

# 1

## ***The Activity of Design***

### ***What Designers Say***

Design is all around us, and the wish to design things is inherent in human beings. One of the most basic characteristics of human beings is that they make a wide range of tools and other artefacts to suit their own purposes. As those purposes change, and as people reflect on the currently-available artefacts, so refinements are made to the artefacts, and sometimes completely new kinds of artefacts are conceived and made. The world is therefore full of tools, utensils, machines, buildings, furniture, clothes, and many other things that human beings apparently need or want in order to make their lives better. Everything that isn't a simple, untouched piece of Nature has been designed by someone.

In pre-industrial societies, craftspeople made things according to long-established traditions, following the patterns transmitted through apprenticeship. It was during the emergence and growth of industrial societies, with the shift from craftwork to manufacturing, that designing became regarded as a different kind of occupation. Although there is now so much designing going on in the world, how people perform this activity of design was rather poorly understood for a very long time. An ability in design has been regarded as something that many, probably most, people possess to some degree, but only a few people have a particular design 'talent'. However, through decades of design research, there is now an established and growing body of knowledge about design activity and how to

conduct it, about the design process and how to improve it, and about design ability and how to develop it.

When designers are asked to explain how they work, and to discuss their abilities, a few common themes emerge. One theme is the importance of creativity and 'intuition' in design – even in engineering design. For example, the engineering designer Jack Howe has said:

*I believe in intuition. I think that's the difference between a designer and an engineer. . . I make a distinction between engineers and engineering designers. . . An engineering designer is just as creative as any other sort of designer.*

Some rather similar comments have been made by the industrial designer Richard Stevens:

*A lot of engineering design is intuitive, based on subjective thinking. But an engineer is unhappy doing this. An engineer wants to test; test and measure. He's been brought up this way and he's unhappy if he can't prove something. Whereas an industrial designer. . . is entirely happy making judgements that are intuitive.*

Another theme that emerges from what designers say about their abilities is based on the recognition that problems and solutions in design are closely interwoven; that 'the solution' isn't always a straightforward answer to 'the problem'. For example, the furniture designer Geoffrey Harcourt commented on one of his creative designs like this:

*As a matter of fact, the solution that I came up with wasn't a solution to the problem at all. I never saw it as that. . . But when the chair was actually put together (it) in a way quite well solved the problem, but from a completely different angle, a completely different point of view.*

A third common theme to emerge is the need to use sketches, drawings or models of various kinds as a way to explore the problem and solution together. The conceptual thinking processes of the designer seem to be based on the development of ideas through their external expression in sketches. As the engineer-architect Santiago Calatrava said:

*To start with you see the thing in your mind and it doesn't exist on paper and then you start making simple sketches and organising things and then you start doing layer after layer. . . it is very much a dialogue.*

This 'dialogue' occurs through the designer's perception of the sketched concepts, and reflection on the ideas that they represent

and their implications for the resolution of the problem. The designer responds to the perceptions, reflections and implications, and so the 'dialogue' between internal mental processes and external representations continues.

The quotations above are taken from interviews conducted with successful and eminent designers by design researchers Robert Davies and Bryan Lawson. The designers' comments support some of the hypotheses that have emerged from more objective observational studies of designers at work, and other research that has been conducted into the nature of design. Some of this research reflects and supports the view that designers have particular, 'designerly' ways of thinking and working.

## ***What Designers Do***

People have always made things. In traditional, craft-based societies the 'designing' of artefacts is not really separate from making them; that is to say, there is usually no prior activity of drawing or modelling before the activity of making the artefact. For example, a potter will make a pot by working directly with the clay, and without first making any sketches or drawings of the pot. In modern, industrial societies, however, the activities of designing and of making artefacts are usually quite separate. The process of manufacturing something cannot normally start before the process of designing it is complete. In some cases, for example in the electronics industry, the period of designing may take many months, whereas the average period of making each individual artefact might be measured only in hours or minutes.

