Asynchronous Learning Networks: A Sloan Foundation Perspective

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ABSTRACT

This paper is based on a chapter in THE LEARNING REVOLUTION, the challenge of Information Technology in Academia (Diana G.Oblinger and Sean C. Rush, eds.), to be published this year by Anker Publishing Co., Boston, Mass.

Over the years small numbers of motivated individuals have studied by themselves, away from university centers, to acquire knowledge in post-secondary subjects. Correspondence study began over a century ago and since then, other forms of "distance education" have become established. In spite of all this progress, off-campus learners have worked mainly in isolation, with only occasional contact with instructors and peers.

Today's low-cost communications and computer technologies, however, enable learning in Asynchronous Learning Networks (ALNs), in the process simultaneously overcoming barriers of isolation, distance and those imposed by rigid time constraints. The paper describes some projects at institutions of higher education funded by the Sloan Foundation, identifies some early results and possible evolution of ALN's to large scale implementations.

KEY WORDS

Asynchronous
ALN
Distance

I. INTRODUCTION

Over the past century, we have seen accelerating interest in education for off-campus or "non-traditional" learners. As technology and infrastructure have progressed, the advances have been modified by educators to package learning resources for these off-campus learners.

The history of serving these off-campus learners began a century ago. Correspondence style off-campus education first appeared in the late 1800s and remains popular today. Technology delivery has evolved from print and radio to broadcast television and computer-aided instruction, and now to CD-ROMs and the World Wide Web. These disparate technologies along with some others, are the enabling tools for what is now called "distance education." They have had a large -- even revolutionary -- influence on education. In the process, they have extended educational opportunities to people in places that would otherwise not have been served.

Most of today's distance education techniques can be grouped into two categories: **self-study techniques**, with little or no human interaction (such as books, videotapes and learning software), and **techniques with limited human interaction** (such as interactive television). While these techniques continue to be important, there is one channel of learning that these techniques fail to address -- the channel that goes beyond lectures, tutorials, and reading materials to permit learners to engage in interactive discussion with peers and instructors. A self-study model or a televised classroom, even one advertised as “fully interactive,” cannot begin to provide the formal and informal person-to-person exchanges that our campuses offer -- exchanges that are an important supplement to lecture and textbook instruction.

Today, technologies exist that enable asynchronous interactivity, i.e., a high degree of interactivity among geographically separated learners, independent of time or place. By asynchronous we mean that participants in a discussion need not engage in that discussion at the same time, as they would in a face-to-face or telephone conversation. Rather, as in an e-mail exchange, there is some elapsed time between message exchanges -- perhaps minutes, hours or even days.

Asynchronous interactivity can become the basis for a new and large-scale learning model among distance learners. Such interactivity is already the basis for project work in business enterprises, where geographically dispersed teams can develop project goals, share analyses, carry on discussion and debate, and prepare presentations or reports without ever meeting in the same room or even connecting at the same time through a conference call. Such interactions are extraordinarily popular on Internet bulletin boards and associated networks run by various Internet service providers, where people who have never met can carry on discussions on a wide variety of topics, all in a time-elapsed, asynchronous fashion.

Asynchronous interactivity is the third major distance education approach. Asynchronous Learning Networks (ALNs) combine self-study techniques with asynchronous interactivity to create environments in which learners can access remote learning resources asynchronously -- using relatively inexpensive equipment -- to learn at home, at the work place or at any place of their choosing. Remote learning can enlist dynamic resources such as other students, outside experts or the instructor, or more static resources such as assignments, course notes or libraries. Additional digital resources can include databases, spreadsheets or even software-generated simulations.

In an ALN we can think of every person on the network as both a user and a resource. This concept is crucial to the power of an ALN, making it not just an electronic network but a network of people -- an interactive learning community that is not limited by time, place or the constraints of a classroom.

Rapid asynchronous access to resources is made possible by computer and communications technologies. Group activities or team projects involving discussions, spreadsheet analysis or report preparation can be carried out through commercial software linked to computer conferencing software or “groupware” [1]. In an ALN, “lectures” can be transmitted through groupware, videotape, CD-ROM or the World Wide Web. Books and other printed material continue to have a role. Material may be posted on the World Wide Web or it may be provided through fax or a voice-response unit [2]. All represent asynchronously accessed resources. Most of the academic campus activities a student might participate in (Table 1) have an asynchronous analog, which allows us to envisage “distributed classes,” populated with learners we can think of as “distributed cohorts,” in the same way we think of on-campus classes and cohorts. Participants in these distributed classes, however, access resources and interact asynchronously.

