SEASnet - A Progress Report

for the First Two Years

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by

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INTRODUCTION

During the past three years computer usage in the School of Engineering and Applied Science has changed dramatically. We have evolved from dependency on a single large mainframe facility (OAC) to workstation-based computing supported by a school-wide Local Support Center and two departmental facilities. Undergraduate access to computer resources has increased at least ten fold over previous usage at OAC. This dramatic evolution has occurred within two years and has been made possible primarily through several large grants: two from IBM, one from AT&T, and one from Hewlett Packard.

This report was written in response to a request to evaluate the impact of the largest of these grants, IBM's AEP grant, Project Advance. The other grants which have impacted our efforts to develop a workstation based computing network are also described, but in less detail. The report describes the distribution of machines and their impact on instruction.

HISTORICAL COMPUTING USE IN SEAS

FACILITIES

Prior to Project Advance, computer usage in SEAS was restricted to three large facilities and a very few minor facilities. OAC was by far the major supplier of computing cycles to Engineering, with all departments having access. There were approximately thirty 3270 style terminals in Engineering with access to OAC.

The Computer Science Department operated a Unix-based network of VAXes and PDP-11's which were generally available only to their graduate students and faculty. At their peak they operated 21 VAXes (one 780 and twenty 750's) with more than half of them dedicated to research groups in Computer Science. Professor Popek's research group is one example.

The Manufacturing Engineering Program, housed primarily in the MANE department, obtained an IBM 4341 in November, 1983 from IBM under a Manufacturing Engineering grant, a number of graphics terminals, several microcomputers attached to robots, and a large number of specialized software packages. This facility runs VM/CMS, and its operation has not been dramatically affected by Project Advance. Project Advance has provided network access, and competition for the Manufacturing Engineering computer was less pronounced than it would have been had there been no Project Advance.

Other smaller efforts included SEAS Administrative Computing which started with a single PDP-11 and has evolved to two VAX 11-750's. Although these machines were intended primarily for SEAS administrative computing, they were for a long time the only source of Unix for many faculty; consequently, a number of faculty outside the Computer Science Department used these machines to prepare educational materials. However, no "hands-on" student access was permitted.

A small number of micros and mini's existed in the school, and a few examples are summarized as follows:

1. A Sol-8 eight-bit (S-100 bus) based hardware laboratory in the Computer Science Department.

2. Several PDP-11's in Computer Science (e.g., Prof Bussell's hardware laboratory, Prof. DiStefano's Biocybernetics facility)

3. A PDP-11 in the MANE Department used for real-time data acquisition.

4. Professor Martin's PDP-11/44 instructional laboratory in Electrical Engineering

5. A Vector Graphics 8 bit CP/M classroom in Computer Science.

These facilities had varying success. The machines which were closely associated with researchers generally fared the best, since there was considerable motivation and resources to use the machines. The Sol-8 hardware laboratory was used extensively in Computer Science. The Vector Graphics laboratory was generally a failure due to the limited power of CP/M and 8 bit processors, and the room was mostly used for instruction not requiring computer access.

At about the time Project Advance started for other parts of the Campus, which was about a year earlier than it began in Engineering, several new computer projects were started in Engineering. These included:

1. The Artificial Intelligence Laboratory in Computer Science, based upon 25 Apollo's in a token ring network. (acquired with Keck Foundation grant funds).

2. Electrical Engineering's purchase of a Pyramid 90X supermini.

3. A donation from Gould of a PN-9080 supermini.

4. Purchases of small, multiuser micro's, such as MANE's purchase of a Fortune Systems 68000-based Unix machine. These machines were small by current standards (+ 3 years), but were significant departmental purchases.

5. A Hewlett Packard grant of thirty 68020 based workstations to support Artificial Intelligence (AI) and Very Large Scale Integration (VLSI).

Planning for these projects was for the most part not affected by Project Advance. Undoubtedly had we known the extent of Project Advance we would have done many things differently. The eventual use of these early machines was dramatically affected by Project Advance; for example, the Sol-8 based machines have been replaced by PC's, and the Fortune Systems machine became

a "white elephant" very quickly with users preferring DOS machines.

Finally there were some "high-end" users who had access to networked Cray's (e.g. MFEnet). These users were strictly research users having little impact on the classroom-based educational programs.

NETWORKS

Prior to Project Advance there were no networks in SEAS, other than Computer Science's VAX network. The first ethernets in CS were introduced to provide terminal access to VAXes (Bridge Communications CS-1's) and to network the experimental Locus VAXes. The Apollo token ring in Computer Science was started about the time we were planning SEASnet. Other machines were connected in star configurations (terminals to timesharing machines, which is not considered a network for the purposes of this document).

QUANTITATIVE ASSESSMENT OF PROJECT ADVANCE

IBM GRANT EQUIPMENT

During the planning of Engineering's share of Project Advance we envisioned 175 workstations and a single 4381 server. At the time of the planning the PC-AT was only a rumor and the RT was unknown, except that we expected IBM to compete with other companies making scholar's workstations. We made plans around 115 workstations based on the 80286 CPU and 60 scholar's workstations. Three classrooms of 30 workstations each were planned.

The allocation of machines to departments within the school was deliberately not included in our initial planning. We envisioned that the allocation of workstations from the School's pool would be made to the departments by the Dean based on his assessment of each department's educational plan. Departmental educational plans were initially described in our first proposal[1] and were discussed in greater detail in a proposal to the Office of Instructional Development (OID).[2-4] The Dean purchased 10 PC-AT's for use by faculty at home and were allocated on the basis of each department's educational plan. Table 1 shows the distribution of IBM equipment.

AT&T GRANT EQUIPMENT

After a lengthy negotiation period AT&T donated eighty-five 6300 Plus PC's (an 80286-based workstation, very compatible with an IBM PC-AT), one 3B15 and ten 3B2/400 servers. These machines were configured in such a way that they would complement the existing workstations and network, and produce an environment 100% compatible with our existing environment using PC-AT workstations. The workstations were allocated to departments in a similar fashion as the IBM equipment, except that departments were required to create "clusters" of machines in small rooms that would be available to graduate students and other "good citizens" of the department on a 24-hour basis. Table 2 shows the distribution of the AT&T grant equipment, and Table 3 shows the combined distribution.

Table 1. Distribution of IBM Workstations*

Department	Convertibles	AT's	RT's	Total
CS	1	30	13/9**	44
ChE	1	7	1/1	9
CE	1	9	3/1	13
EE	1	12	3/0	16
MANE	1	19	5/2	25
MSE	1	5	1/0	7
Classrooms, Staff***	4	74	42	89
Total	10	156	68/24	192

* includes 10 purchased by the Engineering Dean

** the RT column shows allocated machines/delivered machines, at the time of this writing.

*** includes a pool of machines used as spares to replace classroom machines being repaired, and machines to be delivered to departments.

Table 2. Distribution of AT&T Grant Workstations

Department	Clusters	Labs/Offices	Total
CS	7	5	12
ChE	4	2	6
CE	5	2	7
EE	8	3	11
MANE	8	3	11
MSE	3	2	5
Classrooms, staff	33	0	33
Total	68	17	85

Table 3. Distribution of Grant Workstations

Department	AT&T	IBM PC-DOS	IBM UNIX*	Total
CS	12	31	13	56
ChE	6	8	1	15
CE	7	10	3	20
EE	11	13	3	27
MANE	11	20	5	36
MSE	5	6	1	12
Classrooms, Staff	33	78	42	122
Total	85	166	68	277

* allocated as of this writing. Additional Project Advance funds are required to complete this allocation.

EXPENDITURES AND NON-GRANT EQUIPMENT

Virtually all of the networking equipment and all the VAXes were obtained through University resources. SEASnet purchased one used VAX-11-750 expressly for the purpose of allowing non-CS users terminal access to the servers. Computer Science's VAXes existed prior to the grant, and Extension purchased a VAX-11-750 to allow their students to access the network. It was necessary to equip each PC-AT with an ethernet card at a cost of $500. Locus Computing Corporation (LCC) donated 150 PC-Interface licenses. For the early RT's we purchased ethernet cards; later the IBM grant was able to supply ethernet cards. Appendix A shows the equipment expenditures for non-Grant equipment and personnel. UCLA has spent $2.5 million on SEASnet over the last three years. Additional FTE within the School are used for computing that are not associated with SEASnet. Approximately 3.5 FTE in Computer Science, 1.0 in Electrical Engineering, and 1.5 in MANE are associated with computing and are paid from University resources.

