

DUKE UNIVERSITY COMPUTER SCIENCE PROGRAM

Presented to Vice Provost Harold W. Lewis

by

The Computer Science Working Group

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ABSTRACT

Scholars from inside and outside of the University have studied the need for a Department of Computer Science at Duke University, and the Trustees have twice acted favorably on this question. The present proposal reviews the national and local need, reviews the magnitude and strengths of the ongoing instruction and research in computer science, and offers plans for three levels of activity.

The minimal program reorganizes present activities and requires no new commitment of money or space. It provides for orderly growth and satisfactory quality.

The second plan, supplementary to the first, provides for greater assurances of excellent quality. It requires \$180,000 of University support over a five year period and addresses the space problem.

A third plan, supplementary to the first two, provides for a position of national leadership. It requires the University to give very high priority to the Department of Computer Science.

1. Introduction

Computers will have, within a few decades, an impact on society comparable to that which the printing press produced over a much longer period. The industrial revolution eventually relieved most men in our country from arduous physical labor. The computer revolution will relieve them of most routine mental chores. We are now seeing only the first signs of this impact.

The time scale of change may be inferred from the fact that the IBM 650 computer which Duke University acquired in 1958 (and which was instrumental in the work behind many Ph.D. dissertations) took about one tenth of a second to multiply two numbers in a scientific computation while the presently installed IBM 360 Model 75 does the same thing today in about one millionth of a second, a change of five orders of magnitude. Scientists have found in the past that a one order of magnitude improvement in measurement usually has drastic effects. (The difference in speed between a moonbound space capsule, for example, and a man on foot is only about four orders of magnitude.) Computers at least two orders of magnitude faster than the Model 75 will be in use before the end of this decade. The packing density of computer memory elements will be one quarter that of neurons in the human brain by 1975. Man can not learn overnight to make intelligent use of such explosive changes in technology.

Clearly today every child should be taught, before the end of his formal education, at least three skills: to drive an automobile safely,

to type with reasonable speed and accuracy, and to program a computer.

Less obvious are the intellectual implications of computer science. Many people still think of the role of computer science in a university in terms of vocational or technical training. It is not yet widely understood that computer science (or its absence) is beginning to set the intellectual tone for a university. The following quotation from Malcolm C. Harrison of the Courant Institute of Mathematical Sciences may be helpful in explaining why this is so.

Most people think of mathematics as being a very complicated subject. On the contrary, if we define the complexity of a problem as the amount of information required to describe the problem and its solution, it is apparent that mathematics can deal only with simple problems. Further, if we consider the universe of all problems, almost all of them are too complex for solution by mathematical methods, which rely heavily on abstraction and conceptualization, which themselves reflect the limitations of the brain. Thus, while it is reasonable to expect a mathematical solution of the four-color problem, it is not reasonable to expect a mathematical solution to the problem of language translation, which can be stated only in terms of massive amounts of information from grammars and dictionaries, and whose solution will probably require an algorithm of comparable size. The importance of the computer is that it permits the consideration of such irreducibly complex problems.

2. Background of this proposal

In March, 1967, the Council for Social Studies sent a memorandum to President Douglas M. Knight urging that an Office of Computer Sciences be established at Duke. This memo stated that the Office of Computer Sciences should be "charged with the responsibility to develop, coordinate, and administer computer activities at Duke," and should also "provide a structure within which innovative use of computing and teaching about computers could be conducted in a manner balanced in the best interests of the total University community."

In May of 1967 President Douglas Knight responded to the memorandum by recommending that a search for a Chairman of the Office of Computer Science begin. This recommendation was not followed, primarily because of opposition from within the Department of Mathematics which at that time had responsibility for the Computation Center and computer science education. It should be emphasized that at the present time the Department of Mathematics is not opposed to the formation of a separate Department of Computer Science.

During the late spring and summer of 1967 information and recommendations were requested from all interested departments concerning their needs in computer-related education. Approximately twenty departments responded.

In December of 1967 Vice Provost Frank de Vyver appointed a committee chaired by Professor Thomas Naylor and charged it with the

responsibility of preparing a proposal to the NSF for help in the program for computer science education. Using the information and recommendations previously gathered from individual departments as a basis, a proposal was prepared and submitted to the NSF Office of Computing Activities in February of 1968. The Executive Committee of the University Board of Trustees approved the proposal prior to its submission to NSF. This proposal called for the formation of a Computer Science Laboratory which would have the responsibility of assisting existing departments in the development of computer science activities.

In April of 1968 the NSF conducted a site visit to the University concerning the proposed Computer Science Laboratory and, on the basis of this visit and written reviews of the proposal, recommended the formation of a Computer Science Department.

This recommendation led to a reconsideration of the proposal. During this process consultants were asked to visit the University to give advice regarding the formation of a Computer Science Department.