The Alfred P. Sloan Foundation has established a program to explore the potential of ALNs to provide learning to anyone who wishes to learn, at a time and place of the learner’s choice. Projects at a number of mainstream, campus-based institutions, devoted to exploring the unique possibilities that might emerge from ALNs, are an important element of the Sloan Foundation program. The basic ideas underlying computer network learning pre-date the Sloan projects, having been discussed in the 1970s [3] with early implementations starting in the 1980s. The number of these implementation projects has grown steadily, so that today, hundreds of courses are listed on the Internet. Some degree programs are available, as well.

Although real progress has been made in asynchronous education, this growth is limited. The number of courses available on-line is relatively large, but most are isolated offerings resulting from the zeal and skill of a handful of faculty members. The courses vary widely in approach, quality and credibility. Some are little more than Web-based reading material; others are advertisements for on-campus continuing education courses. Few are part of a true learning network.

Consider the differences between on-line and classroom-based programs at established colleges and universities. Whether for traditional or continuing education students, classroom programs are more than a skeletal assembly of isolated courses; rather they are a coherent sequence of courses that constitute a curriculum. These programs lead to degrees or certification. They are listed in catalogs and are available at predictable times. Complementing their academic offerings, colleges and universities also provide sophisticated support services including recruitment, orientation, registration, advising, financial aid, grade recording and report keeping. These support services are quite robust: they handle tens of thousands of students in the largest universities.

By these kinds of measurements, asynchronous learning has much ground to cover. Even self-study and televised classrooms at major institutions are far ahead of ALN-style education in their systematic approach and accompanying services and support [4], [5]. To distribute education asynchronously in a truly useful way to off-campus learners, educational institutions will have to make a commitment to build organizations that deliver certifications and degrees along with a full array of student services. Society would benefit greatly from the emergence of such organizations serving a community of motivated learners whose life circumstances make it difficult for them to attend scheduled campus classes.

While off-campus learners will benefit the most from ALNs, it is likely that important benefits will also be realized on campuses. ALNs bring with them new kinds of functions that may, in turn, allow new outcomes. High quality computer networking is available to students and faculty at many, if not most, campuses and it is very widely used. This capacity for asynchronous access and communication, which comes at a price, is then overlaid onto traditional activities. The price is justified in terms of "improvements in learning outcomes" or, simply, better learning. However other outcomes could also be sought. For instance, <u>peer-to-peer collaborative learning</u> among students might be greatly enhanced through asynchronous access to each other or to tutors and teaching assistants. Improved communication among all network "nodes"--in this case students, teaching assistants and faculty--may favorably impact student <u>motivation</u> and <u>retention.</u> <u>Learning productivity</u> may increase. <u>Self-pacing</u> would also become possible for some students.

Some of the Sloan-supported projects are exploring these and other possibilities by experimenting with new ways to integrate ALNs with traditional on-campus processes. Our goals for the Sloan on-campus projects are to improve <u>productivity outcomes</u> with some simultaneous improvement in learning outcomes and at about the same faculty effort. A particular interest is to explore how productivity gains can, in some way, pay for the cost of the ALN. Increased class sizes reduced dropout rates and self-pacing may all lead to improved productivity. Other projects are exploring ALNs for off-campus learners. These can be either near-campus or very-far-from-campus ALNs. For example, a community college that draws students from a radius of 50 or 60 miles might establish a near-campus ALN. Courses might be taken at home or at the workplace through an ALN, but examinations, laboratory work, counseling and other support activities might require a campus visit. An ALN for learners located at greater distances from the campus requires more function and sophistication.

Some of the Sloan projects are experimenting with one or two courses before making a decision to pursue a more ambitious agenda (Table 2). Others are offering, or plan to offer, multiple course sequences leading to certifications or degrees. The focus of these courses is primarily in scientific and technical fields, although other disciplines are represented, as well. Some projects have enrollments in the hundreds. Over the next few years, some course enrollments will exceed a thousand and begin to demonstrate scalability.