CLASSROOM AND NETWORK UTILIZATION

Appendix B shows the classroom utilization over the periods from the Fall Quarter, 1985 to the Winter Quarter, 1987. The courses offered by departments for each quarter since the SEASnet classrooms were opened are summarized in Table 4. The majority of the impacted courses are upper division; only a few graduate and lower division courses have been regularly scheduled in the SEASnet classroom.

Table 4. Sections Taught in SEASnet Classrooms or Using SEASnet Classrooms, by Department

Dept	F-85	W-86	S-86	F-86	W-87
CE	4	4	1	2	8
ChE	0	1	1	0	2
CS	2	5	5	3	8
EE	0	2	2	2	4
MANE	7	6	3	6	3
MS & E	0	0	0	0	2
Totals	13	18	12	13	27

It is difficult to recognize trends from Table 4; however, some explanations are offered. Initially the classrooms were made available to instructors in addition to their regular classrooms. This policy continued until the end of the Spring Quarter, 1986. At that time it was felt that space was being wasted and we changed our policy.

Beginning in the Fall of 1986, one classroom was kept open during the weekdays from 10 AM to 10 PM and was open to all students with accounts, on a space available basis. The other classroom was used for classes which were regularly scheduled *only* in the computer classroom. This policy was very successful, allowing many more students to utilize the rooms. The new AT&T classroom is also being used as an open access classroom. A number of professors now make assignments and expect students to complete them using the open-access SEASnet classrooms. They provide no guidance except for helping the students acquire accounts.

A second factor affecting classroom use was network and server performance. The server performance was generally poor in the 1985-1986 academic year, with frequent crashes and very poor response time. This problem resulted primarily from the difficulty of attaching ethernets to IBM 370 Channels, and from our inability to adjust the priority in which programs execute under Locus on the IBM 4300's. A major improvement to network and server performance was made in August, 1986, which resulted in improved stability but only marginal improvement in network response time. A second major change was made in December, 1986, which markedly improved network performance and server response time.

Figures 1 and 2 show the number of users and system loads on the Locus machines. The "Total" line refers to the sum of the PCI and time sharing users on the two IBM 4300's and 6 VAXes. Most of the time sharing users are faculty and staff. The dotted line shows the PCI users who are generally all the students using the classrooms. The dashed line shows the machine CPU load for all servers. The Unix CPU load figure is a representation of the number of CPU-bound jobs averaged over a one minute interval. A highly CPU-intensive job, such as simulation performing many floating point calculations, would create a load of slightly less than 1.0. An editing session would produce a load of approximately 0.1, except when the file is being rewritten to disk. Loads of 3 or 4 generally produce noticeable lags in response time on a VAX-11/750. Loads of 5 or 6 generally cause the 4381 to respond sluggishly to the network.

Figure 1 shows a high load week proceeding exam week in the Fall of 1986. At this time the network was stable but we had not yet implemented the new changes which increased response time. The maximum allowable users on the 4381 was 32 in this time period. Figure 1 shows that we were nearly constrained by this upper bound. In practice it was not possible to connect more than about 25 PCI users to the 4381 because of sluggish response time. Figure 2 shows the average (10AM to 10PM) network loads over the Fall Quarter, 1986. From a practical viewpoint, we were constrained in the Fall Quarter by server performance.

Figure 3 shows the utilization of our open access classroom during the Fall Quarter, 1986 and Winter Quarter, 1987. The numbers represent head counts by the proctors. The number of students using the machine exceeded the number connected to the servers, indicating that many users were operating without logging into the net. This is possible and quite workable since all machines have local hard disks. On a number of occasions the number of students using the classroom exceeds the number of machines that are available, indicating that students were working together in groups of two or more.

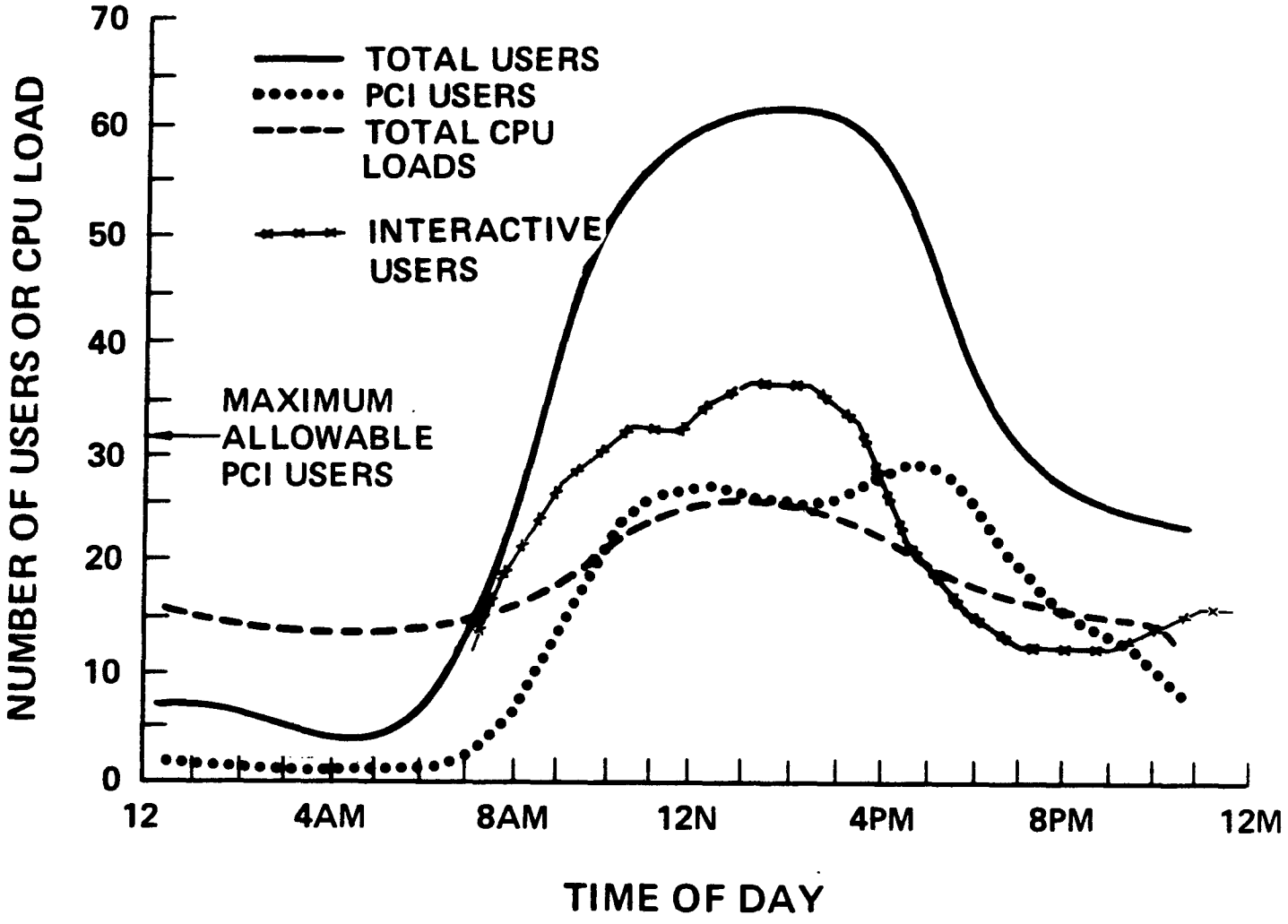

Fig. 1 Average Daily Network Load versus Time of Day (five day average during a week near the end of the 1986 Fall Quarter)