One of those invited to visit was Dr. Alan Perlis, Chairman of Computer Science at Carnegie Mellon University. Subsequently he submitted his recommendation for a Computer Science program at Duke, which included the following statement.

The computer, and the atmosphere surrounding its use, is spreading into almost every area of intellectual pursuit. I guess my most telling point is that serious intellectual effort in the field of computer science will ramify and affect in a very serious way the approach which other departments bring to their work. I will gladly predict that campuses without programs in computer science will find themselves ill-equipped to educate in years to come.

Mr. Richard Gilbert and associates of Burlington Management Services Company of Greensboro also visited the University to give advice concerning a computer science department. In their report they wrote:

The need for a Computer Science Department at Duke University would appear to be well established. Computers have become a necessity in many areas of industrial and commercial activity and fundamental to research in many diverse fields. The University of today requires adequate resources and capability in Computer Science to provide for student and faculty research and to prepare students to apply the concept to their post-graduate environment.

Their report states

Failure to commit to a Computer Science Department at this time would almost assure a continuation of the current unstructured growth of activities in this area at Duke University. Within several years Duke support of these divergent and uncoordinated activities might well exceed the cost of support of the formal academic department. A dedicated Computer Science faculty will be the most efficient method of providing instruction, research, and intellectual guidance in this field. This approach must be contrasted with the corrosive and costly long term effects of numerous splinter activities.

In addition to off-campus advice favoring the formation of a Computer Science Department, some on-campus groups have indicated their support. In May of 1968 the University Computer Advisory Committee resolved "that the committee go on record as saying that a Department of Computer Science is desirable and necessary for the continuing development of the educational and research programs of Duke University." Also at a meeting in May of 1968 the University Planning Committee endorsed the establishment of a Computer Science Department at Duke. Department Chairmen, such as Dr. Fairbank

of Physics, wrote letters and in other ways indicated their support at that time for formation of a Department.

The above reports and recommendations led to the preparation of a proposal to NSF requesting support for the formation of a Computer Science Department at Duke. The final revision of the proposal was approved by the Executive Committee of the Board of Trustees in January of 1969.

In June of 1969 a representative of NSF visited with members of the University administration and informed them that NSF would not support the formation of a Computer Science Department at Duke unless the University contributed a larger share of the cost. Since that time additional monies have been committed by the University for instructional use (see for example remarks on the MIRU project below).

At approximately the same time representatives of Bolt, Beranek, and Newman, Inc., were invited to review the requirements and resources for computing at Duke University. In their report of July 31, 1969, they state: "A Computer Sciences Department should be created as soon as budgetary considerations permit. If this department cannot be created immediately, a degree granting Computer Science program should be developed with a view to acquiring departmental status at the earliest possible date."

3. Need

The national demand for persons trained in computer science, at all degree levels, is currently insatiable. The estimated number of computers in use in the United States has been

1944	1
1954	3 00
1959	2,0 00
1964	12,0 00
1969	50,0 00

The number may be expected to exceed 1,000,000 well before 1990. Each requires analysts, programmers and operators. Many thousands of people are currently engaged in developing new computers and the standard programming systems for them.

The need is most acute for persons trained to the Ph.D. level. A handful of universities have been awarding Ph.D. degrees in this subject matter (under the auspices of a number of departmental names) for more than a decade. (Duke University awarded one such Ph.D. in 1961.) In recent years most of the leading universities have created departments of computer science. The less-than-200 products of these programs are now playing the major roles in the design of new equipment and new programming systems, and in the development of new application techniques. They are also developing the new abstract theory, guiding the most successful research programs, and establishing the educational programs to fill the needs at every level.

The need for Ph.D. training will increase yet more as hundreds of colleges begin to offer undergraduate and master's level work in this field. The quality of instruction, research, development, and application in the field will suffer seriously unless competent, well-grounded, broadly and deeply trained leaders can be developed rapidly.

Duke University, in particular, has at least five important needs of its own for a Computer Science Department.

First, a Department of Computer Science will attract a nucleus of computer scientists to Duke University who can provide the intellectual leadership and guidance to existing faculty members and graduate students which is necessary, if we are going to take full advantage of the capabilities of computers. The presence of a group of computer scientists should have a stimulating effect on the computer related faculty members and students in other departments.

Second, courses in the Computer Science Department will afford opportunities for both faculty and students to upgrade their competence as computer users.

Third, the existence of the Computer Science Department will be of material assistance to other departments in attracting computer oriented faculty. Recruiting such personnel for the University in the absence of a Department of Computer Science is becoming increasingly difficult.

Fourth, the knowledge and skills of the members of the Computer Science Department will constitute a valuable resource to the University in the overall

planning of University computing activities.

Fifth, the increasing demand for courses, and programs in Computer Science can be met in an orderly and efficient manner.