Development of a Resource Center for Introductory Computer Science

Technical Report Number CS76015-E

by

J.A.N. Lee
Professor of Computer Science
Department of Computer Science

Virginia Polytechnic Institute
and
State University

Blacksburg, Virginia 24060

1976 December 29

Prepared for the COMPCON Tutorial on CSE Curriculum

San Francisco

1977 February 28

ABSTRACT

This paper reviews the experiences of developing a Computer Sciences Resource Center through the joint efforts of faculty and students, at minimal cost to the institution, yet with maximal opportunity for learning experiences by students in even the initial offerings of the courses. Although especially directed at the so-called "Computer Appreciation" courses, the resources developed through this program are applicable to other computer science courses and to other presentations across the college campus.

INTRODUCTION

The opportunity to develop meaningful learning experiences in the field of Computer Science has often been lead astray by the concept that nothing meaningful can be presented to participants unless there is a large dose of computer interaction. Whether this is accomplished by means of batch operations through a closed shop operation or through an interactive laboratory, the cost per student is often sufficiently high, that it's use is restricted to only those students who have a "need to know".

The project which is described here bases its syllabi and supporting materials on the concept that there is much more to Computer Science than just programming. In particular, in the presentation of (so-called) "Computer Appreciation" to non-majors, every advantage has been taken of their native interests in order to achieve two intrinsic goals. Primarily, the acquisition and presentation of materials which were highly pertinent to the major interests of the students in the courses was considered a necessary goal in order to sustain their interest and further to include them (and consequently their faculty) in further course development. Secondly, the skills that these non-majors possessed were to be put to work in assisting in developing resources for succeeding courses.

COURSE CONTENTS

The Department of Computer Science at Virginia Polytechnic Institute and State University (VPI&SU) is responsible for the presentation of "beginning" courses in Computer Science for the whole institution. This responsibility is based on the notion that there needs to be standardization of presentation of materials at this level. In particular, the department has emphasized current techniques and technologies in these courses prior to the time when other non-specialist departments would have been aware of the trends. Thus the inclusion of disciplined programming techniques in introductory programming courses has been easily attained.

Notwithstanding the centralization of instruction at the introductory level, the department and college have encouraged the development of applications courses by other departments in the University. Thus the School of Architecture has a broader offering in computer graphics than the Department of Computer Science, and the departments of Chemistry and Chemical Engineering have more students registered in courses on TTL circuits, minicomputer interfacing and microprocessors than the combined departments of Computer Science and Electrical Engineering.

However, the majority of students registered in introductory Computer Science courses are there simply because of departmental and college graduation requirements. While we recognize that the reason for this requirement in science and business major curriculum is to provide a base

for the use of computers in later applications courses, the presentation of material to non-science, non-technical majors is not so cut and dried.

It is interesting to contrast the learning objectives of these two styles of curriculum as related to these introductory courses:

For introductory programming courses:

The purpose of an introductory programming course is to acquaint the students with the principles, methods and techniques of converting problem solutions into computer programs.

The major desired outcome of this course is to provide a base on which the student can build an ability to apply the computer to his own major field of interest.

As a result of this course, a student should be knowledgeable of the techniques of programming in one particular language and be able to recognize the applicability and limitations of the computer.

For computer appreciation courses:

The purpose of this course is acquaint students with the basic concepts of computers, computing and computation, through studies of the historical development of the science, the fundamentals of computer hardware and software design, and applications of the computer technology to his major field of interest.

The major outcome of this course is to broaden the student's knowledge of the technology to which

he is subjected day by day and hence for him to understand the applicability and limitations of computer technology.

As a result of this learning experience, each student should be able to understand the applications of the computer to his major field of interest and to be able to judge the usefulness of attempting to use the computer in various situations to which he may be exposed, and to possess a vocabulary in order to interact with professional computer personnel.

It is to students in these latter courses that we turn our attention now.