It seems quite clear that ALNs offer new possibilities in off-campus as well as on-campus education. However, experience with large-scale implementation and institutional commitment are needed to realize the extent of these possibilities. The remainder of this chapter describes the issues of how well people learn in ALNs, potential outcomes from ALNs and possible evolution of this new approach.

II. LEARNING IN ASYNCHRONOUS LEARNING NETWORKS

Do ALNs work? Do people learn in these environments? Will ALN-style learning appeal to a variety of learners across a broad range of disciplines?

These are complex questions, which are embedded with research as well as practical aspects. The research questions will not be resolved quickly, since many variables need to be accounted for and control groups established for comparisons, which is a difficult task in educational environments. Over time, we will learn whether asynchronous learning is more effective in some disciplines than others, and we will learn more about student and faculty characteristics which lead to success in ALNs. For example, we may find that gender is a factor. At a more practical level, we might apply different kinds of measures. We can ask, for instance, whether the evidence we have supports a conclusion that the learning that takes place in ALNs is equivalent to traditional classroom learning. We might also try assessing the demand side. Are learners enrolling in properly delivered and properly supported ALN programs? Is a need being fulfilled? To these two practical measures, the answer appears to be affirmative. The majority of institutions in Table 2 have now gained valuable learning experience in ALNs, some quite extensive, and in all instances the indicators point to a conclusion of equal or better learning in an ALN compared with traditional methods. Some specific examples follow.

A. Example 1: CORNELL UNIVERSITY

In 1993, the Cornell University physics department began a project to re-think and restructure certain physics courses, both at the graduate and undergraduate level, in an attempt to learn more about the possible benefits of extending computer and communications usage and reducing lecture-style pedagogy. A number of ideas were tried; experimentation continues (K. Gottfried, personal communication). The following example is based on Solid State Physics (Physics 454).

Solid State Physics is a four-credit course, with three lecture sessions and one recitation section per week. Typical students are physics undergraduates planning to go on to graduate school or graduate students from engineering and other sciences. In the spring semester of 1995, Professor Robert Silsbee taught the course with no face-to-face sessions. Students were given a course syllabus, along with information about books needed and reading assignments for the semester. They turned in assigned homework problems and took one quiz per week. Learning took place through assigned readings, reviews of a library of 24 computer simulations which illustrated solid-state phenomena created by Silsbee and co-worker [6], and work on problem sets. Students worked asynchronously. The schedule required that homework problems and quizzes be turned in at prescribed times. Silsbee or a graduate assistant were available through e-mail or a Web-based system, and class participants could get help from each other, either face-to-face or though e-mail.

Silsbee has taught this course using a traditional classroom model many times during the past 30 years. Student learning involves mastering hard-to-visualize topics such as reciprocal lattices and Fermi surfaces. His assessment at the end of the semester was that this asynchronous cohort had learned as much as other classes he had taught. He based his assessment on results from homework sets, quizzes and post-semester discussions with students on the subject matter. This somewhat unique experiment is an indicator that, at least for this rather specialized group of science and engineering students, an ALN learning experience was approximately equivalent to that of colleagues in face-to-face classes.

In terms of demonstrating the full capabilities of an ALN, the experiment was only partially successful. Students did access remote resources such as the instructor and a teaching assistant over the network, and there was some networked collaboration among students. However, such collaboration was limited, possibly because the collaboration was optional and not built into the structure of the course. It is also possible that since students met in the computer lab to work on simulations, they needed less in the way of networked communications.

B. Example 2: DREXEL UNIVERSITY

Drexel University has converted eight courses in the Information Systems (IS) curriculum to a format suitable for ALN, and has been offering these mainly to their on-campus students over the past two and one-half years. One undergraduate course, System Design and Analysis, has now been taught seven times. A graduate course in Policy and Management has been taught five times. Other courses have been taught from three times to once. Drexel's approach is to put as much of the material needed by students as possible into a Lotus Notes database, which is accessed over the computer network. The Course Materials database contains a course description, a course syllabus, all required reading materials (books, articles and notes), criteria for grading as well as photographs and short profiles of students in the class [7].

