Not only computing - also art

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From time to time, we all hear of exciting and imaginative concepts which, if only they were realised, would make our lives easier, better, or at least more fulfilling. Alas, these promising ideas often turn out to be impractical, if not impossible. Thus, after frequently being disappointed, we usually - and with some justification - tend to treat new ideas with a fair degree of scepticism.

Some time in the late 1960s, I received a letter from an artist in California - whose name I've now forgotten - telling me that he was using a computer-controlled system which could create truly three-dimensional objects in a novel way. Apparently, the system comprised a vat of special liquid chemicals and three lasers, which were mounted in mutually perpendicular axes so that they could shine into the vat. The positions of the lasers were controlled by the computer in such a way that the three beams could intersect at any point of the liquid. Where they did this, they would create a spot of light sufficiently strong to solidify the solution just at that point. By getting the computer to plot the voxel coordinates for a desired form, the artist could then build up a solid object which, after pouring off the unused chemicals, became a physical piece of sculpture.

I thought this a marvellous notion, but was a little unclear about its realisation and, although I asked him to send me more details, heard no more about it. From time to time, I would ask others about this system, but no-one else had heard about it at all, and I had come to believe that it was mythological. However, unless an elaborate hoax is being played, I have now reason to think that the system really does exist - indeed, that the whole thing has been a standard commercial device for some years.

My latest information comes from the proceedings of a conference on *Computer Aided Architectural Design Futures*, held in Zurich in July 1991. In these proceedings, edited by Gerhard Schmitt of ETH, there is a paper by Professor Bernd Streich of the University of Kaiserslautern, Germany. This paper, entitled Creating Architecture Models by Computer-aided Prototyping, describes a system dating from the middle of the 1980s, which uses a vat of photopolymer plastic together with an ultraviolet laser and scanner, all controlled by a computer. Unlike the California system (or at least, my understanding of it), this one uses a single laser to locate the x-y points. The z position is determined by mechanically moving a platform, on which the model sits in the vat of photochemicals, in the vertical direction. Thus, the model is built up slice by slice in the manner of a CAT scanner, but with the bottom slices being created first (Figure 1). The technique seems to be known as 'stereolithography', and still appears to me as unlikely a process now as when I was first told about it, although, from what Streich says about it's high cost, I am coming round to believing in it. I would be glad to hear from anyone who actually has seen the system in action.

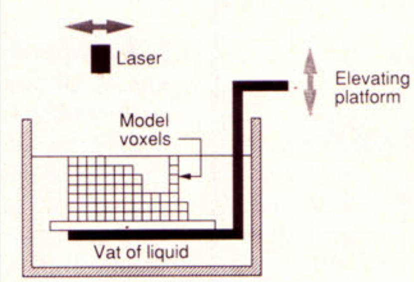

Figure 1. Showing notional layout of modelling device.

Wiggly lines revisited

In the same volume of the *CAAD Futures '91* proceedings is another piece of exotica of special interest to me. Back in the early pre-fractal days of this column, I told you about a problem I was having in drawing wavy lines by computer. Many of you sent in ideas to tackle this problem - some of which I adopted (although the best method seemed to be to employ a variation of a technique invented by Lambert Meertens, and which I'd been using for some time to generate computer music. This turned out to be fractal anyway). However, a paper in the conference by the unusually-named pair W Davis van Bakergem and Gen Obata, from the Urban Research and Design Centre at Washington University, St Louis, gives the most ingenious solution yet. They simply equipped their plotter with a loosely fitting pen! The amount of wobble they can achieve can be controlled by bulldog clips and other ad hoc devices, so that a variety of line types can be produced. Having been able to get the results they

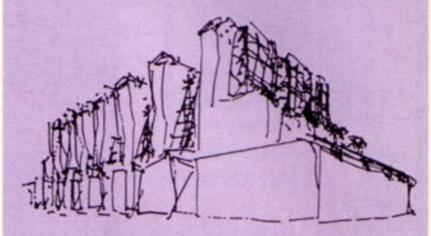

Figure 2. Mendhelson's Labor Hall: normal line drawing

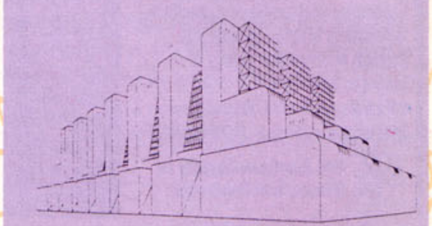

Figure 3. Squiggly pen plot: mild wobble

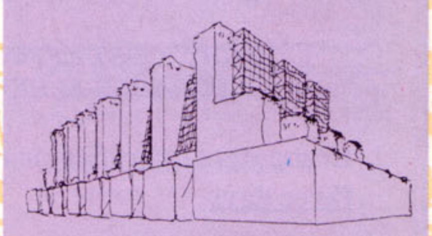

Figure 4. Squiggly pen plot: severe wobble

needed by this simple process, one of their colleagues was able to write a PostScript program to simulate it.

This is certainly one way to solve the wiggly line problem and the effects are quite impressive, as can be seen in Figures 2-6. Of course, any mixture of randomness and order as will occur by putting a loosely-fitting pen into a plotter is likely to be fractal and nowadays, the normal programming way to draw a wavy line is by use of well-known fractal techniques.