In order to achieve the learning objectives, it was determined that the course(s) needed to cover three essential aspects of the subject; the historical development of the subject, the current technology and the applications of the technology. Included in the historical aspects there exist several topics which can be developed extensively. In fact, it has been our experience that that there is so much material here that the tendency to "revel" in the intracasies of the history must be subjugated to the needs of the students. However, like the other areas of study the complete presentation of the material is impossible and thus it is necessary to provide opportunities for the students to further investigate specific topics themselves. Included in the historical topics are three elements which have been found to be of specific interest to students in other disciplines. These are studies of the progression of

development of certain concepts (such as number systems, codes and cyphers, the elementary computer, etc.), studies of the personalities involved (such as Babbage, Napier, or even more recent figures such as Grace Hopper, Herman Goldstine and others), and studies of the construction of specific devices and their effects on the problem solving community (such as Jacquard's loom, Hollerith's card processors etc.).

The information needed by a student with respect to the current technology amounts to an understanding of the basics of both hardware and software. It is the intensity of presentation of this aspect of the subject area that distinguishes the various introductory Computer Science courses. For the student in the humanities, the material presented covers sufficient logic and circuitry to develop (say) a full adder and thus to realize the simplicity of the construction of a machine, sufficient exposition on the construction of computer peripherals and their media (such as magnetic tapes and disks) to provide an understanding of the options available to the user of a system, and sufficient knowledge of programming and languages to realize that the development of programs is neither a mystic art nor a faultless activity.

The applications area of presentation is divided into two specific subject areas; the application of the computer to the student's major field of interest (or vice versa) and the general application of computers to daily life. The former topic is covered by independent student projects while the latter (which includes such topics are social

implications of computer usage and "way out" computer applications such as artificial intelligence and robotics) is covered in classroom activities.

METHODS OF DEVELOPMENT

While many University educators have decried the ability of the average student to express himself clearly in his native language, either in written or vocal expression, it has been our experience that the average Computer Science student is below the average with respect to this measure. However, the students from other disciplines such as journalism, interior design or education have skills which can be tapped for the benefit of all students. Thus our "Computer Appreciation" course (more aptly titled "Computer Concepts") has become the foundation of an ongoing resource development project within the Department of Computer Science.

This particular course has been taught on both the semester system (at the University of Massachusetts at Amherst as COINS 101, Introduction to Computer Science) and during a quarter (at Virginia Polytechnic Insitute and State University as CS 1020, Computer Concepts). Obviously the difference in time periods made a significant difference to the amount of material covered, but the enthusiasm of the students to assisting in the development of course materials as part of the assignments has not diminished.

Initially, (in 1971, when the course was first offered at the University of Massachusetts at Amherst) the projects chosen for student preparation were totally the "brain-child" of the faculty member, and left no room for student options. That is, each of the assignments was specific in nature, though the mode of presentation of the student's efforts was not specified. Since that time, student

assignments have been chosen on the basis of University, Departmental and course needs, and have been widened to provide the student with as many options as possible. The need for such options was necessitated (in my opinion) by the need to match course requirements with student's skills. That is, every opportunity should exist for the student to express themselves in the medium which they prefer.

The results of this experiment have been extremely satisfactory. Not only have the students benefited from the opportunity to show their knowledge of the subject in terms of their own skills, but also the whole University community has benefited. For example, a student of agriculture choose to research the application of the computer to the dairy industry and as a result produced a 17 minute tape and slide presentation on genetic mating services. This presentation is now in use both in the Department of Computer Science for succeeding generations of the course in which it was developed, but also in several other introductory courses. At the same time, the Department of Dairy Science possesses a pedogogical tool for introducing the computer to its students, as well as showing off a faculty member's research topic to other interested parties. This latter group includes presentations at University career days, prospective student groups, high school visitations, and accreditation committees. Similarly, the choice of a student project on the applications of computers to air traffic control, chosen by a student on the basis of her father's occupation, lead to a closer relationship between the Department of Computer Science and an ongoing radar

related research project, and aroused interest of several other students in aviation related projects.