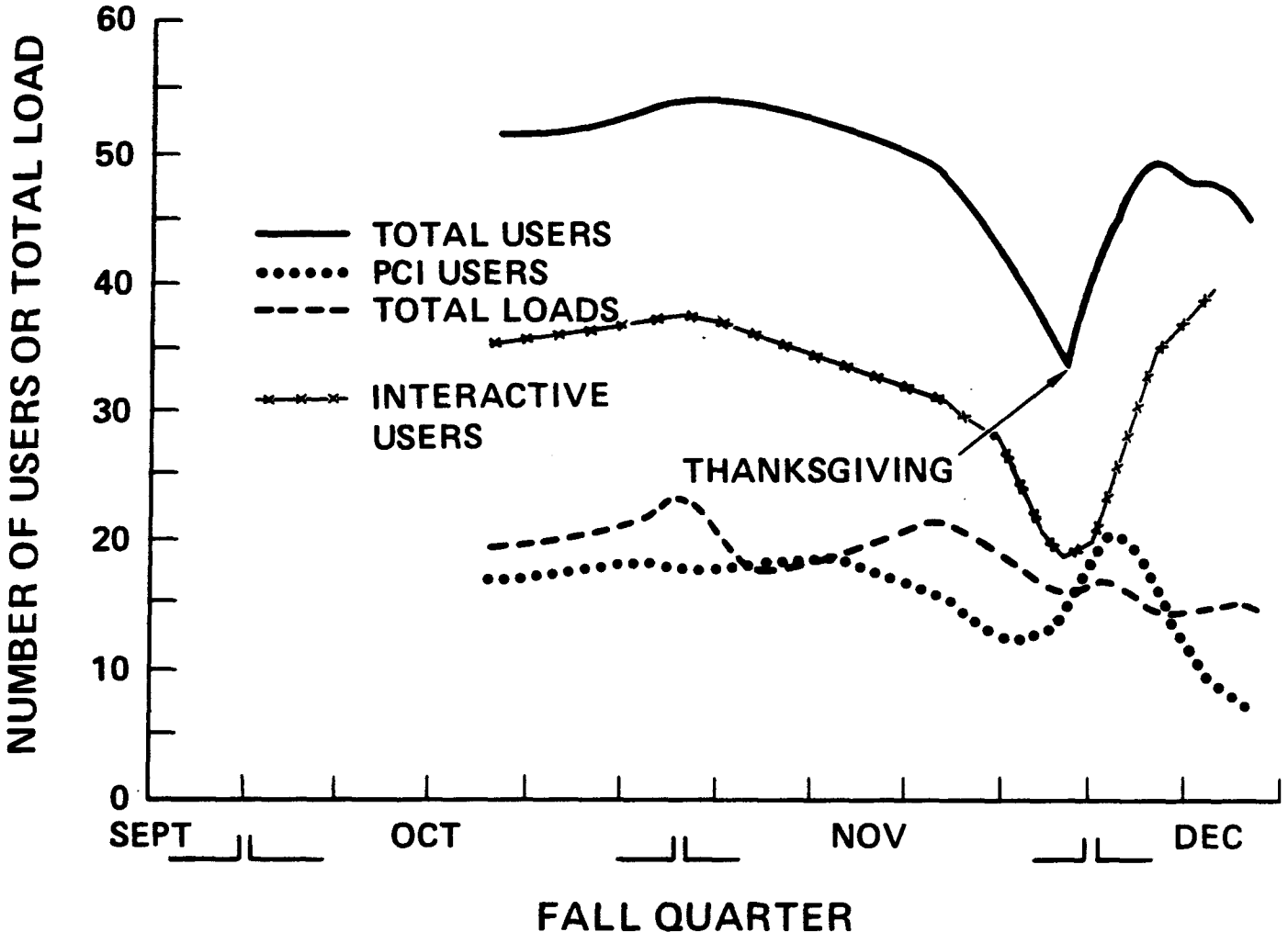

Fig. 2 Average Daily Network Loads versus Day of the Quarter (1986 Fall Quarter)

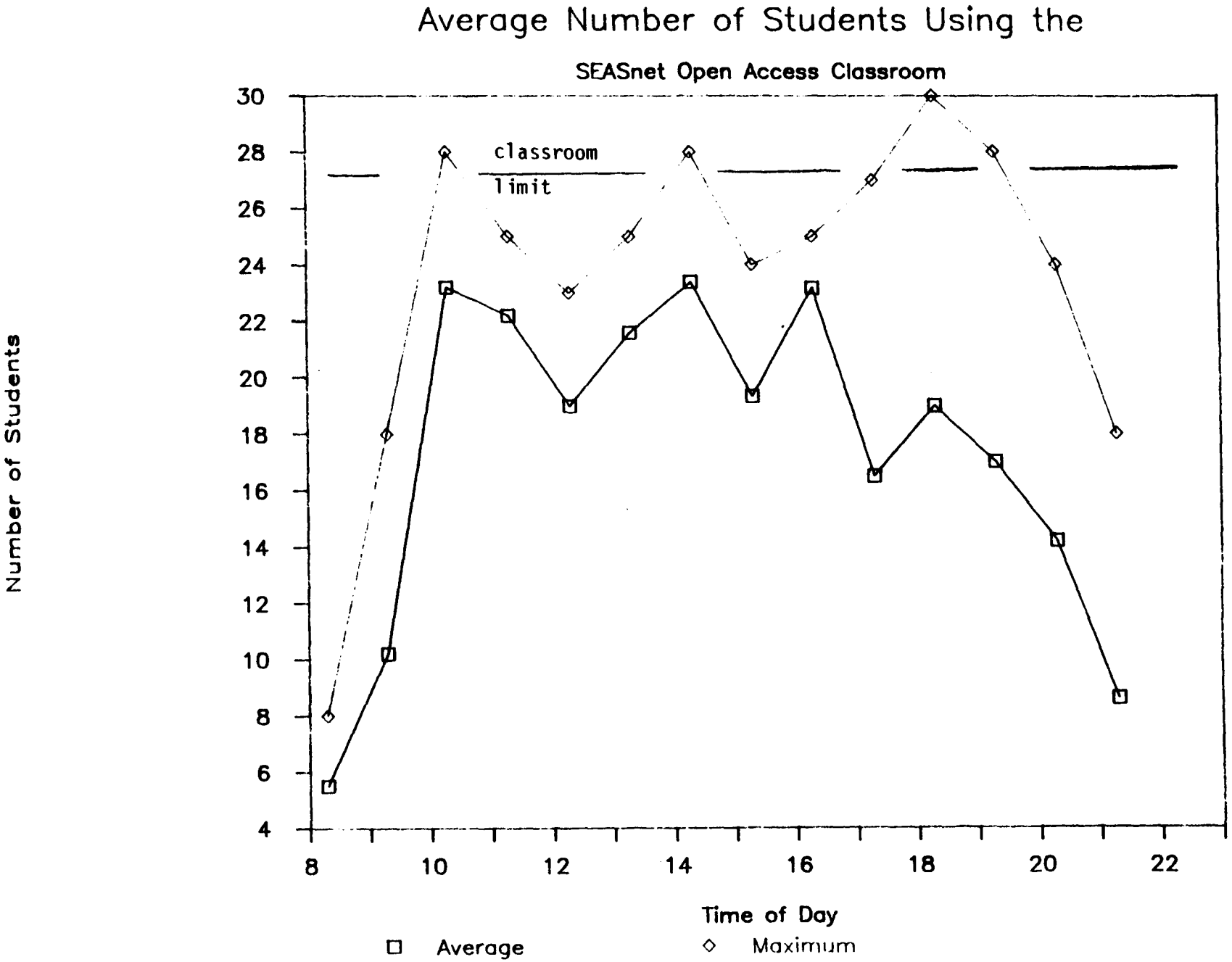

Figure 3. Average Hourly Classroom Utilization (Oct 1986-March 1987)

It is not possible to exactly summarize the utilization of classrooms. A fair statement of utilization for the open access classroom is shown in Figure 3. The tables in Appendix A show the utilization of our scheduled classroom. The reserved hours for the 1985-1986 Academic year are only approximate, since the instructors may have had more than one room available to them; for the 1986-1987 year instructors had only the SEASnet classroom which means that the room was utilized as shown in the tables. The total number of enrollments in SEASnet classrooms for the 1985/86 year was 1108 and increased to 1876 in 1986/87, or an increase of 69%. This compares to the total school enrollment of 15,125 for all of SEAS in 1986/87. Approximately 12.5% of the students enrolled in SEAS use the SEASnet classrooms as a part of their formal instructional program. The largest inroad was made into upper division courses, where 13.7% of the students used SEASnet classrooms.

The activities being performed in the classroom are also impossible to exactly quantify, but are primarily recitation, with TA's and instructors working with students; some instructors also lecture in the classrooms. The open access rooms are almost always being used by students completing homework assignments or working on projects.