Unlike physics, the IS discipline is not highly mathematical or quantitative. The System Design and Analysis course, for example, stresses an understanding of the factors (requirements) underpinning the application for which the software is to be designed, how to convert these requirements into a model and then to convert the model into a prototype. These elements require thought and analysis. However, there is usually no single correct answer. There are likely to be several good designs, as well as mediocre or unsatisfactory designs. Various design approaches can be refined through discussions with experts or by testing them against empirical design principles.

A design course, to be successful, also requires discussion and dialog -- among students and between students and the instructor. Discussions are integral to all IS courses and in the ALN versions they are carried out in the Lotus Notes discussion database. Typically, a discussion is initiated by the instructor; student participation is required for satisfactory performance in the course. In a conventional classroom environment, one opinionated individual can dominate a discussion, in the process excluding the opinions of others. An asynchronous networked version of this phenomenon occurred in one of the Drexel classes when one individual submitted many more messages than other students. However, because of the nature of the medium, this caused no time penalty for anyone else, and the distraction was easily overlooked.

The Drexel courses are all quite structured -- readings and assignments are laid out for each week of the term and one week is devoted to a substantive discussion topic. Students learn new material through assigned readings then engage in discussions with each other. They turn in homework assignments every week -- recorded in a Lotus Notes Assignments database -- and carry out a system design project for the semester, also recorded in the Assignments database. All work, including readings, discussions and assignments, is carried out asynchronously. Note, however, that the overall course is synchronized. For example, everyone in the class must complete the weekly subject module.

To date, approximately 250 students have completed these courses. Homework and project grades, along with surveys and interviews with students, lead to the conclusion that learning in the ALNs is equivalent to that of face-to-face classes. Particularly striking were results from surveys which showed that virtually all (100%) students felt that seeing the ideas and assignments of others was useful, 67% felt they had more communication with fellow students, 97% felt they had more access to the instructor than in conventional classes and 91% said they would take another ALN course (Charlton Monsanto, personal communication). We should note, however, that about half of the students also indicated that they missed classroom lectures.

C. Example 3: NORTHERN VIRGINIA COMMUNITY COLLEGE

With five campuses and nearly 40,000 students, Northern Virginia Community College (NVCC) is one of the largest two-year colleges in the country. The Extended Learning Institute (ELI) unit at NVCC is specifically charged with serving home-based, non-traditional learners -- who are likely to be working adults -- through independent study programs. The average age of the population registering for ELI courses is 28. In 1993, the ELI unit undertook a two-stage program to implement a near-campus ALN that would, when completed, permit off-campus learners to earn a full Associate in Science (AS) degree in Engineering. Fourteen courses will have been converted to a format suitable for an ALN when the project is completed. To date, ten have been converted and offered, some several times.

The ALN is built around lectures on videotape, books and other instructional materials, recitations, homework help and other person-to-person communication through networked computers running First Class groupware. Students can register remotely through telephone and computer messaging. This is a typical near-campus ALN since students come to campus for services, such as financial aid, placement testing, or library books and periodicals. Examinations, when required, are also on campus, as are chemistry laboratories [8], [9], [10].

Chemistry I is a required course in the AS (Engineering) sequence and requires 12 laboratory sessions. NVCC implemented six double sessions on Saturdays and found this arrangement quite satisfactory for students and faculty. While the full suite of courses for the AS (Engineering) degree is still being developed, teaching experience gained so far with approximately 250 students indicates that ELI ALN students are doing as well or better in courses, in terms of grades and retention rates, as NVCC students in the same courses offered in traditional format. Faculty participating in the project are pleased with the results and with their involvement. In addition, students have been very positive in their comments and in survey responses.

D. Example 4: NEW JERSEY INSTITUTE OF TECHNOLOGY

The New Jersey Institute of Technology (NJIT) has had a long history of research and experimentation with computer conferencing and education. In 1993, NJIT started a project to develop a suite of courses in a format suitable for ALNs that would lead to two undergraduate degrees -- a Bachelor of Arts (BA) in Information Systems and a Bachelor of Science (BS) in Computer Science. A total of 26 courses have been developed and offered, some as many as six or seven times. ALN students view lectures on videotape and participate in class discussions through NJIT's proprietary EIESII computer conferencing system. Homework assignments are received and submitted by students through this system. Because most of the courses in the ALNs were also taught face-to-face, comparisons could be made across a wide range of parameters. The conclusions are somewhat clouded by the fact that students had difficulty accessing the NJIT course server due to an insufficient number of modems at the university. But, in spite of this difficulty, students in ALN sections responded to surveys by indicating that the ALN improved their learning. Distribution of grades is an indicator that students in the ALN performed at least as well, perhaps better, than those in traditional sections [11].

