COMPUTERS AND MODELS

Our ability to model and explore complex three dimensional structures like these has been revolutionized in recent years by new computer technology, which allows us to construct, display and manipulate models at a level of detail which was previously impossible. Indeed, computer modeling and graphics are influencing almost all aspects of science and technology. But the role of computers in contemporary science is more profound. The enormous achievements of science over the last few hundred years have given us an increasingly accurate knowledge of the fundamental forces of nature. To achieve this, it has been necessary to strip down nature to its essentials - to simplify reality. Given this fundamental understanding obtained by the strategy of simplification, we can now move to an even more exciting phase of exploring the complexity that we see in the world around us. And this is where computers play such a central role. The constantly expanding processing power and memory of modern computers allows us increasingly to translate fundamental knowledge into models of reality. We show a schematic representation of how this works. The computer is programmed in accordance with the laws of physics and has access to data bases of relevant information. It then explores, develops and displays a model specified by the scientist

The computational scientist is, of course, almost uniquely privileged in that the power of the technology which he uses continues to grow almost explosively. At the time of writing, computational power is roughly doubling for a given cost every eighteen months. Moreover, the increasing availability of high performance and high resolution graphics workstations allows the computational scientist to display and visualize his models with images of remarkable quality.

Does this expansion in computer power promise to continue indefinitely? It certainly will continue into the foreseeable future. And one reason for this is that the computer industry is exploiting a simple but very effective idea - the idea summed up in the proverb "Many hands make light work". One (but only one) strategy in modern computer hardware is to use the principle of parallelism - to distribute a huge, complicated task to a large number of modest (and cheap) processors. If the computational task is such that the processor scan work independently for a period of time and if the different processors can rapidly communicate their results to each other, we can achieve high performance with only modest technology for each processor. Several computer manufacturers are now producing massively parallel processors. Of central importance is the connectivity between the different processors.

Detailed discussions of the fascinating field of computer hardware are beyond our scope here. Rather we will show how the unique model building power of the computer is being exploited in contemporary science. Global or cosmological models are of huge importance, but pride of place is given here to models of matter at the atomic level - possibly the greatest intellectual achievement of twentieth century man.

Molecules In Our Lives