To identify certain University needs, close cooperation is maintained between the course director and two other campus activities; the Computing Center (through User Services and the Publications Division) and the Learning Resources Center. The latter group have themselves been essential to the success of this project by the provision of consultation and services with respect to the production of instructional aids. As a source of project topics, both are able to provide information on requests, initially directed to them, which can be satisfied by student projects. For example, a recurring request of the Computing Center was to provide instruction or materials on the use of key punches. By simply assigning the development of poster size instructions on the method of using a key punch as one of the optional projects in the course, there now exist displays in each key punch room on the campus. This also fulfilled a need in the course to have students understand the use and operation of a key punch for later programming activities.

Needs for the course are often met by the students themselves by proposing alternative assignments to those presented by the instructor. For example, for the first year of the course, the explanation of basic computer organization and the presentation of a simple machine language, was accomplished in terms of the CARDIAC computer*. This was chosen not only for its simplicity and

---

* CARDIAC - CARDboard Illustrative Aid to Computation

generality, but also because of the low cost of the cardboard computers themselves. It was a student who proposed, as his final project in the course, to write a CARDIAC simulator in the BASIC language so that students could actually run CARDIAC programs. In a later course (at a higher level) a symbolic version of CARDIAC called ASCARD (ASsembler for CARDiac) was developed by students who had earlier participated in the Computer Concepts course. This processor is now in use in the introductory courses as a simple example of an assembly language.

COST EFFECTIVENESS

The cost of operating this course and hence the cost of developing the resource center depends on two factors; how much use is to be made of commercially available aids and how much is to be developed locally. The experience of this author has been that starting from a humble beginning and operating on a shoe string budget, not being overly concerned with the professional quality of the aids initially produced (though obviously there was always deep concern with respect to the learning experiences of the students in developing the materials and the accuracy of their presentations), lead to a snowballing effect where other agencies besides the Department of Computer Science became interested and involved, so that both funding and technical support became more readily available. Both at the University of Massachusetts and at Virginia Polytechnic Institute, college agencies concerned with the improvement of teaching were only too eager to assist, and both institutions supported continuing work by providing Teaching/Learning grants. Thus the cost of curriculum materials is well within the budget of the smallest department and is infinitessimal when contrasted with the cost of operating a quarter long programming course.

CONCLUSIONS

As mentioned in the introduction, the cost of providing hands on computer experience for non-science (and non-engineering) majors has been so high that there has been a tendancy to turn to providing a totally different kind of course for them. Often this has been in the form of a "Social Implications" course, where the cost of presentation has been so minimized that the student recieves little direct contact with the computer. While it must be agreed that such courses have their place, it is the premise here that an understanding of computer technology is equally important, and that such an understanding can be achieved without incurring high costs. In fact, the cost of procuring materials is minimized to the acquisition of the raw materials themselves, such as poster boards, film, cassette tapes and artist's materials. Add to this the enthusiasm of students and the skills which they have developed in other fields, together with the broad base of contacts they have outside of the field of computer science, and there is the basis for the establishment and continued development of a Computer Sciences Resource Center at any institution.

One measure of our own success may simply be the freedom with which faculty utilize the available materials in other courses, and then themselves assist in the development of additional materials. For example, once the center has been established it is surprising how much material in the way of computer parts (old disks, magnetic tape heads, cores etc.)

are accumulated from the faculty. Faculty have also contributed their efforts to construct devices which will aid in the teaching of various concepts.

The only drawback to the project is that time must be taken initially to produce the first few aids. However, where a department has an independent study course, this can be initially used to have students research the basic topics and to produce the core set of aids. Thereafter, the course itself will self generate its own materials.

One additional benefit of this program of development which cannot be overlooked is the improvement of "town/gown" relationships that can be a side effect. This was particularly evident as the result of a student assignment which asked the student to investigate the application of the computer to a local industry. It had been anticipated that students would descend upon the local manufacturing industry, and a little advance preparation with the computing center directors and managers had prepared for the expected student enquiries. However, the flood of enquiries did not materialize; instead the students had made their investigations much closer to home. In the local bookstore which had recently installed a point of sales operation; in the discount store that used "computerized" clothing tags; in the catalog store which used a teletype to send in their daily orders, and the tire company who used hand printed invoices which were later processed by computer. The ingenuity of the student, as usual, was overwhelming.