Perhaps a way towards understanding design is to begin at the end; to work backwards from the point where designing is finished and making can start. If making cannot start before designing is finished, then at least it is clear what the design process has to achieve. It has to provide a description of the artefact that is to be made. In this description, almost nothing is left to the discretion of those involved in the process of making the artefact; it is specified down to the most detailed dimensions, to the kinds of surface finishes, to the materials, their colours, and so on.

In a sense, perhaps it does not matter how the designer works, so long as he or she produces that final description of the proposed artefact. When a client asks a designer for 'a design', that is what they want: the description. The focus of all design activities is that end-point.

***Communication of designs***

The most essential design activity, therefore, is the production of a final description of the artefact. This has to be in a form that is understandable to those who will make the artefact. The most widely-used form of communication is drawing. For a simple artefact, such as a door-handle, one drawing would probably be enough, but for a larger, more complicated artefact such as a whole building the number of drawings may well run into hundreds, and for the most complex artefacts, such as aeroplanes or major bridges, then thousands of drawings will be necessary.

These drawings will range from rather general descriptions, such as plans, elevations, and general arrangement drawings, that give an 'overview' of the artefact, to the most specific, such as sections and details, that give precise instructions on how the artefact is to be made. The drawings will often contain annotations of additional information. Dimensions are one such kind of annotation. Written instructions may also be added to the drawings, such as notes on the materials to be used.

Because they have to communicate precise instructions, with minimal likelihood of misunderstanding, all the drawings are themselves subject to agreed rules, codes and conventions. These codes cover aspects such as how to lay out on one drawing the different views of an artefact relative to each other, how to indicate different kinds of materials, and how to specify dimensions. Learning to read and to make these drawings is an important part of design education.

Other kinds of specifications as well as drawings may also be required. For example, the designer is often required to produce lists of all the separate components and parts that will make up the complete artefact, and an accurate count of the numbers of each component to be used. However, there is no doubt that drawings are the most ubiquitous form of communicating the description of an artefact that has yet to be made. Drawings are very good at conveying an understanding of what the final artefact has to be like, and that understanding is essential to the person who has to make the artefact.

It is not always a person who makes the artefact; some artefacts are made by machines that have no direct human operator. These machines might be fairly sophisticated robots, or just simple, numerically-controlled tools such as lathes or milling machines. In these cases, therefore, the final specification of a design prior to manufacture might not be in the form of drawings but in the form of a string of digits stored on a disk or memory stick, to be used in computer software that controls the machine's actions. It

is therefore possible to have a design process in which no final communication drawings are made, but the ultimate purpose of the design process remains: the communication of a proposal for a new artefact.

### ***Evaluation of designs***

For the foreseeable future, drawings of various kinds will still be used throughout the design process. Even if the final description is to be in the form of a string of digits, the designer will probably want to make drawings for other purposes.

One of the most important of these other purposes is the checking, or evaluating, of design proposals before deciding on a final version for manufacture. The whole point of having the process of design separated from the process of making is that proposals for new artefacts can be checked before they are put into production. At its simplest, the checking procedure might merely be concerned with, say, ensuring that different components will fit together in the final design; this is an attempt to foresee possible errors and to ensure that the final design is workable. More complicated checking procedures might be concerned with, say, analysing the forces in a proposed design to ensure that each component is designed to withstand the loads on it; this involves a process of refining a design to meet certain criteria and constraints such as minimum strength, or maximum weight or cost.

This process of refinement can be very complicated and can be the most time-consuming part of the design process. Imagine, for example, the design of a bridge. The designer must first propose the form of the bridge and the materials of which it will be made. In order to check that the bridge is going to be strong enough and stiff enough for the loads that it will carry, the designer must analyse the structure to determine the ways in which loads will be carried by it, what those loads will be in each member of the structure, what deflections will occur under load, and so on. After a first analysis, the designer might realise, or at least, suspect, that changing the locations or angles of some members in the bridge will provide a more efficient distribution of loadings throughout the whole structure. But these changes will mean that the whole structure will have to be re-analysed and the loads recalculated.