To summarize this section then: evidence to date, albeit sample evidence, points to a conclusion that those who choose to enroll in ALN courses, on the average, do about as well as those who are in traditional classrooms, across a number of disciplines; measures of success here are exam and course grades and qualitative assessments of faculty about performance on assignments, homeworks and discussions. Generally, student satisfaction is as high or higher than for traditional classrooms. These conclusions are supported by results from other Sloan projects not described here. Statistically pure conclusions will require larger numbers and a rigorous effort to create equivalent "traditional" and "ALN" cohorts, and this kind of research is not likely to appear soon. Much more likely, is stronger qualitative, sample evidence of the kind cited here, and this leads to the second conclusion: the numbers of off-campus learners enrolling in ALN's continues to rise steadily. The market is gradually putting its imprimatur on ALN.

III. NEW OUTCOMES

Several references have been made to the traditional classroom teaching model, a model that has been dominant for over a century and one that encourages certain accepted practices. For example, learners accept the necessity of coming to a campus center to learn, the idea that a degree requires four years of residence, and the premise that smaller classes and student faculty ratios are preferable to larger ones. One might conjecture that ALNs produce different outcomes, because entirely new capabilities are being brought to bear. Three capabilities -- asynchronicity, efficiency and geographically distributed cohorts -- brought together in different ways could create a variety of possibilities with profound implications for education. This section considers examples from a range of institutions where new outcomes are being explored.

One new possibility is widespread availability of high quality, cohort-style education (courses, certifications and degrees) for anyone, anywhere. Indeed, this possibility is the single most important motivator for developing extensive ALNs that go beyond today's handful of degree programs and isolated courses. Progress is being made by a number of institutions in the near-campus and very-far-from-campus categories, which are developing certifications and degrees. We have already noted that NJIT is offering Bachelor degrees in Computer Science and Information Systems. Drexel has used their experience from on-campus ALNs to create a Master of Science (MS) in Information Systems that is initially being offered in the Philadelphia area starting in the fall of 1996. NVCC is offering a two-year Associate in Applied Science degree in Engineering. Other institutions are also following this path.

A. Non-residency Degrees

The State University of New York (SUNY) now has in place a degree-completion program. Learners who finish two years at any of six community colleges in the Mid-Hudson Valley can go on to complete bachelors requirements for either of two degrees without having to leave home and go to a four-year college: Liberal Studies from SUNY New Paltz, or Business from SUNY Empire State. A Lotus Notes network and the Internet are core elements of the SUNY ALN. Stanford University, with one of the largest and most successful televised graduate degree programs, has begun to digitize its television lectures and offer them on-demand. Fourteen courses are currently available in asynchronous form, with more to follow.

B. Non-residency Certificates

Many certifications are also available through ALNs. New York University has already graduated two classes with a four-course graduate certification in Information Technology. They are using a Lotus Notes network and require ISDN connections [12] for learners so that video, animation and text are all part of the learning materials. The University of California at Berkeley has enrolled a class for a nine-course certification in Hazardous Materials Management, available over America On-line. The University of Wisconsin-Stout offers certification in Food Handling. Others schools are planning to offer certifications soon: Metropolitan State in Purchasing Management, Pace University in Telecommunications, Pennsylvania State University in Acoustics Engineering, and Rio Salado Community College in Computer Usage and Applications. The University of California-Berkeley has a major effort under way to have 175 of their extension courses on America On-line by the middle of 1998. A number of other institutions will also be moving forward with degree and certification offerings in the coming years.

