Enhancement of Undergraduate Computing in the School of Engineering

Report of the School of Engineering Computer Committee

May 6, 1987

I. Introduction

This document summarizes the position of the School of Engineering Computer Committee on the issue of computer usage within the undergraduate curricula in the School of Engineering. This issue was first raised by the computer committee during the 84-85 academic year and has been the principal focus of the computer committee since that time. The primary motivation of the committee is a concensus among the faculty that the current level of integration of computing in the undergraduate curricula is less than desirable. The goal of the committee has been to identify the factors which tend to inhibit the incorporation of computing into the curricula and to develop a plan to help diminish or remove those inhibitory factors.

The factors identified by the computer committee as inhibitory towards the incorporation of computing into the undergraduate curricula were discussed in detail in the report of the 84-85 committee, and summarized in the 85-86 committee report. That summary is restated here for convenience:

Inadequate facilities. The committee found that most faculty perceive the presently available facilities inadequate with respect to both quantity and quality to support large scale undergraduate computing. The departmental computer systems, while they are mostly perceived as high quality, do not have the capacity to support a significant amount of undergraduate computing. The campus system and TUCC, on the other hand, are perceived by both students and faculty to be less than adequate in terms of user friendliness and ease of use.

Lack of an organized contact with computing in the freshman year. The committee expressed a belief that an organized and positive experience with computing in the freshman year would increase the student's incentive to use the computer in his or her normal approach to study and problem solution. This problem has been referred to the Course and Curricula Committee for further study.

Lack of faculty incentive. The committee found a general feeling among the faculty that incorporation of computing in the undergraduate courses requires a significant amount

of time and effort, both in the classroom and outside the classroom, and that there is little or no incentive to put forth this effort.

The 84-85 committee recommended several measures to combat these problems. Basically, the recommendations call for an integrated approach to undergraduate computing in the School of Engineering, starting with a common introductory course in the freshman year, and a significant "infusion of resources, both in hardware and in support for the faculty." The 85-86 committee then worked to define an "ideal" undergraduate computing environment for the School of Engineering. The 86-87 committee has been concerned with how such an environment can be created and maintained, and what factors are necessary to ensure its long term success. To this end, we have entertained a series of vendor presentations to help assess the feasibility of implementing our "ideal" environment, and a presentation on roughly similar efforts which have been successful in a university setting similar to our own. In addition, three committee members, Tom Miller, Henry Schaffer, and Carl Malstrom, recently traveled to Carnegie-Mellon University to attend presentations on the Andrew project, which in principle is very similar to the computing environment that we have proposed.

The remainder of this document outlines the current committee's position and recommendations on enhancing undergraduate computing in the School of Engineering. The issues considered fall into four categories: 1) recommendations for a *computing environment*; 2) *support* of that environment; 3) *faculty incentives* for incorporating the capabilities provided by the environment into their courses; and 4) *student incentives* for utilizing and contributing to the positive growth and perception of the environment.

II. Recommended Computing Environment

There are at least four major components to a computing environment: hardware, software, access, and support services. These components, particularly the first three, are not independent and therefore must be considered collectively. The "ideal" environment defined by the 85-86 committee dealt with those first three components in a generic manner and did not consider them individually. The fourth component, support services, was dealt with superficially if at all. The committee recommendation basically calls for a highly distributed system, primarily composed of clusters of high performance workstations with centralized file servers. The characteristics of the recommended environment are presented below, and are updated and reorganized from the original 85-86 committee report to fit in the first three categories mentioned above. The issue of support services is covered in section III of this document.

1. Hardware requirements.

(a) system should be composed of CPU-per-terminal type computers (i.e., single-user workstations) with *transparent, high speed file access* to a centralized server via a local area network (Ethernet).

(b) support for medium to high resolution *interactive graphics*.

(c) system architecture should be *incrementally expandable* to a level which will support the entire SOE student population at a ratio of one workstation per ten students.

(d) system should be robust and should exhibit *graceful degradation* in the event of equipment faults.

2. Software requirements.

(a) must support a sufficient array of *compilers and engineering application packages* to satisfy virtually all undergraduate computing needs.

(b) user interface must be "friendly" and oriented towards *interactive computing*.

(c) must allow easy *migration of software* from all major systems currently in use in the SOE.

(d) must support a large number of externally developed *engineering applications*, as well as general purpose applications such as *word processing, spread sheet*, etc.

3. Access.

(a) easy accessible to both faculty and students.

(b) faculty should be able to access the system from their individual offices.

(c) some form of off campus access, such as modem lines, should be available.