In this kind of situation, it can be easy for the designer to become trapped in an iterative loop of decision-making, where improvements in one part of the design lead to adjustments in another part which lead to problems in yet another part. These problems may mean that the earlier 'improvement' is not feasible. This *iteration* is a common feature of designing.

Nevertheless, despite these potential frustrations, this process of refinement is a key part of designing. It consists, firstly, of analysing a proposed design, and for this the designer needs to apply a range of engineering science or other knowledge. In many cases, specialists with more expert knowledge are called in to carry out these analyses. Then, secondly, the results of the analysis are evaluated against the design constraints and criteria: does the design come within the cost limit, does it have enough space within it, does it use too much fuel, and so on.

Many of the analyses are numerical calculations, and therefore again it is possible that drawings might not be necessary. However, specialists who are called in to analyse certain aspects of the design will almost certainly want a drawing, or other model of the design, before they can start work. Visualisations of the proposed design may also be important for the client and designer to evaluate aspects such as appearance, form and colour. Sometimes the designer makes a complete, three-dimensional mock-up or prototype in order to evaluate and communicate the design.

### ***Generation of designs***

Before any of these analyses and evaluations can be carried out the designer must, of course, first generate a design proposal. This is often regarded as the mysterious, creative part of designing; the commissioning client makes what might well be a very brief statement of requirements, and the designer responds (after a suitable period of time) with a design proposal, as if conjured from nowhere. In reality, the process is less 'magical' than it appears.

In most cases, for instance, the designer is asked to design something similar to that which he or she has designed before, and therefore there is a stock of previous design ideas on which to draw. In some cases, only minor modifications are required to a previous design.

Nevertheless, there is something mysterious about the human ability to propose a design for a new, or even just a modified, artefact. It is perhaps as mysterious as the human ability to speak a new sentence, whether it is completely new, or just a modification of one heard, read, or spoken before.

This ability to design depends partly on being able to visualise something internally, in 'the mind's eye', but perhaps it depends even more on being able to make external visualisations. Once again, drawings are a key feature of the design process. At this early stage of the process, the drawings that the designer makes are not usually meant to be communications to anyone else. Essentially, they are communications with oneself, a kind of thinking aloud. At this

## ***Exploration of designs***

stage the designer is thinking about many aspects together, such as materials, components, structure and construction, as well as overall form, shapes and functions.

At the start of the design process, the designer is usually faced with only a partially defined problem; yet he or she has to come up with a well defined solution. If one thinks of the problem as a space or territory, then it is largely unexplored and un-mapped, and perhaps imaginary in places! It may therefore be appropriate to think of the designer as an explorer, travelling inquisitively through an unknown land, paying attention to unusual finds as well as the mundane.

Equally, if one thinks of all potential solutions as occupying a kind of solution space, then that, too, is relatively undefined, and perhaps infinite. Here, the designer is searching for possibilities, and often creating new ones. The designer's task is therefore two-fold; understanding the problem and seeking a solution.

Often these two complementary aspects of design – problem and solution – have to be developed side-by-side. The designer makes a solution proposal and uses that to help understand what the problem 'really' is and what appropriate solutions might be like. The very first conceptualisations and representations of problem and solution are therefore critical to the kinds of searches and other procedures that will follow, and so to the final solution that will be designed.