SOFTWARE ACQUIRED THROUGH SEASnet

Forty eight different software packages were purchased or acquired by SEASnet during Project Advance. A great deal of IBM software was acquired from the Grant. OID funds were used extensively for acquiring special purpose software not available on the Grant. The most general piece of software acquired with OID funds was Turbo-Pascal. Appendix C lists the software and shows a number of site licenses. This list has been restricted to those products which were primarily sought by SEASnet (software licensed by the MIC, which also happens to be used at SEASnet, is not shown). Many SEASnet users take advantage of the products made available through the Microcomputer Information Center (MIC), such as SAS, T_EX, and BMD; we do not function as a liaison between SEASnet users and the MIC, although we will occasionally make a product available over our network for which the MIC acquired the site license.

A great deal of software has been acquired by faculty in various ways and in varying quantities. Many faculty routinely exchange software through their graduate students. It is not possible to quantify this informal exchange.

No software standards have been adopted by our academic units or SEASnet, other than some broad guidelines and selection of particular products for particular courses. The availability of IBM grant software has created some defacto standards, e.g., Professional Fortran is used by most PC-DOS Fortran programs at SEASnet.

We are supporting PC-DOS and several flavors of Unix. We are not supporting VM/CMS, MVS, VMS or other operating systems. OAC is still considered the supplier of VM/CMS and MVS cycles and software to Engineering (other than the Manufacturing Engineering Program), and we have provided networking to OAC in anticipation of their continued role in computing for Engineering and Computer Science. OAC will continue to serve SEAS in several areas, including CPU-intensive programming, SAS, and other mainframe applications.

We also hope that it will be possible for them to run a suitable version of Unix at OAC under VM once it becomes technically feasible to do so.

We are attempting to provide similar tools for PC-DOS and Unix environments. For example, we are attempting to make PC-DOS editors function like Unix editors, with the objective of making the transition of PC-DOS users to Unix as easy as possible.

We still believe that Unix can satisfy most of the needs of engineering/computer science users. The largest shortfall of Unix and particularly Locus is the poor compiler quality. FORTRAN is particularly poor. Our initial interest in PC-DOS was created primarily by our inability to obtain an adequate number of Unix workstations from Project Advance. As a result of this experience we have discovered that PC-DOS and an AT's computing power are adequate for many engineering requirements. Additionally, our transparent network bridge PC-Interface has provided an excellent way to integrate PC-DOS into our environment. At present, the 640K memory appears to be its biggest drawback for non-Computer Science users. Computer Science users have not found PC-DOS as useful, and most instructors would quickly convert to Unix if the hardware and support were available.

NETWORK CONFIGURATION

Figure 4 shows our network configured as of (3-1-87). The network is now available at all places in Engineering. Users with appropriate accounts can access all the machines using a single flavor of workstation and a single connection.

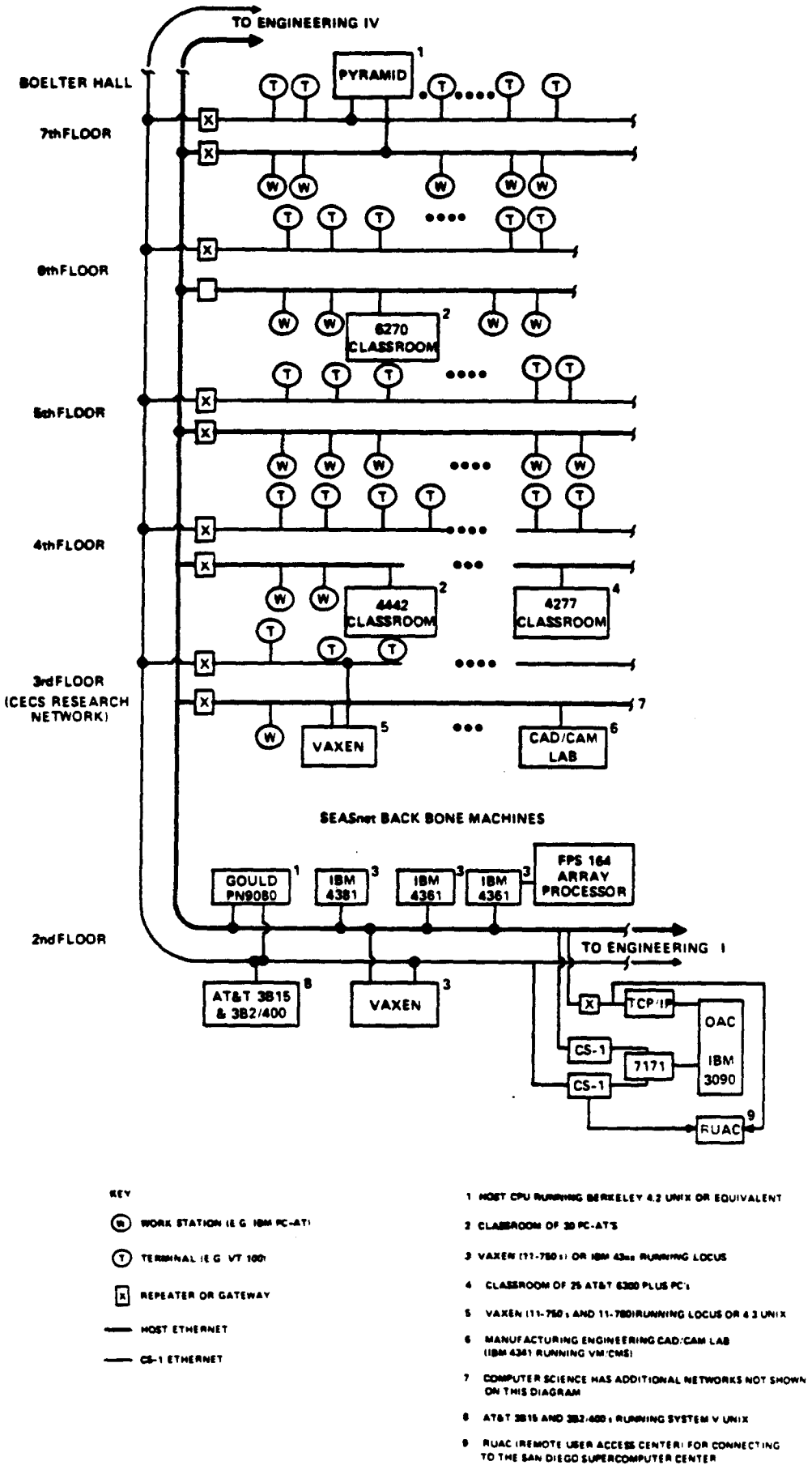

Figure 4. Network Configuration

QUALITATIVE ASSESSMENT OF PROJECT ADVANCE

Our original Project objective was to provide computer based instruction to engineering students. To accomplish this objective we required a network and open access computing for engineering students and faculty. For practical purposes we developed such a network and have accomplished our objective. We have networked over 275 workstations. Any undergraduate student enrolled in a course requiring computing has access to three PC-DOS classrooms (2 IBM and 1 AT & T). There are over 100 workstations in departments for graduate students and faculty. Several medium sized computers are available for problem solving, and the FPS-164 MAX is available to faculty and graduate student researchers, and for "high-end" educational projects. All of these users have access to electronic mail and OAC, and other locations, such as the San Diego Supercomputer Center and the ARPAnet, if they have permission.

Unfortunately we have made only marginal impact in Computer Science. Many of the new aspects of networking, which have now been extended to the five other SEAS departments, existed in Computer Science before SEASnet began. At the time of this writing only nine RT's have been made available to Computer Science from the Grant. The major educational impact for Computer Science will not come until after the RT classroom is constructed. We need additional Project Advance resources to complete this classroom.

The success of SEASnet is a two-edged sword. We have created a very large demand for computing resources. We are limited now in our classrooms (although the AT & T room and the RT classrooms will provide temporary relief). We have too little staff to accomplish our objectives. We need to double the number of workstations each year for the next two years in order to keep pace with the increased need for resources.

Our biggest shortfall, and perhaps the least anticipated need is for user education and documentation. We have constructed a new environment linking PC-DOS and Unix; there is no existing documentation to tell users how to take advantage of the synergism. Many users have not begun to take advantage of the networking resources simply because they do not know how to use them. Unfortunately our environment is developmental and has evolved quite rapidly; the specifics of the user documentation change monthly, which makes it difficult to write documentation.

