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Computers

An issue of almost any scientific journal shows the impact of computers on the practice of research. The computer has become a required and common tool in many fields. We find applications, for example, in some of the purest mathematics, in particle physics, in organic synthesis, and in molecular biology.

This issue of *Science* focuses on computers. Since it is not desirable, or even possible, to present the whole range of the enterprise of computers and computing, we have chosen to highlight some aspects of computing that are likely to show rapid development and that are likely to have great and immediate impact on a large number of scientists. There are, obviously, a number of other topics that might have been covered; these we hope to look at in individual articles in the future.

The articles in this issue concentrate on three thematic areas: interfaces, languages, and hardware. Each of these overlaps and affects the others. Indeed, a number of the articles address some common problems and issues, although one can see major advances occurring in each field.

We begin with the most personal of the subjects, interfaces, an area related to how we can best take advantage of our computational resources. Jennings *et al.* address networks and networking. It is networks that will allow communication between remote locations and that will enable us to use expensive resources in an efficient and convenient way. Their planning and implementation require careful thought, since the decisions will affect almost all users. Crecine discusses the development of standardized workstations. With these the scientist will be able to manipulate data and produce manuscripts with a uniform and efficient set of standardized protocols. Programs written in one location will be transportable and will function on someone else's machine. Again, the combination of human and machine interactions as well as the emphasis on uniformity require that decisions be made correctly because the consequences are far-reaching.

Languages are a critical component in the use of computers. (We do not address here the issue of the long-term viability of FORTRAN, or even Ada.) Two major, serious problems present themselves. What kinds of languages are required to get the most out of new computer architecture? What kinds of languages will allow us to solve problems related to the processing of massive amounts of data in problems that by nature are too diffuse or broad to be handled easily or intuitively by an individual or group? Bobrow and Stefik address the question of new languages and programs and an environment in which to produce them. Davis discusses knowledge-based systems and questions of artificial intelligence.

Finally, hardware makes things possible. As we approach some of the limitations on computing speed that are due to such physical constraints as the speed of light, ingenious developments in architecture can provide remarkable benefits. Gabriel discusses one of the most dramatic aspects, massive parallel computing. He points out, also, the language problems inherent in effective use of such constructions. Baskett and Hennessy address the problem of using many microprocessors together in a "small" machine, thereby providing unusual power at the user's desk. Finally, Kuck *et al.* describe some of the advances to be expected in the area of supercomputers, the frontier of the largest and most expensive calculations.

It is everyone's hope and many people's expectation that all of these advances will further the scientific enterprise and make life more productive and, possibly, more pleasant. We can be certain that with inevitably lower costs and improved computing capability we will see the solution of many scientific problems at an increasingly rapid rate. The future of much of the activity of science is bound up in the development of computers, and all of us will be affected.—JOHN I. BRAUMAN, Department of Chemistry, Stanford University, Stanford, CA 94305