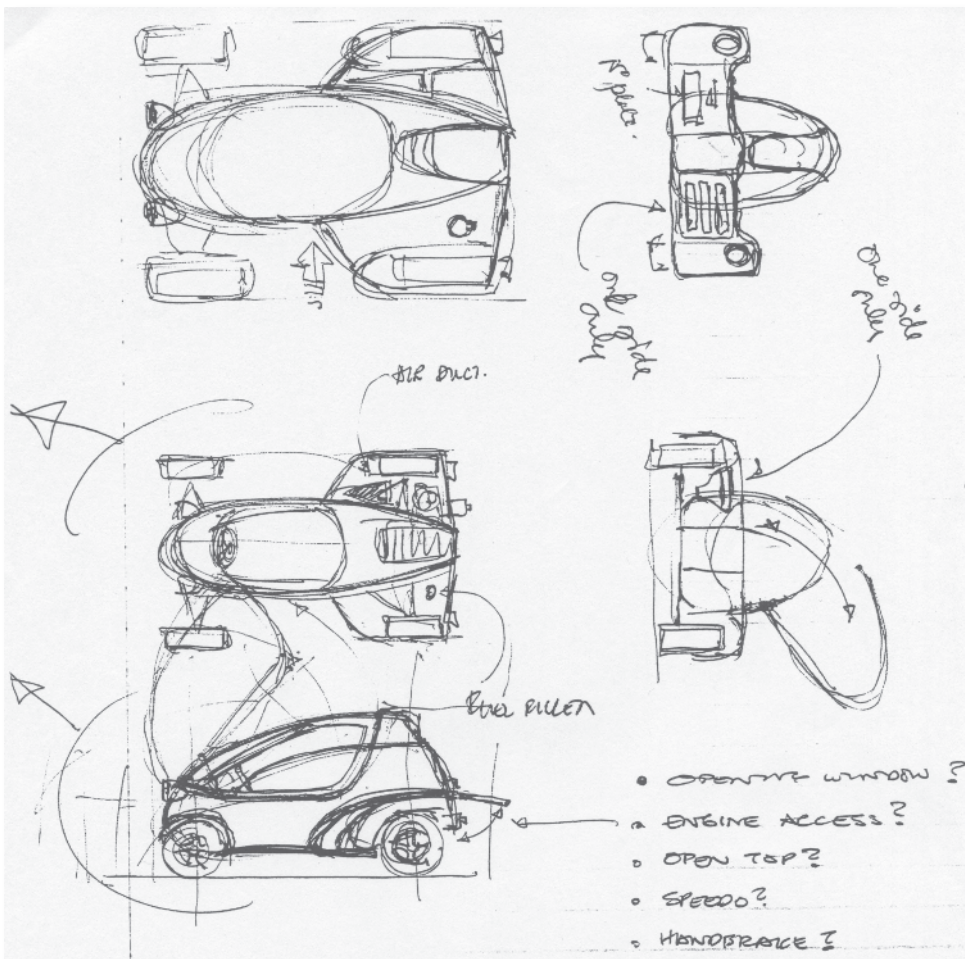
The exploration of design solution-and-problem is also often done through early sketching of tentative ideas. It is necessary because normally there is no way of directly generating an 'optimum' solution from the information provided in the design brief. Quite apart from the fact that the client's brief to the designer may be rather vague, there will be a wide range of constraints and criteria to be satisfied, and probably no single objective that must be satisfied above all others.

## ***Case Study***

This case study, following a complete design process, is drawn from the work of the ex-Formula One racing car designer, Gordon Murray. Although known principally for his highly successful and innovative racing cars, for many years Gordon Murray also had in mind a very different concept of what a car could be – a small, cheap, efficient and enjoyable city car. After he retired from Formula One he began the development of this very different kind of car within his own design practice. The concept became his T.25 city car. The T.25 is a very practical but attractive urban-use vehicle that can carry a

driver with two passengers or a large amount of luggage or shopping; it is light and agile, with good performance and very low fuel consumption, and occupies one-third of the road or parking space of a conventional car.