EDUCATIONAL IMPACT

Survey Results

A student survey was conducted over the three quarters of SEASnet operation. Appendix C shows the questionnaire. Table 5 shows the combined summaries of the basic questions. The surveys were not solicited in any statistically significant way. Some instructors gave students the opportunity to complete the survey in class, which biased the survey to those classes. For this reason the survey is biased toward the CS 12 and CS 13 students. We mailed surveys to other students.

Table 5. Survey Results

SEASnet COURSE EVALUATION

Class Information:

Instructor:

Class (date and time):

TA of your class using SEASnet:

Personal Information:

What year are you completing?

Freshman	*Sophomore*	*Junior*	*Senior*	*Grad*
10	20	18	41	7

What is your major?

Civil	Elec.	Chem.	Comp. Sci.	Mane	MS&E	Other
5	1	5	47	35		3

Why are you taking this course?

Required	*Breadth (Because I want to...)*
90	6

Course Evaluation:

How much did you know about PC/DOS before?

Expert	*Intermediate*	*Beginner*	*None*
8	27	31	32

Have you used an MS/DOS microcomputer before?

Yes, alot	*Yes, a few times*	*Never*
11	50	36

Did you know much about SEASnet before?

Yes, a lot	*Yes, a little*	*No*
5	34	57

How tentative were you in using the PC/AT's?

Very	*A little*	*Not at all*
14	50	32

What was your previous experience with computers?

CS Classes (Please list))
99

Engineering Courses	*Science Courses*	*Non-science Courses*
51	8	10

Work Related	*Home Computing*	*Other (Please specify)*
26	50	3 - highschool

Several trends in the second page comments are noted:

1. The most frequent comment related to open access times of the classrooms. Courses such as CS 12 - CS 13 and other courses where programming is taught require large blocks of open time, especially toward the end of the quarter. Students want 24 hour access to the classrooms and do not understand why they cannot have it. Upper division courses, where concepts are taught using computers, usually require less open access time, and tax the classrooms far less. Students taking courses where programming is taught and other courses which require large blocks of computer time, need 24 hour access to workstations. To remedy the situation a large number of the AT&T computers were placed into "clusters" under departmental control. These machines are easier to manage and graduate students can have 24 hour access. Departments are free to create their own access policies. Although the clusters have only been operational for one or two months, their impact is already noticeable. All departments except Electrical Engineering have completed their clusters.

   To provide more hours for undergraduates, and to improve the quality of open access time, TA's are being sought from school resources. Currently we use undergraduate students, especially work study students, to proctor the classrooms. Graduate students functioning as TA's could be asked and trusted to proctor the classrooms for the after midnight hours near exam time.

2. A number of students felt disadvantaged with respect to students with more experience in computing, and students with better access to PC's. Several students commented that grading was not fair because they did not have a PC at home and therefore could not prepare as well as other students.

3. Several students commented that they were being expected to learn quite a bit more material in the same length of time - the normal course material in addition to computing technology. They felt that insufficient time was being allotted to cover computing principles. Many faculty have just the opposite view, feeling that there is insufficient time to cover the course material since the students are preoccupied with understanding the computer applications. Undoubtedly many of the problems are transient problems, and will disappear as we teach more classes using computers. The computer skills learned in beginning courses, perhaps the basic programming courses at the freshman level, will provide the foundation for the computing skills in more advanced courses.

   Undoubtedly the most important ingredient to success of this policy is a common operating system and software tools for beginning, intermediate, and advanced courses. Unfortunately we already have two operating systems. Unix and PC-DOS with which the students must be familiar. Further proliferation of operating systems is deleterious to success, and efforts are needed to make other environments resemble Unix or PC-DOS as much as possible.

   To accomplish these goals we have purchased a set of Unix utilities for PC-DOS. These

include the most commonly used Unix utilities, including editors and text manipulation tools. They work in nearly the same way as the server Unix utilities function. They can make the PC-DOS user interface very similar to Unix, and will allow students to more easily move to the Unix environment from PC-DOS.

4. The students concluded almost without exception that the PC-DOS/network environment was preferable to OAC and PICnet. The students preferred SEASnet to OAC because of greater resource availability and easier operating systems. They felt less inhibited since computer resources were not metered in dollar amounts. Those with home PC's also expressed satisfaction with the similarity of home computing and school computing.

   PICnet users preferred SEASnet because of faster response time and the less crowded environment. They preferred PICnet because of its Unix operating system and its 24-hour per day availability.

5. Only one response categorily rejected the notion of using computers in instruction.

6. Almost all students with previous Unix experience indicated a preference for Unix.

7. Another major problem relates to the types of user support provided by SEASnet to users. It was envisioned that many faculty would take a leading roll in teaching the students to use the PC-DOS based computers. This has happened only with a few instructors. Many faculty and department TA's have shown the students how to execute "canned" programs and obtain answers to the example problems. Many students have avoided learning operating system principles and have concentrated on course concepts. This approach minimizes time spent on non-course material, but does not assist the students in learning sufficient computer skills to perform independent work and complete programs of self-study.

   To alleviate this problem one of the SEASnet programming positions will be downgraded in order to hire a programmer or graduate student(s) to assist students in the classroom and provide consulting to faculty. The lower level position will also provide savings for other functions.

   An error in our original planning related to "high-end" user applications and consulting. It was thought that hiring a programmer who understood the high-end applications would be welcomed by faculty. Faculty understand the applications and often resist the programmer's efforts; instead they prefer to obtain assistance on the parts of the problem that directly relate to the computer, e.g. operating system questions, and solve the applications oriented computer problems themselves, or have their own RA's assist them.

Overview

When we were planning SEASnet it was intended that many courses would be taught as "computer aided" classes, where lectures would be interspersed with demonstrations on computers. This concept has been tried by a number of instructors and has succeeded in only a few cases. Where it has succeeded the success is related to the instructor's interest in using computers, OID funds, and amenable subject matter. An instructor's interest in research applications related to the course material is also a large motivating factor.

The most popular and successful courses are those that use computers in recitation periods and as self-study tools. Subject matter and instructor's interest are important but secondary for these types of courses. MANE 171A, *Introduction to Feedback and Control Systems*, is a good example. This course was modified in order to use the PC-DOS classrooms in the first year of SEASnet's operation. Funds were made available to the instructor for summer salary (one month) and a special TA (50% time, one year). Additionally, special software was purchased from a third party using OID funds which is customized for this application. The instructor in charge of this course has explained the impact of computing by saying that he can now expect the students to work greater numbers of realistic problems, where in the past they had only been able to work one or two smaller and less significant problems. This course normally has enrollments greater than 50, which makes lecturing in the computer classrooms impossible; however, the instructor is not convinced that he would want to lecture in the classroom even if this were possible.

CE 184D is another course where significant progress has been made. This is a smaller course and lectures and computing are combined. OID funds were used to develop courseware. TA and summer salary were also provided. Computer programs were written to demonstrate major course topics. Turbo Pascal was used and the instructor wrote most of the programs. Students now work many more example problems than previously and obtain a much better understanding. The easy-to-use graphics afforded by Turbo Pascal were very helpful.

In Computer Science there has been much less success. The AT's are useful for only a few of their courses. Most faculty are unwilling to convert their existing Unix based programs to PC-DOS. The Locus servers have been helpful for many courses, but their poor stability in the first year, and the continuing poor compiler quality have inhibited its use in Computer Science. Fortran users in other departments have had difficulty with the Locus Fortran compiler as well.

The major impact in Computer Science will not be seen until after the RT classroom becomes available. Four of the nine RT's that were allocated to Computer Science have found their way into the VLSI lab. Their impact there is limited so far, due to poor CPU speed and lack of high resolution color displays (1024 x 1024 x 8). The new RT is promising for this and other CS applications. A number of problems still exist, such as support for all the applications and hardware under a single operating system (e.g. 4.2 or AIX). Currently most of the software works under 4.2 while the best monitors only work with AIX.

The School's shops and other services were heavily utilized in building the network and getting it extended to all parts of the School very quickly. Most of the cabling was pulled within a few months and at low cost. This was very effective in getting us started. Unfortunately there were no similar resources for computer maintenance. Resources must be redirected to assist with maintenance. We are hoping to hire an additional person with existing resources. More will be needed. We hope to be able to fix 80% of the problems internally and send the remaining 20% to outside shops. Over a two year period one PC-AT in two has required maintenance. The largest problem has been the CMI hard disk and the second largest problem has been the EGA display. A large fraction of the hard disk failures are unique to the CMI disks, but we still anticipate a significant number of failures in the future.