C. At-risk Populations

The certificate offerings from Rio Salado and Penn State deserve additional discussion for they illustrate how ALNs can be used to meet the needs of very specific groups of distributed cohorts. Rio Salado's Project Reachout is designed to recruit applicants from an "at-risk" population -- those with physical disabilities, child care issues and transportation difficulties, factors that may be barriers to a post-secondary education. Members of this group may be the first in their families to have high school credentials. Project Reachout is having surprising course completion rates for this population, currently around 55%. Their near-campus ALN imposes a strict selection process for new applicants, including testing and interviews, to ensure maximum likelihood for success. Once selected, participants are provided counseling and other services, both face-to-face and on-line, to further enhance their chances for success. Participants use the computer network as an added element of a support among themselves, since encouragement and support are not always forthcoming from the families.

D. Low Demand Specialties

The Penn State Acoustics Engineering certification, to be offered in early 1997, also aims to demonstrate a new kind of outcome -- the special value of an ALN approach in narrow specialties. Acoustics expertise is needed in many industries such as appliances, automobiles and auto parts, office equipment, aircraft, machine tools and the government sector, where noise control and vibration reduction are important to success. However, many corporations do not have a special acoustics department and may prefer that a mechanical engineer also be a part-time acoustics engineer. Higher education institutions are not likely to offer courses in such narrow specialties because local demand is low. Corporations are also not likely to have on-site classes for the same reason. This does not mean that the specialty is unimportant, only that few individuals at any location require the training. Penn State's plan is to establish cohorts nationally when their acoustics ALN (offered on the Internet and with CD-ROMs) is rolled out, ensuring that classes of 30 to 50 can easily be assembled. Small groups of 3-5 will work together on engineering projects. Cohort-style education in narrow specialties appears viable on a national scale, even when it is not viable on a local scale in conventional classes.

E. Efficiency

Access to high quality, cohort-style learning, even for special learner segments and narrow specialties, represents a new outcome that is made possible through the three features of ALN approach -- asynchronicity, efficiency and geographically distributed cohorts. But, does asynchronous access to remote resources really introduce new efficiencies? The answer is yes. The rapid increase in use of phone answering machines, digital voice response units, e-mail and groupware provide the evidence. The reasons for this may have to do with the fact that although the face-to-face method is the most efficient form of communication, in most instances such meetings do not take place very often because of difficulties and costs associated with scheduling and distances. When a group is together in a room, there may be very effective communication. Other than these instances, however, there is little or no communication. Said another way, the communication bandwidth peaks during face-to-face sessions and drops to zero in between. The result is that, averaged over periods of several hours or more, the effective bandwidth for asynchronous communication can be much higher than in face-to-face communication.

The second efficiency has to do with the fact that distribution of documents and other learning materials over the Web and groupware is more efficient than via any other method. These communication and distribution efficiencies make possible the idea of distributed cohorts. If a geographically dispersed group of people were connected only through the mail and synchronous telephony, they would effectively be a self-study group.

F. On-campus Outcomes

ALNs may also create new productivity outcomes for on-campus learning while improving learning outcomes at the same time. The University of Illinois at Urbana-Champaign has launched an ambitious project through their Sloan Center for Asynchronous Learning Environments (SCALE). SCALE plans to de-synchronize elements of more than 100 courses over a three year period and explore the possible outcomes achievable through on-campus ALNs. So far, asynchronous elements have been integrated into approximately 50 courses ranging across many fields, such as humanities, social sciences, engineering and physical sciences. Burks Oakley, Associate Director of SCALE and a pioneer in the area of on-campus ALNs, has summarized SCALE projects and activities in recent papers. He gives one particularly striking example for a high enrollment, lower division electrical engineering course, ECE270 [13].