Throughout his career, Gordon Murray has always kept small note books, in which he jots down and sketches ideas. A page from his sketch book (Figure 1.1) captures some very early thoughts on a concept for a city car, some years before he began work in earnest on the project. This shows an *exploration* of thoughts and ideas; not only sketches of external form, but also thoughts on practical aspects such as engine access, window openings and fuel filler point. Even at this



**Figure 1.1** Very early idea sketches for a new city car. Source: Gordon Murray

very early stage several key aspects of the final version are present, including the big opening canopy instead of conventional doors.

Later sketches (Figure 1.2) show the developing *generation* of a more detailed concept. The concept is for a small, narrow, tall car which has advantages in space saving on the road and in parking, as sketched diagrammatically at the top of the page. But those advantages have implications for vehicle dynamics, which are also being considered in the sketches, especially in the suspension system. The suspension system was an important feature in early considerations because a tall, narrow car will tend to roll sideways when cornering, and that has to be controlled in the suspension. So even at an early, conceptual stage, details that could later influence the overall realisation of the project are being identified, considered and tentatively resolved.

After producing many dozens of sketches and drawings of the overall concept, development work turned to experimenting with performance – for example, testing some existing small cars fitted with different engines – and manufacture, trialling a novel new chassis for the city car. Very early on the team also built a very simple, full-size mock-up of the car, formed just from bent wire and cardboard (Figure 1.3). The mock-up became a useful *evaluation* tool in the design work, as it began to indicate not only any unforeseen