A different, lighter sponge

Fractals and chaos dominate my last example of new developments too. Huw Jones and Aurelio Campa, two of my colleagues at Middlesex Polytechnic, have recently been exploring fractal objects based on regular polyhedra. The technique they use for creating and illustrating these objects is an extension into three dimensions of Michael Barnsley's Chaos Game - a brilliantly simple, but enormously powerful, idea that was introduced into these columns a year or two ago, and which is describe in detail in Barnsley's fascinating book, *Fractals Everywhere (Academic Press, 1988)*. In order to make their three-dimensional objects, Jones and Campa generate many 'clouds' of points in space using a technique similar to statistical random walking. These clouds comprise hundreds of thousands of points which, in the case of Figure 7, relate to 32 attracting points

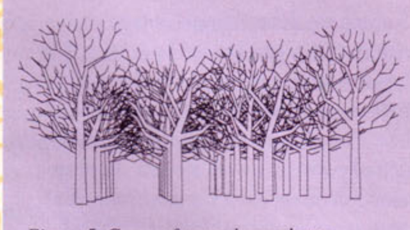

Figure 5. Grove of trees: laser plotter

Figure 6. Grove of trees: squiggly pen plot

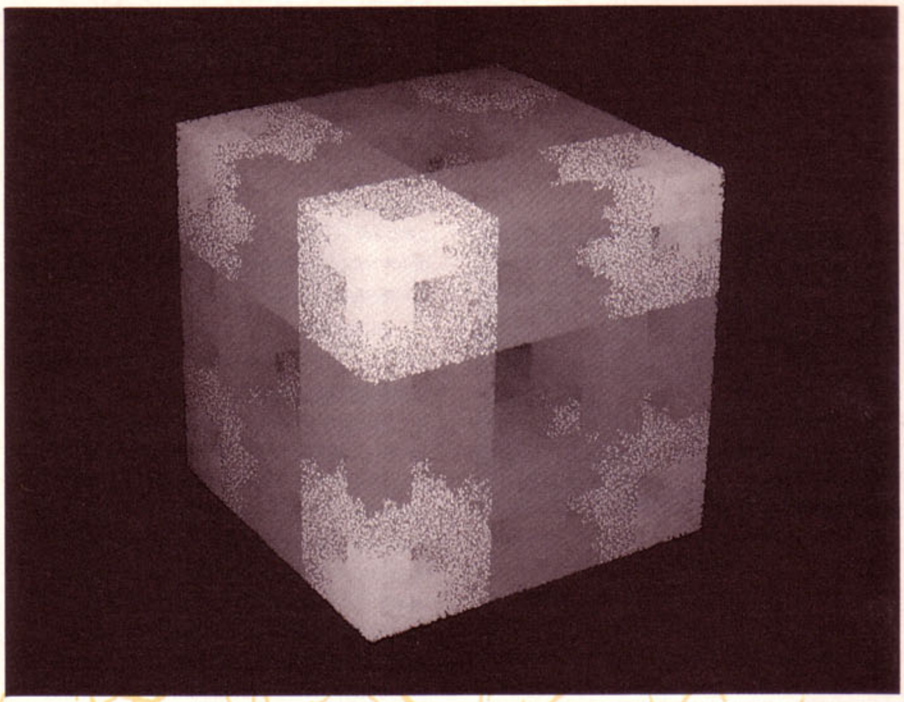

Figure 8. Diagonal section of 'cake'

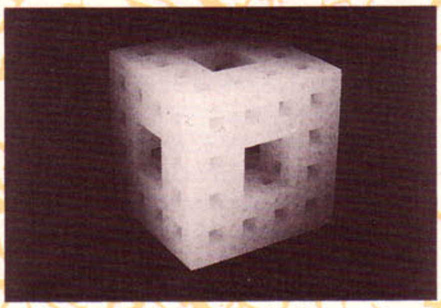

Figure 7. Cloud of points related to 32 attracting points

arranged at the vertices and along the edges of a cube.

As you see, by using this technique, the clouds come together in a form which looks like the well-known Sierpinski or Menger 'Sponge' - so-called because of its 'holey' resemblance to the sea animal. If you don't know the sponge, a picture of it can be seen on page 167 of Mandelbrot's *Fractals: Form, Chance and Dimension (Freeman, 1977)*. This object has the curious property that, in the limit, its volume vanishes whilst its surface area grows infinitely large! There is, however, an important difference between the Sierpinski-Menger 'Sponge' and what I am calling the Jones-Campa 'Cake'. The former has a central hole surrounded by eight smaller holes which, in turn, are surrounded by eight even smaller holes and so on. The latter has a central hole surrounded by twelve smaller holes which, in turn, are surrounded by twelve even smaller holes and so on. As the 'Cake' is straight out of the oven as I write this, no one has yet had a chance to investigate the properties of what appears to be a genuinely new and important mathematical form. From what I know about its mode of generation, I have a feeling that it is more 'correctly' related to the two-dimensional Sierpinski triangle (from which it derives) than is the Sierpinski-Menger 'Sponge', and should actually replace it.

The great early twentieth-century geometer, Sierpinski, of course, did not have computer graphics to make pictures of his ideas, and I am sure he would have been fascinated by the possibilities that the new techniques give rise to. Figure 8, for example, is a diagonal section taken across a corner of the 'Cake', whilst Figure 9 illustrates the effect of colour coding the image according to the last attracting point used. I will keep you informed about developments in this exciting new area.

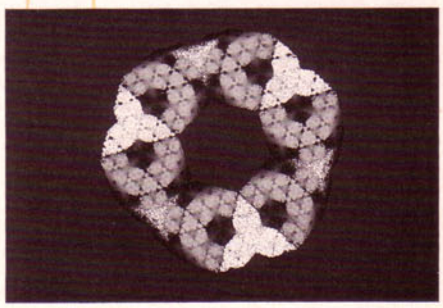

Figure 9. Colour coded 'cake'