Software maintenance is a growing problem. Most of the IBM supplied PC software is not current, and will need replacing. It appears that IBM does not intend to keep its third party software current. On the surface this does not appear to be a major drawback, since the most current version of a particular software item is not always required; however, it is a serious problem exists because much of the current software has at least one serious bug which hampers users' efforts. Professional Fortran is a good example. Many of our users have obtained Microsoft Fortran 3.3 in lieu of Professional Fortran, even though Professional Fortran executes faster and produces smaller executable files. Another example of a poor product is IBM's version of Multiplan. It is so inferior to Microsoft's Multiplan, and Lotus 123 that instructors will not invest the time required to develop courseware using Multiplan.

An additional software maintenance problem is keeping DOS file systems current. In spite of our efforts to protect the local hard disks on the AT's by hiding files and educating users, we continue to have a problem with lost files. These files can be restored over the network, but most users do not know how to restore them. Consequently we spend a great deal of time restoring DOS files.

The OID funds have been instrumental in converting new classes. The faculty who have obtained resources have responded very well. The junior faculty have been responsive to these resources, even though they know they must start up their research.

Currently about 30% of the SEAS student population uses the SEASnet facilities in any given quarter. We believe that at the junior and senior levels nearly 100% of the students have been impacted. Our rate of growth indicates that we will need additional classrooms by next year. The IBM RT classroom will be a very important additional resource. Its completion will unload the PC-DOS classrooms of most of the Computer Science courses, since they will greatly prefer the Unix workstations. Most of the Computer Science courses which use the PC-DOS classrooms do so only because Unix workstations are not available.

SUMMARY

Over the next year SEASnet resources must be allocated in different ways and additional resources must be obtained. We need to achieve the following goals:

1. Personnel must be changed and added to provide more support for low-end applications, including classroom proctors who can consult as well as protect the classroom equipment. Maintenance personnel must also be provided.

2. Additional resources for user consulting, especially to faculty, are required.

3. Additional resources for maintenance are required. IBM maintenance for the 4381 and peripherals is approximately $40,000 per year. PC maintenance was previously provided by IBM. As of July 1, 1987 most of the PC's and RT's will no longer have IBM supplied maintenance. AT & T is providing maintenance until December 31, 1987.

4. We need to improve the IBM 4381 ethernet interface. Although it is very much improved over the original Auscom version, it is still the greatest source of problems related to network performance and stability.

5. We need to acquire a number of new software packages, such as a high quality spreadsheet.

6. We need additional resources from Project Advance, as follows, in order of priority:

    a. Funds to cover the existing RT order (30 machines for the RT classroom, and 13 machines to cover existing allocations to courseware development projects, $1,075,000 list price)+

    b. Upgrades to existing software when available.

    c. PC/2's to replace the PC-AT's in existing classrooms, with the existing PC-AT's to become student/faculty workstations in offices and clusters (40 machines, $500,000 list price).

    d. A 4381-13 to add to current server CPU capacity, but using existing tapes and disk drives ($600,000 list price).

7. The newly acquired AT&T classroom, and the soon to be constructed RT classroom will provide growth for the 1987/88 year. Growth in student enrollments in sections using SEASnet classrooms can climb from the current peak of 1,800 to approximately 3,000 without overtaxing the four classrooms.

    To accommodate the additional 12,000 students enrolled in SEAS classes, more

+ At the time of this writing it appears that 22 of the 43 machines and upgrades for our existing RT's, will become available to SEASnet through a special study.

classrooms and additional server and financial resources will be required. Undoubtedly not all classes and students will require computers for instruction; however, many of the current classroom uses are embryonic and more time will be required as instructors become more proficient in incorporating computing into their instruction.

As an approximation for projecting classroom growth, the following model is offered. Given that there are 15,000 enrollments per year in SEAS classes, or 5,000 per quarter, and assuming that 80% of the students will require computing in some way for three hours per week per student, a total of 12,000 hours per week of student access to computers are required. Assuming that a classroom can be operated for six days per week, for ten hours per day with an average of twenty students using the room, a single classroom can provide 1,200 student hours per week. Under these assumptions ten computer classrooms, or six new computer classrooms need to be constructed.

Additional computing resources which are not included in the above classroom figures, will be required for graduate students working on their theses and dissertation related projects. OAC will continue to meet a portion of these needs, but additional workstations will be required for graduate students.

Space will become a severely limiting factor in creating new computer classrooms. One way of addressing the space requirements are to place as many workstations as possible in graduate student and faculty offices. Clusters in dormitories are another option.

For new classrooms we will need an additional 200 workstations (six rooms at 33 workstations each). For graduate students we will need an additional 200 workstations (one workstation per four graduate students). We will need an additional 125 workstations for faculty (one workstation per faculty). Therefore, 525 new workstations will be required.

We cannot rely entirely on Project Advance to address these needs, since its funds are limited; the RT classroom will exhaust SEAS's share of remaining funds. Therefore we will need the School or Campus to cover shortfalls and growth. We will also need to pursue IBM and other manufacturers for additional grants to obtain new resources for growth.

A second issue which needs to be resolved is where growth should occur. Departments can acquire more of their own microcomputer workstation rooms or we can create additional school-wide classrooms. A balance of both is required; departmental based workstation rooms for graduate students and classrooms for undergraduates.

Staffing changes in SEASnet will alleviate some of the problem in that an additional FTE can be created by downgrading an existing position. Our best estimate of additional staffing needs are two full-time professional FTE beyond the newly created position and two to four 50% time graduate students to proctor classrooms and provide user consulting.

The impact on instruction has generally taken the form of improved teaching through better and more abundant computer resources. Faculty are now able to enhance their teaching with more realistic, and therefore more complex, instructional problems. The availability of the new computer resources has stimulated a few new courses, such as courses to teach computing skills. There is a controversy between teaching programming versus teaching computing skills, such as using spreadsheets.

We have not seen very many radically different courses stimulated by the new computing resources. This is probably due in large part because only PC-AT's are widely available. Higher power machines will enable Engineering faculty to explore and develop more innovative courses.

This section has concentrated primarily on the current deficiencies in SEASnet and the need for change and growth. This should not be taken as a negative appraisal of SEASnet, but as recognition of our need for growth and evolution to higher powered workstations and servers. The positive appraisal is that SEASnet has created an environment which is stimulating a *renaissance* for instructional computing in SEAS.

REFERENCES

1. **SEASnet: A Distributed Academic Computing Environment**, A proposal to develop SEASnet, School of Engineering and Applied Science, October 15, 1984.

2. **SEASnet - Courseware Development Projects**, April 1985.

3. **SEASnet - Courseware Development Projects**, April 1986.

4. **SEASnet - Courseware Development Projects**, April 1987.

APPENDIX A - EXPENDITURES

Table A1. SEASnet Expenditures

Category	1984-85	1985-86	1986-87*
Payroll	32,000	300,000	360,500
Supplies and Maintenance	31,000	141,600	195,000
Shops (Materials)	6,800	42,000	20,000
Equipment	463,500**	182,500	48,000
Travel	500	6,000	7,000
OID	0	118,000	143,000
Work study & Casual Staff	2,200	14,000	8,100
Capital Projects	270,800	-	26,800
Shops (Labor)	9,000	56,000	20,000
Total	815,800	860,100	828,400

* Projected
** Includes $235,000 for the FPS-164 MAX

Table A2. Reallocated Space

Room	Square Footage	Source
PC-DOS Classroom 1	859	Dean
PC-DOS Classroom 2	1,151	Dean
PC-DOS Classroom 3	429	Registrar
Printer Room	162	Dean
Machine Room	3,411	Dean
SEASnet Offices	1,345	Dean
Total	7,357	

* At the time of this writing each department is building a cluster of PC's, which will generally require 100 to 200 square feet per cluster. Therefore the above space allocations should increase by another 500 to 1000 $ft.^2$ The RT classroom will require an additional 500 to 1000 $ft.^2$

Table A3. Special Expense Categories[1]

