remembering (Bartlett 1932) developed the notion of an internalised mental image which he called the 'schema'. The schema represents an active organisation of past experiences which is used to structure and interpret future events. In a series of experiments in which Bartlett asked subjects to remember drawings and reproduce them perhaps several weeks later, he showed how such memory is dependent on the drawings being meaningful. That is, we must have already formed the appropriate schemata in advance to interpret and appreciate events. The developmental psychologists such as Bruner and Piaget have shown how human thought processes develop in parallel with the child's formation of such basic and fundamental schemata.

I have for many years tried to teach first year architectural students to remember how they 'see' architecture before they develop the sophisticated concepts which architects use to debate the subject. A real problem for designers is that they have so many more concepts or schemata for describing the objects they design that they genuinely do 'see' them differently to those for whom they design. This can easily lead to a result known as 'architects' architecture', which can only be appreciated and enjoyed by other architects!

The cognitive science approach

The advent of electronic communication devices and information processing machines such as computers has generated a new perspective on human thought. Information theory has provided a metric which allows the amount of information processed during a problem to be measured. Psychologists have attempted to uncover the mechanisms with which we think by measuring our performance on simple tasks against the amount of information processed. Such writers as Posner appear to bridge the gap between the behaviourists and Gestaltists by concentrating on mechanisms while still viewing thinking as a strategic skill. Garner's (1962) influential book on cognitive psychology reports experiments in short-term memory, discrimination, pattern perception, and language and concept formation all using information theory to provide the yardstick for human performance. Other workers in this field have proposed theories of human problem-solving based on the model of the computer program. The most famous application of this technique being the GPS (general problem solver) program of Newell, Simon and Shaw (1958). Such programs cause the computer to exhibit behaviour

resembling such hitherto peculiarly human characteristics as 'purpose' and 'insight'. This has the potential to shatter some of the mystique surrounding work on thought processes by showing how sequences of very elementary information transformations could account for the successful solution of complex problems. Whether such simple processes are actually the basis of human thought is, of course, still open to considerable doubt. Unfortunately there are limitations to the usefulness of such computer programs as models since they rapidly become as complex as the processes they model.

The new cognitive approach to human thinking sees human beings as much more adaptable and genuinely intelligent organisms than the early behaviourist approach. It deals with process and operational function rather than physical mechanism, and it stresses the influence of the context in which problems are perceived on the thought process itself. The cognitive psychologists, while building on the Gestalt tradition, also follow on from the first flush of enthusiasm shown by psychologists for applying information theory to human thought, but are less fanatical about its potential. In his brilliant treatise on cognitive psychology Neisser (1967) points out that humans are different from machines from the very beginning of the perceiving and thinking process:

> Humans . . . are by no means neutral or passive towards incoming information. Instead they select some parts for attention at the expense of others, recording and reformulating them in complex ways.
>
> (Neisser 1967)

As we shall see in later chapters this phenomenon of our selective perception of problems has exercised the minds of many design methodologists who seek to devise ways of broadening designers' perceptions.

Perhaps the most important feature of the cognitive psychology approach to thinking is the new recognition of the existence of some kind of executive controlling function in the mind. Since cognitive psychology accepts that information is actively reorganised and reconstructed in memory rather than passively recorded and recalled, it follows that something must control this process. The existence of such an executive function was denied not only by classical association theory but also by the Gestaltists, however, more recent work on artificial intelligence has shown how executive routines in computer programs can control the order in which a very complex sequence of operations are performed in extremely flexible and responsive ways. There is not space here to do justice to this profound and fascinating subject but the interested reader will find brilliant and readable discussions of the matter in *Plans*