Goals for Computer Science Education in the 1980s

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The nature of computing, and hence of computer science, is changing rapidly. Many topics that now seem interesting will be obsolete or irrelevant within ten years, and our perspective on other topics will change. If a curriculum designed now is to remain effective through 1990 or beyond, we must try to understand the forces that are shaping the field and to anticipate the roles that computing and computer science will play in the future.

At Carnegie-Mellon, a group of eight faculty and graduate students is designing a new undergraduate computer science curriculum. We began by examining the trends that will affect the field over the next decade and the new phenomena and issues that may arise. From this basis we are developing a new curriculum without prior assumptions drawn from existing curricula. In this talk I will discuss our view of current trends in computer science and the roles that colleges and universities must play over the next decade.

A View of Future Computing

Computers are becoming smaller and cheaper, and they are being distributed across a wider and more varied population. Important current trends include:

- Decreasing hardware costs
- Increasing share of computing costs attributable to software
- Increasing expectations about scope and power of applications
- Increasing significance of distributed computing
- Increasing access to computing power
- Widening view of computers as an information utility
- Increasing quality of interfaces to humans
- Increasing exposure of naive people to computers
- Continuing or increasing shortage of qualified professionals
- Increasing importance of "intelligent" systems
- Increasing adaptation of the workplace to computing technology
- Increasing complexity of computing systems
- Increasing economic impact of computing

As a result, we can expect a substantial qualitative shift in the role of computers in the world at large. The nature of education will surely be affected as well. Further, entertainment technology has raised students' expectations about the educational process.

This view of the future raises a number of issues. These include consumer concerns, distribution of computers in the retail marketplace, safety and security of computers and computer-based products, the economic impact of widespread computing, and human and social impacts. Universities must respond to these issues by broadening their computer-related offerings in order to prepare students to use the new electronic tools and to adapt these tools to a variety of new uses. We believe that this is best accomplished by teaching students the principles that support current tools; current practices will rapidly become obsolete, and students must be prepared to adapt.

Roles for Universities

Professional education in computer science is growing more rigorous, and we expect an increasing need for students to master a growing set of fundamental concepts. Mere programming skill will no longer suffice for most computing professionals. Computer science will require solid technical expertise comparable to that expected of engineers, and most development work will require genuine competence in both the application field and computer science. In addition, many people will need to use computers in sophisticated ways and need to understand the implications of the spreading computer technology. Universities must begin now to respond to these emerging needs.

Because of the growing importance of computers in many fields, universities now have a responsibility for teaching several distinct groups of students about computers and about computer science. I will discuss the pattern of student involvement with computing and suggest that a significant change in that pattern is taking place.

There is currently a documented shortage of computer professionals at all levels, from technicians to researchers; this manpower shortage is projected to continue through the 1980s. We believe that a major component of the demand for bachelor's and master's level computer professionals will soon be for students with advanced technical competence in computing as an integral component of computing specializations within other disciplines. Such joint education in computer science and another discipline is now seriously neglected; indeed, many of the students who currently select computer science majors might be better served by computing specializations in other departments. In addition, the criteria for general literacy in the university at large will require education for large numbers of students who will *use* a variety of sophisticated programs and packages but who will do very little *creation* of programs.

We conclude that there are four significant roles for universities to play in computer-related education. These include

- Educating future computer scientists at all degree levels,
- Educating non-computer scientists who will bring computing expertise to their own fields of specialization,
- Educating people who need modest programming skills, and
- Educating the entire university population about the potential and use of computers.

Report on Carnegie-Mellon Curriculum Design

Carnegie-Mellon's curriculum design has been done by a group including Steve Brookes, Marc Donner, James Driscoll, Michael Mauldin, Randy Pausch, Bill Scherlis, Mary Shaw, and Alfred Spector. A technical report entitled "Proposal for an Undergraduate Computer Science Curriculum for the 1980s" elaborates the points discussed here and presents a detailed curriculum proposal. This report is available on request.