Special Categories	Year (1984-85)	Year (1985-86)	Year (1986-87) Projected Total
Networking Equipment and Supplies	203,000	50,300	58,522
Insurance	-	2,900	5,100
Maintenance	-	65,000	99,000
OAC	-	-	1,600
ARCUS, Inc. (tape storage)	-	-	970
Classroom Proctors	-	1,400	8,000
Shops and Facilities (Materials)	6,800	42,000	20,000
Shops (Labor)	9,000	56,000	20,000
Capitals			
Classrooms	42,000[2]	-	26,800[3]
Machine Room	200,800	-	-
Ethernet Installation	28,000	-	-

1. These sums were incorporated into Table A1. They are separately identified here.

2. 4442 and 6270 BH (IBM PC/AT Classrooms)

3. 4277 (AT&T Classroom)

APPENDIX B-COURSES TAUGHT IN SEASnet CLASSROOMS

Table B1: Total Number of Enrollments in Courses using the SEASnet Classrooms

Division	Fall		Winter		Spring	
	1985/86	1986/87	1985/86	1986/87	1985/86	1986/87
Lower	0	0	106	109	90	79
Upper	218	470	345	619	225	445
Graduate	62	17	49	61	13	76
Total	280	487	500	789	328	600

COMPUTER CLASSROOMS SCHEDULE
FALL 1985

ROOM 4442

TIME	Monday	Tuesday	Wednesday	Thursday	Friday
8					
9		MA171A		MA171A	CE167A
10		MA171A	MA197F	MA171A	CE167A
11		CS162A	MA197F	CS162A	CE167A
12	MA271A	CS162A	MA271A	CS162A	MA171A
1	MA271A		MA271A		MA162A
2	MA257A		MA257A		MA162A
3	MA257A		MA257A		MA171A
4	MA171A	MA162A	MA171A	MA162A	
5	MA171A		MA171A		
6	MA271A		MA271A		

ROOM 6270

TIME	Monday	Tuesday	Wednesday	Thursday	Friday
8	MA150P		MA150P		
9	MA150P		MA150P	CE184D	
10	CE165B	CE184D	CE165B	CE184D	MA131A
11	CE165B	CE184D	CE165B	CE184D	MA131A
12		MA131A	CS163	MA131A	
1		open	CS163	open	
2	CE265A		CE265A		CS163
3	CE265A		CE265A		CS163
4		CE184D			
5		CE184D			
6	CE165B				

*Lab Time

COURSE	PROFESSOR	COURSE	PROFESSOR
CE165B	Nelson	CE167A	Selna
CE184D	Neethling	CE265A	Nelson
CS163	Dyer	MA131A	Catton
MA150P	Karagozian	MA162A	Yang
MA171A	Mingori	MA197F	Fleury
MA257A	Mal	MA271A	Gibson

COMPUTER CLASSROOMS SCHEDULE
FALL 1986

ROOM 6270

TIME	Monday	Tuesday	Wednesday	Thursday	Friday
8	MA150A	MA131A	MA171A	MA150P	CS270C
9	MA150A	MA131A	MA171A	MA150P	EE103
10	M169L	CE184D	M169L	CE184D	CS141
11	M169L	CE184D	M169L	CE184D	CS141
12	MA171A	EE103	MA162A		CS141
1	MA171A	MA171A	MA162A		CS141
2	EE115A	MA150A	EE103	MA162A	MA171A
3	EE115A	MA150A	EE103	MA162A	MA171A
4	MA150P	EE103	MA131A	EE103	
5	MA150P		MA131A	MA150A	
6					

COURSE	PROFESSOR	COURSE	PROFESSOR
Cardenas/Gerla	CS141	Distefano	CS270C
Fourney	CE M169L	Jacobsen	EE103
Karagozian	MA150P	Martin	EE115A
Mills	MA131A	Mingori	MA171A
Neethling	CE184D	Wilcox	MA150A
Yang	MA162A		
*Mal	MA257A-Not scheduled		
*Lang	CS151B-Not scheduled		

COMPUTER CLASSROOMS SCHEDULE
SPRING 1986

ROOM 4442

TIME	Monday	Tuesday	Wednesday	Thursday	Friday
8		CE165L			
9		CE165L	OPEN*	OPEN*	CE269
10		CE165L	"	"	CS151C
11	EE117M	EE117M	"	"	CS151C
12	CS174				
1	CS174	EE122A		EE122A	CE165L
2	CS174			EE122A	CE165L
3	CS174		EE122A	CS196B	CE165L
4	CS174	CS196	EE122A	CS196B	CE165L
5	CS174	CS196B	OPEN*	EE117M	EE117M
6					

ROOM 6270

TIME	Monday	Tuesday	Wednesday	Thursday	Friday
8		CS13*		CS13*	
9		CS13*		CS13*	OPEN*
10	CE137F	MA131A	CE137F		"
11	CE137F	MA131A	CE137F		"
12					"
1			MA250C		
2	MA131A	CS13*	MA250C	CS13*	
3	MA131A	CS13*		CS13*	CE137F
4	CS241B	MA131A	CS241B	CE137F	CE137F
5		MA131A		CE137F	
6					

*Lab Time

COURSE	PROFESSOR	COURSE	PROFESSOR
CE137F	Cohen	CE165L	Felton
CE269	Hart	CS196B	Mak
CS241B	Cardenas	CS13	Kay
CS151C	Lang	CS174	Vidal
EE117M	Luhmann	EE122A	Hassul
MA131A	Lavine	MA250C	Karagozian

COMPUTER CLASSROOMS SCHEDULE
SPRING 1987

ROOM 6270

TIME	Monday	Tuesday	Wednesday	Thursday	Friday
8	EE103	SEASnet		MA131A	
9	EE141	SEASnet	EE141	MA131A	EE103
10	CH137F	CE198	CH137F	CE198	CS151C
11	CH137F	CE198	CH137F	CE198	CS151C
12		EE103			CS161
1		EE141		EE141	CS161
2	MA164	SEASnet		MA164	
3	MA164	SEASnet		MA164	
4	CH137F	EE103	CH137F	EE103	MA131A
5	CH137F		CH137F		MA131A
6					

COURSE	PROFESSOR	COURSE	PROFESSOR
CE198	Neethling	*EE199	Levan
CH137F	Cohen	*EE241C	Mortensen
CS151C	Lang	*MA162L	Miu
CS161	Korf	*CE184F	Neethling
EE103	Gurlitz	*CE165C	Dong
EE141	Wiberg	*CE264B	Dong
MA164	Mingori	*CE167L	Selna
MA131A	Mills/Lavine	*CE267C	Selna
*CE165L	Felton	*CE286B	Hart
*CE106A	Pfeiffer	*CE281	Perrine
*CS13	Kay	*CS264	Flowers
*CS265	Flowers	*E176A	Rosenstein
*EE239BS	Jacobsen	*MA250C	Karagozian

*These classes will be using Open Lab only.

COMPUTER CLASSROOMS SCHEDULE
WINTER 1986

ROOM 4442

TIME	Monday	Tuesday	Wednesday	Thursday	Friday
8	ChE138	CS12*	ChE138	CS12*	CE184B*
9	ChE138	CS12*	ChE138	CS12*	CE184B*
10	CE286A	CS174*	CS267		CE184B*
11	EE122A*	CS174*	EE122A*		EE122A*
12	CE286A	CS174*	MA171A*	MA164*	EE122A*
1	CE286A		MA164*	MA164*	MA171A*
2	CE286A		MA164*	CS174	
3	CE286A		MA164*	CS174	MA164*
4	MA236C		MA154A		
5	MA236C		MA154A		
6					

ROOM 6270

TIME	Monday	Tuesday	Wednesday	Thursday	Friday
8	EE129A	CS12*	EE129A	CS12*	MA150A
9	EE129A	CS12*	EE129A	CS12*	MA150A
10	CE185B	CE284H	CE185B	CE284H	
11	CE185B	CE284H	CE185B	CE284H	EE129A
12	MA150A	CS264A	MA257B		EE129A
1	MA150A		MA257B		CS161
2	MA257B		CS267	MA154A	CS161
3	MA257B	EE129A	CS267	MA154A	CS161
4	MA154A	EE129A	EE129A	SEASnet	CS161
5	MA154A	MA150A	EE129A	SEASnet	
6	MA154A*	MA150A			

