideal for the cleaners is one central bin that can be emptied quickly and efficiently, without reaching into awkward spaces between seats or bending over. These designers displayed different strategies; some tried to find a way around the paradox by widening the system barrier, looking at the train or the railway carriage as a whole, coming up with original solutions that make use of the possible spread of functions through the different parts of the system (i.e. newspaper racks at the end of the carriage, see Figure 2.15). This is in stark contrast to the designers that followed the 'rule-based' and 'situation-based' approaches, who inadvertently tended to be more focused on the small environment around the user and the seating arrangements within the railway carriage. Other designers followed a strategy in which they made separate designs from the standpoint of the main stakeholders (i.e. a couple of sketches exploring what would be good for the user, and some sketches in which they championed the cleaners), and then they tried to resolve some of these ideas and solutions into an overall design.

Finally, there is the amusing case of an experienced designer who tragically misjudged the design problem, following a rule-based approach and realising too late that he was on the wrong track. This designer, at some point during his analysis, framed the design task very ambitiously. 'Every passenger should be able to throw away his/her litter without rising from the seat, and there should be separate bins for newspapers and other litter'. He went on to develop a concept in which there are one or two bins hanging from every chair (one for newspapers, and one for other litter). He did not consider the problems the cleaners might have until quite late in the 2.5 hours available to him. When he realised that his design made the cleaner's problems a lot

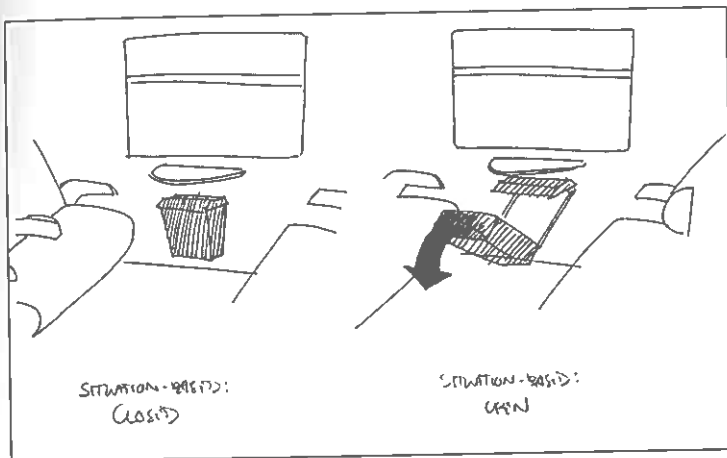


Fig 2.14 Situation-based design thinking: the special properties of this specific design challenge are taken into account

worse (more bins, spread throughout the passenger compartment), he panicked. Reconsidering his core idea would have meant starting all over again. He reacted by thinking up and detailing a rather incredible emptying cart for the cleaners (see Figure 2.16) which is much too complicated, and frankly impractical. This is pure designer's panic, expressed in an incredibly complicated Heath Robinson contraption.

It may seem remarkable that this one design brief was able to trigger all these different approaches and indeed so many completely different designs. The range of expertise of the designers involved suggests something significant. It could be that one of the characteristics of creating design expertise is the acquisition of the ability to work in many different ways and to be able to adapt a process to the situation.

We have deliberately chosen this example to help explain the difference between the types of thinking in design by showing them in stark contrast on one project. But the simplicity of this might lead the reader to a limited view of these types of thinking. It does not do justice to the pervasiveness of these ways of thinking, and to the scope of the distinction we want to introduce here. Each of these ways of thinking can be successful, disastrous and somewhere in between; this will depend upon both the situation and the skill of the designer.

For instance, we can revisit the convention-based approach, and realise that 'style' is often a form of convention-based thinking. The established modernist mantra that ornament is wasteful or that 'less is more', which seems to be in the back of the mind of many designers, is just one of those rules. Some designs can be so successful and widely admired that they set a precedent, create a style and dictate the 'rules' for many other designs that are developed in their wake.

An example of such rule-bound stylistic adoption might be the way some superficial characteristics of the Apple iMac were copied. The original design of this colourful, rounded translucent plastic computer was followed by a host of cheap printers and computers suddenly also being released in transparent plastic. It seemed as if the makers of these sorry products must have thought that translucency was the strong point of the iMac, rather than its toy-like and strikingly original appearance. The trend-followers seemed to believe that humanity has an inherent craving for transparent office products. In superficial copying we can see convention-based behaviour at its most mindless.