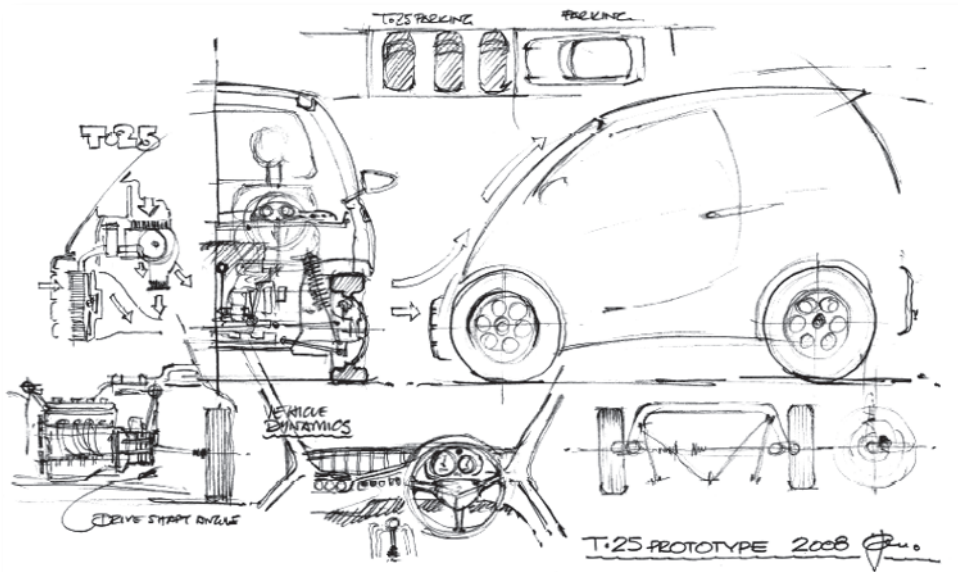


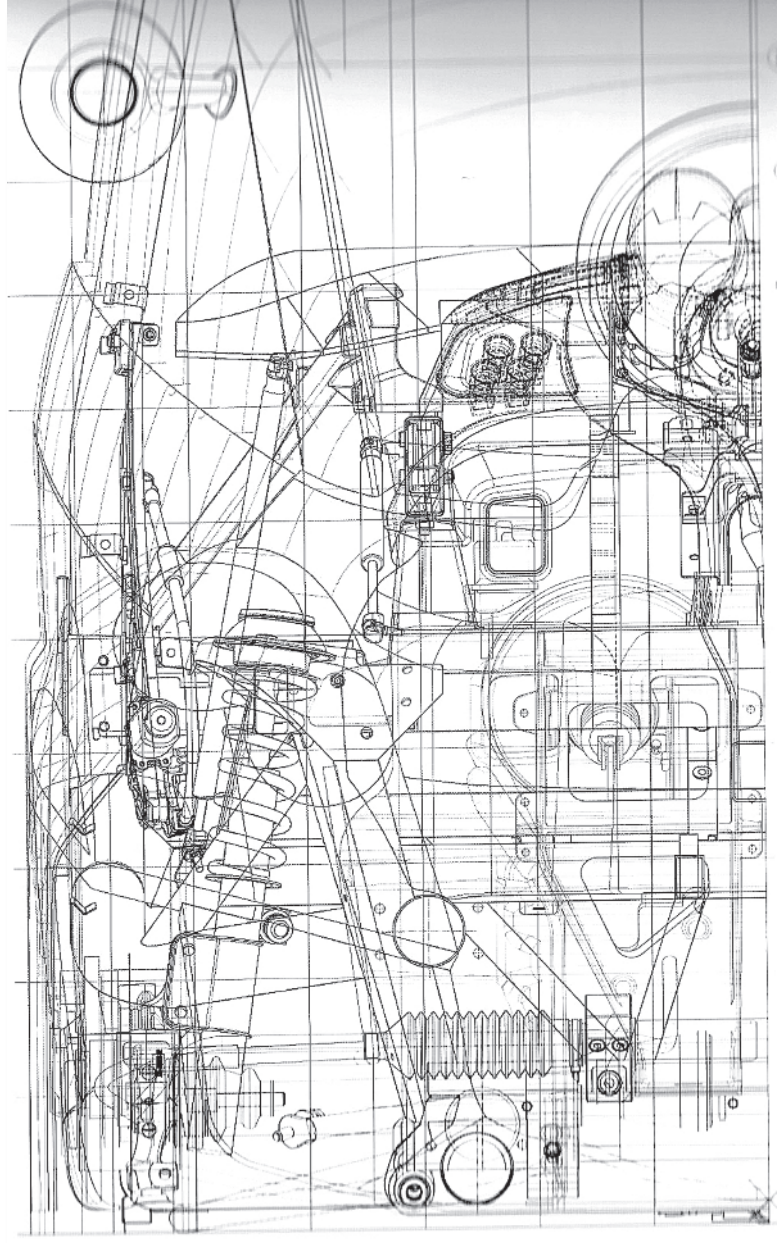
Figure 1.2 First concept sketches for the T.25 city car. Source: Gordon Murray



**Figure 1.3** A wire and cardboard early-stage mock-up. Source: Gordon Murray; Photo: Nigel Cross.

problems but also to suggest some new possibilities. For example, the first idea for the seating arrangement was for two people sitting in tandem, the passenger behind the driver. But when the mock-up was built, they discovered that it would be possible, within the same width of the car, to fit three people in it, using an 'arrowhead' seating layout of a central driver and two passengers slightly behind and to the sides of the driver. In fact, Gordon Murray had not only sketched such a seating layout many years previously, but already used it in quite a different car that he designed – the revolutionary McLaren F1 sports car.

There was, of course, considerable detail work to be done on the many innovative details necessary to complete the *communication* of the final design (Figure 1.4), sufficient to be able to manufacture a



**Figure 1.4** Part of a composite detail drawing of components in the T.25 prototype. Source: Gordon Murray Design.



**Figure 1.5** The first prototype on-the-road version of the T.25. Source: Gordon Murray Design.

prototype version of the car. The prototype version was a complete, driveable, road-worthy car, and it proved the successful design; prototypes in both petrol- and electric-engined versions won each of their classes in the RAC Brighton-to-London 'Future Car Challenge' for energy efficiency.

The prototypes were also important for demonstrating and communicating the concept of the car to potential clients and manufacturers. But that final prototype version of the city car still bore a striking resemblance to the much earlier, simple wire and cardboard mock-up.