research consultant would probably concentrate on whether the buffet cars were on the right trains and so on.

It is quite possible that none of our professional experts was right. Perhaps the food was just not very appetising and too expensive? In fact, probably all the experts have something to contribute in designing a solution. The danger is that each may be conditioned by their education and the design technology they understand. Design situations vary not just because the problems are dissimilar but also because designers habitually adopt different approaches. In this book we shall spend some time discussing both design problems and design approaches.

What does design involve?

Barnes Wallis is perhaps most famous for his wartime invention of the bouncing bomb immortalised in the film of the 'dam-busters'. However his career achievements went much further with a whole succession of innovative pieces of aviation design including aircraft, airships and many smaller items. However, at the age of sixteen, Barnes Wallis failed his London matriculation examination (Whitfield 1975). It seems likely that this was a result of undergoing a form of Armstrong's heuristic education at Christ's Hospital, which did little to prepare its pupils for such examinations but rather concentrated on teaching them to think. Barnes Wallis recalls 'I knew nothing, except how to think, how to grapple with a problem and then go on grappling with it until you had solved it'. Later Barnes Wallis was to complete his London University first degree in astonishingly quick time, taking only five months!

Later in life Barnes Wallis was quite prepared to take technical advice, but never accepted help with design itself: 'If I wanted the answer to a question for which I could not do the mathematics I would go to someone who could . . . to that extent I would ask for advice and help . . . never a contribution to a solution'. Even at an early age it was the quality of Barnes Wallis' thinking and his approach to problems as much as his technical expertise which enabled him to produce so many original aeronautical designs.

For many of the kinds of design we are considering, it is important not just to be technically competent but also to have a well developed aesthetic appreciation. Space, form and line, as well as colour and texture, are the very tools of the trade for the environmental,

product or graphic designer. The end product of such design will always be visible to the user who may also move inside or pick up the designer's artefact. The designer must understand our aesthetic experience, particularly of the visual world, and in this sense designers share territory with artists. For these reasons alone, and there are some others we shall come to later, designers also tend to work in a very visual way. Designers almost always draw, often paint and frequently construct models and prototypes. The archetypal image of the designer is of someone sitting at a drawing board. But what is clear is that designers express their ideas and work in a very visual and graphical kind of way. It would be very hard indeed to become a good designer without developing the ability to draw well. Indeed designers' drawings can often be very beautiful.

Sometimes the drawings of designers become art objects in their own right and get exhibited. We must leave until later a discussion of why the practice of designing should not be considered as psychologically equivalent to the creation of art. Suffice it now to say that design demands more than just aesthetic appreciation. How many critics of design, even those with the most penetrating perception, find it easier to design than to criticise?

Perhaps there can be no exhaustive list of the areas of expertise needed by designers, although we shall attempt to get close to this by the end of the book. However, there is one more set of skills that designers need which we should at least introduce here. The vast majority of the artefacts we design are created for particular groups of users. Designers must understand something of the nature of these users and their needs whether it is in terms of the ergonomics of chairs or the semiotics of graphics. Along with a recognition that the design process itself should be studied, design education has more recently included material from the behavioural and social sciences. Yet designers are no more social scientists than they are artists or technologists.

This book is not about science, art or technology, but the designer cannot escape the influences of these three very broad categories of intellectual endeavour. One of the essential difficulties and fascinations of designing is the need to embrace so many different kinds of thought and knowledge. Scientists may be able to do their job perfectly well without even the faintest notion of how artists think, and artists for their part certainly do not depend upon scientific method. For designers life is not so simple, they must appreciate the nature of both art and science and in addition