

(Gregory 1966), maps of the process (Markus 1969), and proposed methods of working (Page 1963). These sorts of investigations are now generally regarded as rather vulnerable to the personal perceptions of the investigator. However, they undoubtedly created a valuable stimulus to the nascent field of design research.

Later we saw research that effectively put the designer in a laboratory so as to observe the process under more objective and rigorous empirical conditions. Examples of this sort of work include very artificial and highly controlled conditions in order to abstract designing sufficiently to compare the way non-designers might tackle the same sorts of problems (Lawson 1979). Other more recent work tends to allow designers to work in a more normal way but nevertheless in a controlled and monitored session (Cross et al. 1996). This may represent a very respectable form of research but it is extremely difficult to conduct with a sufficient degree of realism to be relevant to what those designers actually do in practice. The designer is still effectively in a laboratory rather than the normal studio. Timescales are compressed, collaborators and clients are absent or simulated, there is seldom open access to design precedents, no other activity takes place in parallel so there is little time for reflection and so on.

We have also seen work that simply observes designers at work in the field, or rather in the studio. An example of this is the recording and analysing of their normal conversations (Medway and Andrews 1992). While this technique offers more realism it inevitably misses much of the real action. Unfortunately the really interesting things that happen in the design process may be hidden in designers' heads rather than being audible or visible. If we simply listen to what designers are saying or watch what they are doing we are likely to be missing some significant data.

More recently we have seen an increasing use of the simple technique of asking designers to tell us what they do (Lawson 1994; Cross 1996). This might be by interviewing them or reading what they have written about their process. Although a simple idea, the skills and knowledge needed to carry out such interviews are not easily acquired. It is also difficult to know how to analyse the data since what designers write or say should not be entirely trusted. The writings of designers are notoriously misleading and this may be for several reasons. First, designers are often not natural communicators with the written word. Second, they may be writing in order to impress rather than explain and are unlikely to reveal their doubts and weaknesses. Third, because designers are used to 'selling' their designs to clients

they seem to develop a post-hoc rationalisation for the process which conceals all the blind alleys which they went down and shows only a logical inexorable progress to what they now wish to present as the 'right' answer. Interviewing designers not about individual projects but about their process as a whole in a confidential way can eliminate some of these problems, but it requires even more skill, as well as extensive knowledge of the designers and their work, to carry out meaningfully and is therefore also very time consuming. However such techniques do have value in that they can be applied to experienced, expert and even famous designers who are unlikely to be willing to take part in laboratory experiments.

There is one further group of research methods that we can use to investigate design processes. Often they are stumbled upon more or less by accident. We can try either to create tools to help designers, such as CAD, simulate design with computers or imagine how computers could be made to design. There are signs that cognitive science is increasingly interested in design because of the challenges that it poses to such models of mental processes (Goel 1995). So far such techniques have tended to reveal the shortcomings of computers and of the computational theory of mind as much as they have provided insights into human designing.

Is a model of designing possible?

Designing is far too complex a phenomenon to be describable by a simple diagram. The early process map diagrams seemed at one time to be logical but turned out to be misleading once we had some empirical data. We have seen that the word 'design' is applied to an extraordinarily wide range of activity including at one extreme something that could also be called 'engineering' and at another something that could be called 'art'. We have seen that design is a highly personal and multi-dimensional process. We have seen that designers often collaborate in teams and that individuals may play quite specialist roles in such teams. Some may be particularly good at early conceptual ideation whereas others may be more skilled in forms of representation such as model-making drawing or computer modelling. Others still may be more skilled in the technical realisation of ideas or even in the actual making of designed objects themselves.