While it is logistically desirable to have a homogeneous computing environment which meets all of the above criteria, this may not be a realistic goal. The diversity of the application domains and individual requirements of the departments and curricula within the School of Engineering seem to preclude an environment based on a single machine architecture and a single operating system. For example, MAE may have an essential application package which runs only on the IBM PC under MS-DOS, while CHE may have packages which require VAX/VMS, and ECE may have VLSI CAD tools which run only under UNIX and require 8-plane color graphics. The apparent solution is to provide an environment which is sufficiently flexible to allow for some level of integration of these existing (and future) heterogeneous sub-systems to accomodate specialized needs. To this end, it is recommended that the hardware and software components of the environment should adhere to inter-vendor standards in the following areas:

Networking. The School of Engineering has a large investment in Ethernet as a physical medium for high speed computer communications. Ethernet is currently supported by all of the major vendors of engineering and scientific workstations and therefore should continue as our backbone medium. We must also consider inter-vendor standards for network access protocols. Currently, TCP/IP is the predominant inter-vendor standard on the SOE network. Recent vendor presentations have demonstrated that all of the major vendors are planning to support Open Systems Interconnection (OSI) as defined by the International Standards Organization (ISO), and it is recommended that any facilities that we put in place should look toward OSI as an eventual standard.

Languages. The predominant general purpose computing languages in the SOE are FORTRAN, Pascal, and C. Full standard implementations of all of these languages is recommended to facilitate software portability among heterogenous systems.

Graphics. A commitment by the vendors to adhere to inter-vendor graphics standards is recommended.

Windows. Multiple window environments have emerged as a standard feature of high performance engineering workstations. Standards for windowing have begun to emerge, most notably the X-windows system developed at MIT. It is recommended that adherence to windowing standards be required for the systems in our environment which support multiple windows.

III. Support Requirements

An environment such as described above is not complete without an adequate level of support services. The required support services can be divided into four categories: 1) *hardware and software acquisition*, 2) *system integration*, 3) *maintenance*, and 4) *user services*. These support services should be provided cooperatively by the School of Engineering and the Campus Computer Center. Within the School of Engineering, it is recommended that support services should provided by expanding the Engineering Computer Operations staff, which currently operates the ethernet network and most departmental VAX systems. While the division of support between Engineering Computer Operations and the Campus Computer Center needs to be studied in detail, a first approximation might be as follows:

- Engineering Computer Operations.
  - responsible for hardware and software acquisition.
  - responsible for integration with existing facilities within the SOE.

  - primarily responsible for providing systems analyst-type services to faculty and student users.
  - primary human interface between the system and SOE faculty and students in general.

- Campus Computer Center.
  - responsible for operator staffing of workstation clusters.
  - responsible for integration with existing campus facilities.
  - responsible for technology transfer to other University schools and departments as appropriate.
  - primarily responsible for system maintenance.

IV. Faculty Incentives

It is recognized that lack of faculty incentive is one of the major inhibitory factors in the incorporation of computing into the undergraduate curricula. Almost any effort to incorporate computing into a course requires a significant amount of faculty time, both inside and outside the classroom, if it is to be a worthwhile and positive experience for the student. In most cases, there is little or no incentive for the faculty to make this time investment other than personal satisfaction. The following recommendations are suggested to alleviate this problem:

- *Release time* and/or *summer support* should be provided by the School of Engineering for faculty to develop software to be integrated into their courses. This support should be awarded on a competive basis, but there must be sufficient resource available so as not to discourage faculty involvement on the grounds that the proposal effort / funding probability ratio is too high. 20% release time awards are reasonable.

- The SOE should also fund a number of *TA positions* to assist in the development and integration of software for courses.

- *Workstations* should be provided first to faculty who make commitments to incorporating computing into their courses. This could be in addition to or instead of the release time mentioned above.

- High quality *technical support personnel* within Engineering Computer Operations should be readily available to the faculty to assist with software development and integration efforts.

- *Funds for travel* to present papers at educational computing conferences should be provided.

- *Recognition of efforts* for tenure/promotion decisions must be considered. Since national and international recognition is a key requirement here, there should be a mechanism for highlighting outstanding developments and distributing software packages developed here to other universities. This should be facilitated jointly by Engineering Computer Operations and the Campus Computer Center.

V. Student Incentives

A positive perception of the computing environment by the engineering students is at least as critical as faculty acceptance. The following recommendations will contribute toward this goal:

- An *orientation* to the SOE computing environment should be incorporated into E100. The students should be introduced to the concepts and capabilities of the environment that is put into place. Several key course-related applications should be demonstrated, and the students should receive a limited amount of *hands-on* experience with the system.

- *"Free" accounts* on the system should be provided to all SOE students, starting with E100. The students should keep the same account until termination of study, with advanced capabilities added as necessary.

- There should be a mechanism for talented students to *participate in software development* and/or integration. Outstanding contributions should be recognized by special awards, course credits, etc.