Engr. Design Methods
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# 1 The Nature of Design

• Design Activities

People have always designed things. 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 completely new kinds of artefacts are conceived and made.

The wish to design things is therefore inherent in human beings, and 'designing' is not something that has always been regarded as needing special abilities. In traditional, craft-based societies 'designing' is not really separate from 'making'; 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 making 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 can take several years, whereas the average period of making each individual artefact might be measured only in hours or minutes.

Perhaps a way towards understanding this modern design activity 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 design 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

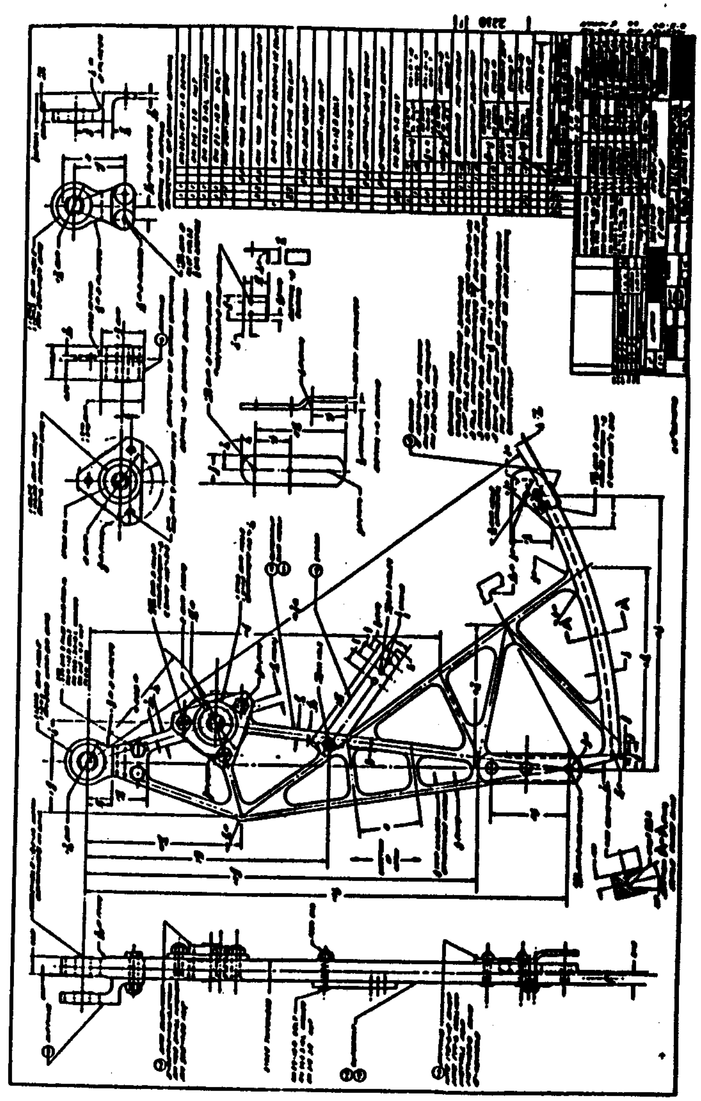
The most essential design activity, therefore, is the production of a final description of the artefact. This has to be in a form that is understandable to those who will make the artefact. For this reason, the most widely-used form of communication is the drawing. For a simple artefact, such as a door-handle, 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 chemical process plants, aeroplanes or major bridges, then thousands of drawings may 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. 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.

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 (as in Figure 1).

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. Written specifications of the standards of workmanship or quality of manufacture may also be necessary. Sometimes, an artefact is so complex, or so unusual,





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| Stage in the design process | Method relevant to this stage |
| --- | --- |
| Evaluating alternatives | Weighted Objectives<br>Aim:<br>To compare the utility values of alternative design proposals, on the basis of performance against differentially weighted objectives. |
| Improving details | Value Engineering<br>Aim:<br>To increase or maintain the value of a product to its purchaser whilst reducing its cost to its producer. |

As we shall discuss later, in Chapter 11, these seven stages of design, and their accompanying design methods, should not be assumed to constitute an invariant design process. However, Figure 19 suggests how they relate to each other and to the symmetrical problem-solution model developed in Chapter 2. For example, clarifying objectives (using the Objectives Tree method) is appropriate both for understanding the problem-solution relationship and for developing from the overall problem into sub-problems.

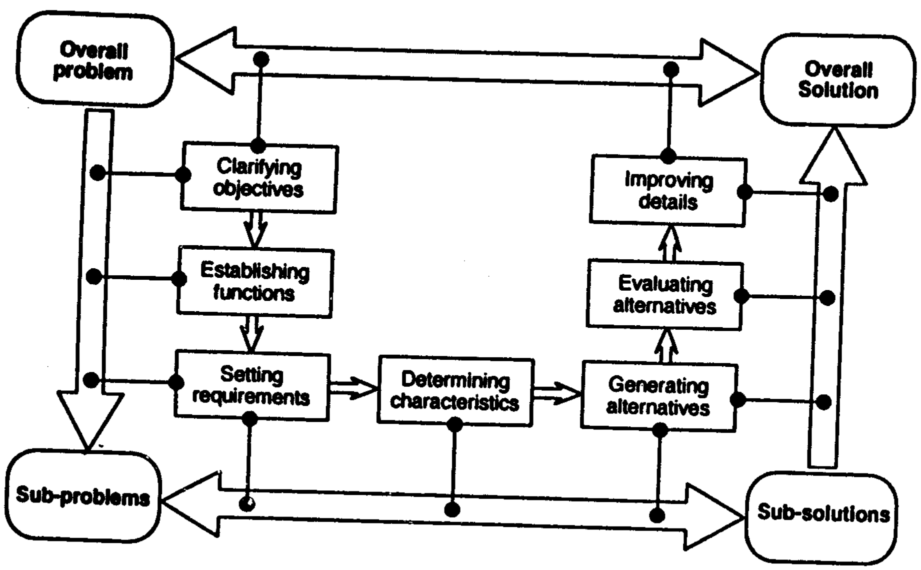


**Figure 19** Seven stages of the design process positioned within the symmetrical problem/solution model



This model of designing integrates the procedural aspects of design with the structural aspects of design problems. The procedural aspects are represented by the sequence of methods (anticlockwise, from top left), and the structural aspects are represented by the arrows showing the commutative relationship between problem and solution and the hierarchical relationships between problem/sub-problems and between sub-solutions/solution.

In the following seven chapters, each of the seven methods included in the model is presented in a step-by-step procedure, followed by a number of short practical examples and a more complete worked example. The examples show that such methods are often adapted to suit the particular requirements of the task in hand. Although it is important not to follow any method in a slavish and unimaginative fashion, it is also important that an effort is made to follow the principles of the method with some rigour. No beneficial results can be expected from slipshod attempts at 'method'.