*Lab Time

COURSE	PROFESSOR	COURSE	PROFESSOR
ChE138	Manousiouthakis	CS12	Kay
CS161	Korf	CS174	Vidal
CS264A	Flowers	CS267	Klinger
CE184B	Neethling	CE185B	Felio
CE284H	Stenstrom	CE286A	Selna
EE122A	Wang	EE129A	Jacobsen
MA150A	Karagozian	MA154A	Dinyavari
MA164	Mingori	MA171A	Gustafson
MA236C	Okrent	MA257B	Mal

COMPUTER CLASSROOMS SCHEDULE
WINTER 1987

ROOM 4442

TIME	Monday	Tuesday	Wednesday	Thursday	Friday
8	CE198	SEASnet	CE198		SEASnet
9	CE198	SEASnet	CE198		SEASnet
10	MA154A	CE284H	MA154A	CE284H	CE167B
11	EE141	CE284H	EE141	CE284H	EE141
12	CE167B	CS141	MA171A	CS141	CS161
1	MS141	CS141	MS141	CS141	CS161
2	MA171A	SEASnet	MA171A	CS163	CE186
3	MA171A	SEASnet	MA171A	CS163	CE186
4	EE237A	MA150A	EE237A	MA154A	MA150A
5	CH138	MA150A	CH138	MA154A	MA150A
6		MA171A		MA154A	
7				MA154A	

COURSE	PROFESSOR	COURSE	PROFESSOR
CE167B	Selna	*CE106	Pfeiffer
CE186	Hart	*CE165B	Felton
CE198	Neethling	*CE265B	Nelson
CE284H	Stenstrom	*CE286A	Mal
CS12	D. Kay	*CS132	Martin
CS141	Inselberg	*CS174	Vidal
CS161	Dechter	*CS264A	Flowers
CS163	Dyer	*EE136	Giardini
ChE138	Manousiouthakis	*CS241AL	Cardenas
EE103	Jacobsen	*CH137E	Resnick
EE141	Elliott		
EE237A	Mortensen		
MA150A	Karagozian		
MA154A	Dinyavari		
MA171A	Gustafson		
MSE141	Rizzo		

* These classes will be using the Open Lab only.

APPENDIX C - Software

Table C1. Software Acquired by SEASnet

Product	Vendor	Class	Acquisition Method	Description
Professional Editor	IBM	B	IBM Grant	General Purpose Editor PC-DOS Editor
Professional Fortran	IBM	B	IBM Grant	General Purpose Fortran PC-DOS Language
Multiplan	IBM	B	IBM Grant	General Purpose PC-DOS Spreadsheet
GKS	IBM	B	IBM Grant	General Purpose PC-DOS Graphics (Low Level)
Graphics Toolbox	IBM	BL	IBM Grant	General Purpose PC-DOS Graphics (Low Level)
TK! Solver	Software Arts	BL	IBM Grant	General Purpose PC-DOS Algebraic Manipulator
IBM C	IBM	BL	IBM Grant	General Purpose PC-DOS Language
MS Word	IBM	BL	IBM Grant	General Purpose PC-DOS Word Processor
PC-DOS*	IBM	B	IBM Grant	PC-AT Operation System
Xenix*	IBM	BL	IBM Grant	PC-AT Operating System
Locus*	LCC	B	Gift	VAX-4300 Operating System
PC-Interface	LCC	B	Gift	Transparent Network Bridge
APL	IBM	B	IBM Grant	General Purpose PC-DOS Interpretor
CC	System Technology	BL	OID	Special Purpose PC-DOS Control Systems Program

Table C1. Software Acquired by SEASnet (Continued)

Product	Vendor	Class	Acquisition Method	Type
PC-Matlab	Mathworks	Singles	OID	Special Purpose PC-DOS Math Package
Matlab	Public Domain	Site	-	Special Purpose PC-DOS Math Package
SSP	Public Domain	Site	-	Old IBM SSP
Andrew	IBM	Site	OID	PC-RT Window Manipulator
4.2 BSD UNIX*	IBM	B	IBM Grant	PC-RT Operating System
Capdet	Hydromantis	Site	OID	Special Purpose Treatment Plant Program
Lab Tech Notebook	XBX Sales	Singles	OID	Real-Time PC-DOS Data Acquisition Program
Process	Simsci	Singles	Gift	Chemical Engineering Mainframe Simulation Package
MS-DOS	AT&T	B	AT&T Grant	6300 Plus Operating System
UNIX-V.3	AT&T	B	AT&T Grant	3BX Operating System
UNIX-V.5	AT&T	B	AT&T Grant	6300 Plus Operating System
Documenters' Workbench	AT&T	B	AT&T Grant	3BX-6300 Plus Writing Package
Micro-Mech	Minnesota Technology	B	OID	Mechanical Design Program

Table C1. Software Acquired by SEASnet (continued)

Product	Vendor	Class	Acquisition Method	Type
PC-Scheme	TI	Site	OID	Lisp for PC-DOS
MKS-Toolbox	Mortice Kern System	Singles	SEAS	UNIX Work-a-Like Tools for PC-DOS
PC-VI		Singles	OID	UNIX - VI Editor for PC-DOS
Turbo-Pascal	Borland	B	OID	General Purpose Compiler
FPLOT	-	Site	In-House	Plotting Tools
CPLOT	-	Site	In-House	Plotting Tools
RDM	-	Site	In-House	Mail Program
Menu-Driver	-	Site	In-House	Graphic Menu's for Customizing Programs written by Faculty
PC/IP	MIT	Site	Public Domain	TCP/IP for PC-DOS
PC/IP	Stanford	Site	OID	TCP/IP networking for PC-DOS.
Word Perfect	Sattelite Software	Singles	SEAS	Word Processor
PCLASER, Postscript	Personal TEX, Inc.	Site	SEAS	Word Processor
ANSYS/PC-ED	Swanson Analysis	BL	OID	Structural Analysis Program

Table C1. Software Acquired by SEASnet (continued)

Product	Vendor	Class	Acquisition Method	Type
Course Software	NAU Foundation	BL	OID	Mechanical Design Program
VTek	Scientific Endeavors	Singles	OID	
PC-File/R	Buttonware, Inc.	Singles	OID	
Textra	Ann Arbor	Singles	IBM Grant	
eroff	Elan Computer Group	Singles	SEAS	Typesetter for DOS
Window-DOS	Window DOS Assoc.	Singles	IBM Grant	
TCP/IP	Bridge Commun.	Site	SEAS	
DBaseIII+	Zebra	Singles	SEAS	

Key:
- B = bulk licenses for each workstation
- BL = bulk licenses for a subset of our workstations
- Site = site license for the Campus and/or SEASnet
- Singles = one or more single copies purchased for individuals
- * = includes compilers, e.g. C, Fortran, and associate utilities

APPENDIX D - SEASnet SURVEY FORM

May 15, 1986

Dear SEASnet user:

I am writing to you to learn a little about your experience last quarter with the SEASnet classrooms. I pulled your name form the class rosters, and I hope you don't mind taking a little time to fill out the enclosed questionnaire. The SEASnet advisory committee and I will use the information you provide in our plans for future classrooms and how the classrooms are integrated into our instructional programs. We have not asked you to sign the survey but feel free to do so if you prefer.

Please use the enclosed envelop to return your questionnaire. You can drop it off at 2567 BH or in any of the departmental offices.

Thank you very much.

Very truly yours,

Michael K. Stenstrom
Professor and SEASnet Director

MKS:mm

SEASnet COURSE EVALUATION

Class Information:

Instructor:

Class (date and time):

TA of your class using SEASnet:

Personal Information:

What year are you completing?
Freshman *Sophomore* *Junior* *Senior* *Grad*

What is your major?

Why are you taking this course?
Required *Breadth (Because I want to...)*

Course Evaluation:

How much did you know about PC/DOS before?
Expert *Intermediate* *Beginner* *None*

Have you used an MS/DOS microcomputer before?
Yes, alot *Yes, a few times* *Never*

Did you know much about SEASnet before?
Yes, a lot *Yes, a little* *No*

How tentative were you in using the PC/AT's?
Very *A little* *Not at all*

What was your previous experience with computers?
CS Classes (Please list))

Engineering Courses *Science Courses* *Non-science Courses*

Work Related *Home Computing* *Other (Please specify)*

In what ways did the use of PC/DOS machines improve the course?

What were the disadvantages of the PC/DOS machines?

Can you compare your course experience using the SEASnet with previous experience using mainframe computers?

What were the most and least helpful software?

How much did you use the network (e.g. Odin)?

What suggestions do you have for improving the learning experience?