actually trying to say. This is not the case with CAD systems. Even simple graphics systems have their own way in which you must enter information. A relatively simple task such as drawing a closed polygon or constructing an arc requires some knowledge about the system itself. A more sophisticated task involving the description of three-dimensional form is an altogether more demanding affair. If the geometry becomes irregular and in particular if it becomes curved and irregular then the whole process is likely to require highly specialist knowledge. No wonder Frank Gehry exploits his luxurious circumstances and has staff who manipulate this knowledge for him.

But even this is not the whole story of the frustration designers have in their conversation with computers. When we talk to other designers, they understand not just the shapes and forms but also the materials, systems and components that the drawings represent. In the case of architecture in particular, designers understand that actually it is what is not drawn that is really important, for architects are really manipulating space. Computers have little or none of this knowledge and are thus generally rather dumb in the conversation. They can perform some clever tricks such as viewing the objects from an infinite variety of angles and rendering them under natural or artificial lighting conditions but here they are really acting as little more than smart drawing boards. If we want to discuss with a computer how well a design might work in some functional or technical way then the computer needs knowledge not just about geometry but about what the graphical elements actually represent. So far this has turned out to be remarkably difficult to achieve reliably and efficiently.

Of course all sorts of research work has been done, and continues to be done to counter all these conversational problems of computers. Some argue that it is simply a matter of time. Once we have big enough and powerful enough computers and we have worked out all the clever algorithms needed, they will talk to us just like another human being, or so this argument goes. Essentially this is the argument behind the whole Artificial Intelligence movement. So successful has this movement been in a relatively short time that the argument appears quite convincing and of course it is remarkably seductive. It is not long ago that the opponents of this movement were saying that although we could write clever little chess playing programs, computers would never beat the grand masters. Well now they can and they have. We already have handwriting recognition and voice recognition and some limited natural language translators. So surely computers

that can converse with us meaningfully about design cannot be so far away?

However there is another school of thought (Dreyfus 1992). Such a view holds that there is something quite different about some kinds of human cognition that simply cannot be reduced to the kinds of simple representation needed to put information into computers. This view claims that although we have crude natural language translators, it will never be possible to instruct a computer to translate sensitively and as accurately as people can. Such a view holds that the act of designing as we have discussed it here is probably even more uncodable. Designing is not just an extension of complex problem solving or of playing chess. It involves some cognition that is fundamentally different from those kinds of activities. It is probably one of the main reasons why designers find it so difficult to explain what they do and to discuss their ideas with their clients and users. It is to do with the fact that there is no text book for design students and there are no overarching theories that designers rely upon to practise. It is to do with the apparent lack of boundaries around the knowledge that may be useful when designing even the simplest of objects. Above all it is to do with the curious and beautiful relation between design problems and their solutions. Quite simply it is what this book is all about.

So in terms of our conversational view of design, certainly at least for now, and probably for the foreseeable future, we need an interpreter before we can talk to the computer. This is hardly the direct creative conversation that we have been discussing in this chapter. Our point here is not to attempt an answer to this or any of the other multitudes of problems of using computers in design. That argument belongs elsewhere. Our interest here is the further evidence that this frustration with computers provides of the very natural, conversational and immediate way in which designers think.

References

Cross, N. (1996). Creativity in design: not leaping but bridging. *Creativity and Cognition 1996: Proceedings of the Second International Symposium*. L. Candy and E. Edmonds (eds). Loughborough, LUTCHI.

Cross, N. (2001a). Achieving pleasure from purpose: the methods of Kenneth Grange, product designer. *The Design Journal* **4**(1): 48–58.

Cross, N. (2001b). Can a machine design? *MIT Design Issues* **17**(4): 44–50.

Dorst, K. and Cross, N. (2001). Creativity in the design process: co-evolution of the problem-solution. *Design Studies* **22**(5): 425–437.