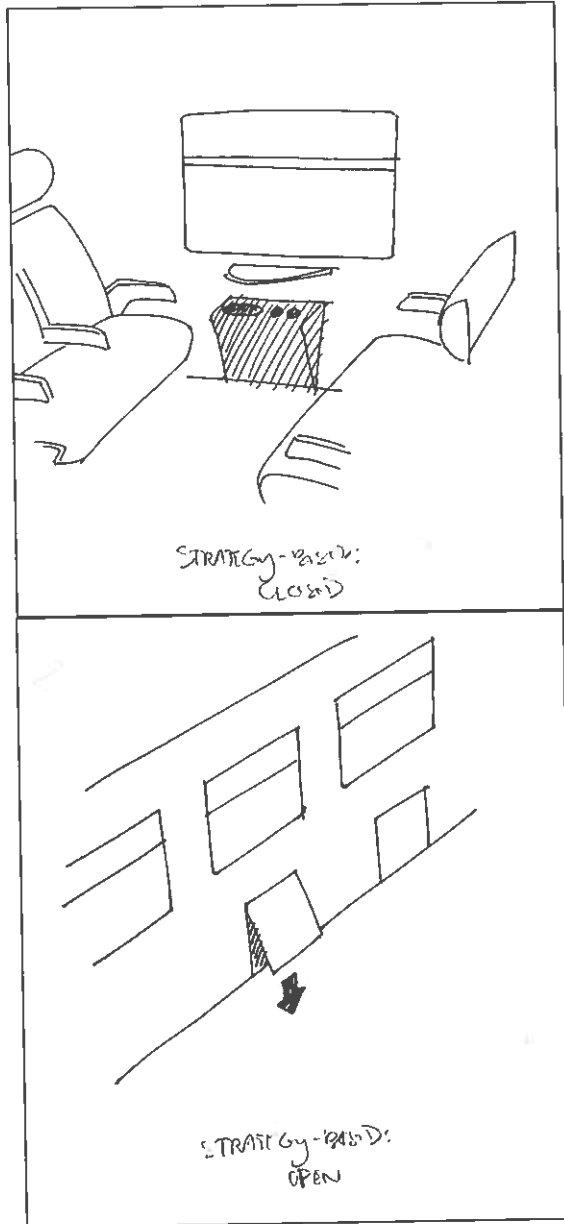


Fig 2.15 Strategy-based design thinking: the design situation has been changed by proposing a different system border—opening up the possibility of a completely different set of design proposals

CONCLUSION: TOOLING UP FOR DESCRIBING THE DEVELOPMENT OF DESIGN EXPERTISE

So far in this chapter we have explored the nature of design activity by describing it from a series of different viewpoints. Then we developed three more detailed models of design. The first of these looked at the activities that together make up designing, and the abilities that support these activities. Then we distinguished four levels on which these activities take place and we went on to discuss three types of design thinking.

One could say that these three descriptive frameworks together form a simple categorisation of design activities, some kind of cube with the three 'languages' forming the axes. The 'types of design thinking' outlined involve all of the design activities explored in the first model, and they apply to the four levels of design (project, process, practice and profession).

Such a model could be an interesting avenue to pursue in a more theoretical treatise; one could, for instance, start thinking through the contents of the different cells in this 3D matrix, trying to find examples of each of the design activities. For instance, the example of Ken Yeang used earlier in this chapter clearly reveals an approach to strategy-based design thinking at the practice level. Each project, particularly in the case of competitions, is seen as a form of research to develop the practice strategy. This then in turn is passed on to every member of staff to apply in their own process. We can also see here a careful intention to combine situation-based thinking in each project.

However, for the purposes of this book we will just use the three descriptive frameworks as three 'languages' that can help us think and talk more clearly about aspects of expertise design in the coming chapters. When talking about the development of design expertise, we will continuously do so in terms of the design activities ('formulating', 'representing', 'moving', 'evaluating', and 'managing'), the levels of these activities (project, process, practice and profession) and the mode of thinking that lies behind the problem solving, creativity and decision making that takes place through these design activities (whether that be convention-based, situation-based or strategy-based). Armed with these models, we will now be ready to begin exploring the nature of design expertise.

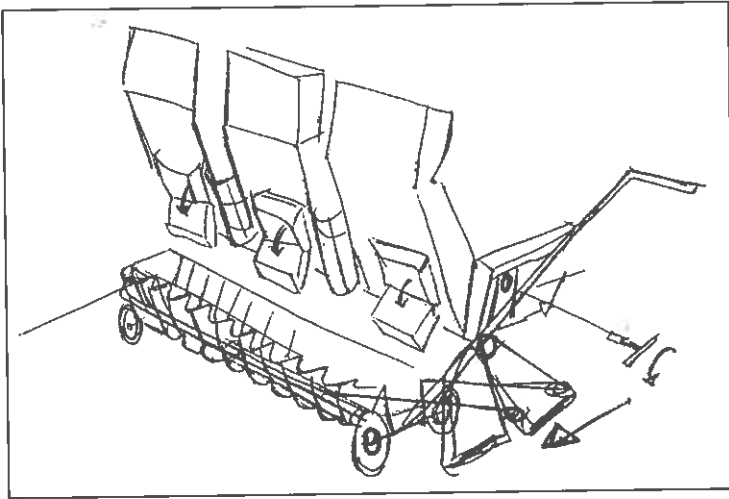


Fig 2.16 The emptying cart, hastily designed to cover the problems created by the design of the litter bins

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