Finally, to ensure that the success of the course was not merely dependent on the enthusiasm of a single faculty

member, the same course has now be administered (one can hardly say taught) by two other faculty, each with comparable results.

ACKNOWLEDGEMENTS

The author wishes to acknowledge the assistance given during this project by Mike Melnik of the University of Massachusetts, Drs. Braden and Head of the Learning Resources Center, Instructional Development Division, VPI&SU, and for the inspiration to develop a center from Dr. Ruth Hoffman, Mathematics Laboratory, University of Denver. Acknowledgement is also due to Nina Thayer of VPI&SU, for her work on developing additional materials for the center and for the photographs contained herein.

REFERENCES

Hagelbarger, D., and Fingerman, S., An Instructional Manual for CARDIAC, Bell System Educational Aid, Bell Telephone Laboratories, 1968. (Now distributed by AMF Industries, Arlington, VA.)

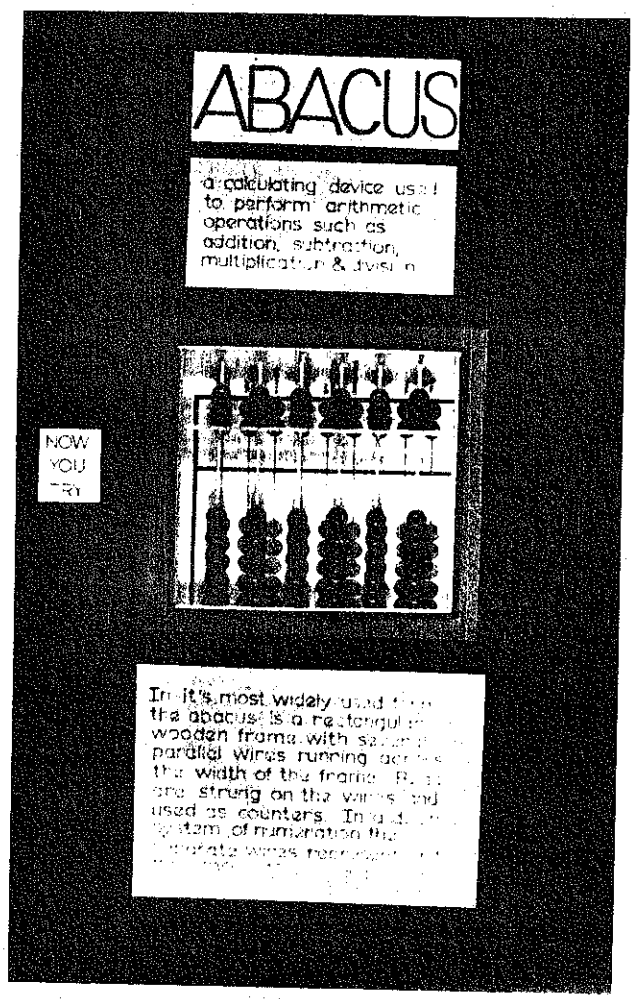

Fig. 1

Part of a 3 element display on the Abacus

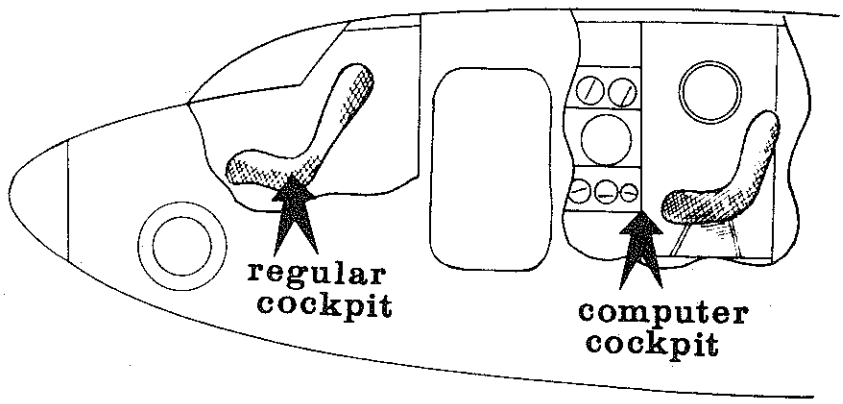

Fig. 2a

Slide and Tape Presentation on the Application of Computers to Aircraft Control

TEST PLANE

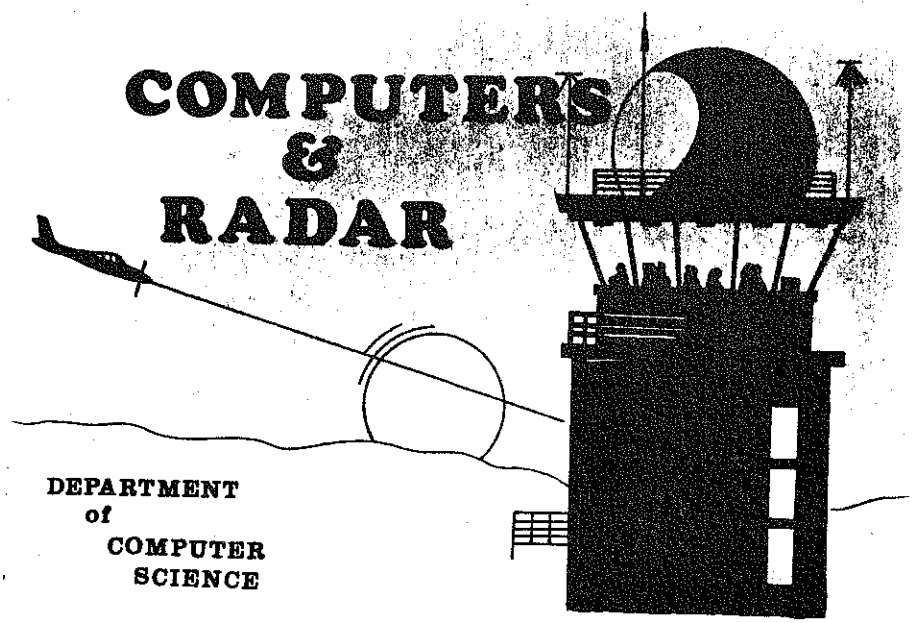

Fig. 2b

A Slide from the "Computers and Radar" Presentation

Fig. 3

A Visual Poster Display on
Point of Sales Applications

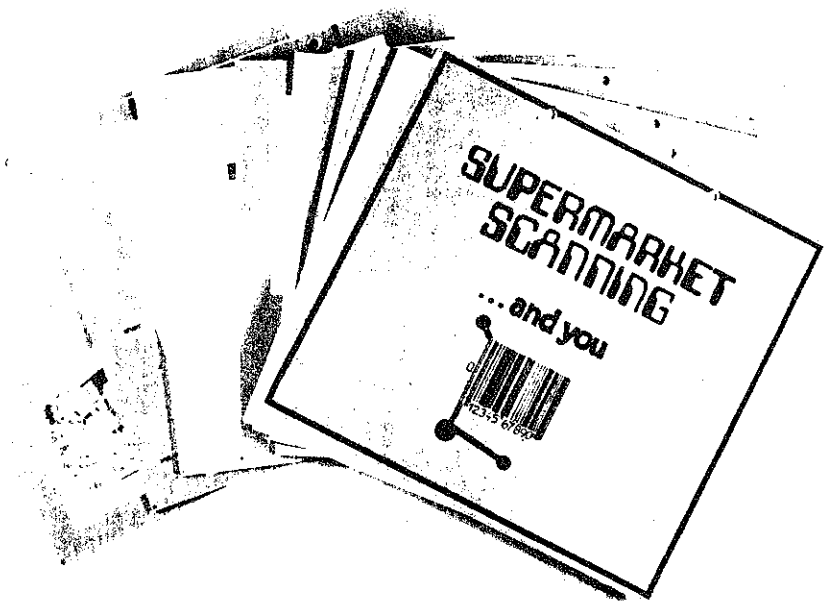

Fig. 4

A Flip Chart on
Supermarket Scanning Devices