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Use of Computers in Undergraduate Education

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Over the past several years automatic digital computers have become accessible to many undergraduate students. This accessibility has given an impetus to the inclusion in the undergraduate curriculum of various aspects of computer utilization such as programming, numerical methods, and computer applications. This paper will examine some of the reasons for including such material in the undergraduate curriculum, and in the course of such examination, some of the ways in which this can be done will become evident.

The reasons for supporting computer activity in undergraduate education may be classified as cultural, professional, and pedagogical. By cultural I mean simply an appreciation of the role that computers play in our society. It is my belief that one cannot fully appreciate how computers have revolutionized governmental and industrial data processing (the "paper revolution") and greatly aided technology and scientific research, not only in doing the same old things faster, but in doing new things, without some understanding of their nature. Certainly the revolution in automation cannot be appreciated without some understanding of computers.

The computer, by its very nature of being a general purpose tool, is interdisciplinary in scope. Hence, it is not unreasonable to require that students gain some facility with a tool that many may need in their professional life. Moreover, the computer industry and computer users are demanding high-level help from many disciplines. These professional opportunities ought to be recognized by our schools and reflected in their undergraduate programs.

The use of a computer as a "teaching aid" can take many forms. Such use in teaching computer programming is obvious. Also clear is such use in teaching numerical methods of solving linear systems and differential equations, finding zeros of functions, evaluation of functions and integrals, estimating errors, and performing simulations involving "random" quantities.

These topics may be part of a course in numerical methods or simply arise in the course of dealing with other areas.

There are many places in the mathematics, natural science, social science, engineering and business administration courses of the undergraduate curriculum where a computer, although unnecessary, could be used to advantage. The important first step for such use is the preparation of a precise outline (a flow chart) of the numerical and logical processes involved. Then, if a computer is available, a program can be written and a machine solution obtained. The use of a computer in some undergraduate courses serves only an enrichment purpose; in others it is an important part of the educational content. I believe that the responsibility for gaining an understanding of computer capabilities and then using this knowledge in the appropriate places in the curriculum rests with the person who is in the best position to judge such appropriateness—the individual teacher. It is he who must ultimately determine the computer's use as a teaching aid.

There is another area in which the use of a computer can have great educational value—that of student research and independent study. By educational value I mean not the performance of routine computations that often are part of one's research, but rather the *motivation* for student research that accompanies the presence of a computer. Computers are easy and fun to use. Much non-trivial work in numerical and logical methods and advanced programming techniques can be done by the student who is long on ingenuity but short on mathematical experience. That undergraduates can engage in a meaningful program of research and independent study is well attested to in the report by May and Schuster, *Undergraduate Research in Mathematics*, Carleton Duplicating Service, Northfield, Minnesota, 1962.

The computer can be, and ought to be, an important part of the academic life of a college.