Typically, about 500 engineering and physical sciences students enroll in this course each semester. There are usually five sections for this course. Over the past few years faculty assigned to some sections have opted for the ALN version while others have chosen the traditional version. In the ALN version, students attend lectures but carry out homework drills through a software package called CircuitTutor. Problem sets are also contained in CircuitTutor, which can be submitted for grading anytime through the network to a computer that provides a grade response almost instantly. Problems graded as incorrect can be re-submitted an unlimited number of times. Students may seek assistance at any time from fellow students or from on-line undergraduate tutors between 8 a.m. and 12 midnight on weekdays, or from the instructor. With these features in mind, it is easy to imagine the following scenario: A student completes the four assigned homework problems late at night and submits them for grading. The computer marks three correct and one incorrect. The student tries two more times but still does not get the assignment right. Of course, this situation is not uncommon in a quantitative field where problem solutions depend on a series of intermediate steps, some of which may involve computations or assumptions. A wrong answer is usually traceable to some incorrectly performed intermediate step, however the person working on the problem may be unable to find the error -- the person is “stuck.” Often a few hints from someone else can “unstick” the thought process. Late at night that other person may be hard to find; an appointment with the instructor may delay the process a day or more. The solution is to turn to the learning network and ask for help -- from anyone. And help is usually swift in coming.
Not surprisingly, the students in ALN sections achieved better results than those who submitted paper and pencil homework problems and received help in traditional face-to-face fashion. Students in the ECE270 ALN sections also demonstrated reduced drop-out rates. Somewhat more surprising was the fact that the superior results achieved by the ALN students were unchanged even when the student/faculty ratio for these sections was increased by 50%.

It has long been assumed that learning outcomes deteriorate as student-to-faculty ratios increase in traditional classrooms. There is, however, no data to tell us how learning networks scale -- what is the relationship between learning quality and the number of people on a network? Classrooms with 10 to 20 students are quite viable, in fact, very effective. Asynchronous learning networks of this size are viable too, as the Drexel experience shows, but the work at Illinois shows that networks of 50 or more students are also viable and effective. As this work indicates, if the users within a network serve as resources to other users, a properly structured learning network may scale very differently from a classroom. The possibility of productivity outcomes seems quite real. Economic benefits could follow.

G. Laboratories

ALNs might produce other kinds of outcomes. Weekly laboratory sessions taking several hours are required in many science and engineering courses -- sometimes with a partner. Could the bulk of a laboratory course be moved onto an ALN so that lab participants (and partners, if appropriate) would need to spend fewer, shorter and more intensive sessions in a real laboratory? Answers to this question would clearly have implications for off-campus learners as well as those on the campus.

At Vanderbilt University, John Bourne of the Electrical Engineering Department and co-workers have developed a software simulator for a junior level Electrical Engineering laboratory [14]. This simulator features state-of-the-art commercial laboratory equipment, electric circuit components, wires and a board on which circuits can be constructed. Part of the simulation software has exercises that direct students to familiarize themselves with the instruments and build assigned circuits. Once a circuit is built it can be tested on the simulated instruments. Recently, the Vanderbilt group carried out controlled assessments to determine the extent to which a simulated laboratory can replace a real laboratory. Students were given comprehensive exams before starting the laboratory course, either the simulated version or the traditional one. Students in the simulated laboratory then took three real laboratory sessions, versus the 12 taken by traditional lab students. The result of the assessment was that students in the simulated laboratory, with only three real sessions, outperformed the students the traditional laboratory with 12 real sessions, based on pre- and post-test comparisons of the two groups [15]. The conclusion is that ALNs involving laboratory simulations hold some promise for producing positive economic outcomes and may permit students to pursue large parts of a laboratory course away from a physical laboratory in a self-paced mode.

H. Self-pacing

Self-pacing is an attractive option for some on-campus students who wish to accelerate their progress or for others who are intellectually capable but lack the background to keep up in a regular class, and thus face the prospect of having to drop the course. A self-pacing capability may only affect a few students, and it does take away the cohort concept, but it is worth exploring, particularly from the productivity angle. The Chemistry Department at Brown University has begun an exploration aimed at understanding the extent to which material on the World Wide Web and networked communications can enable self-paced learning. Very early indications are that some students can self-pace successfully, but considerable care is needed to select only highly motivated individuals in such a program.

There are a number of possible outcomes that could result from ALNs. Some, such as multiple courses leading to certification for off-campus learners in a wide variety of fields, analogous to a university, are likely to become a reality. Others remain attractive possibilities but are not yet fully proven.

IV. ALN: INSTITUTIONAL ADOPTION

Progress is being made toward the goal of providing anyone who wishes to learn, the opportunity to study in a time, a place, and a field of their choice. Can this progress be sustained or accelerated? The self-study and interactive televised classroom models, with occasional augmentation by e-mail communications, are well established. It would seem that a multiplicity of approaches is likely to co-exist in the future. Asynchronous Learning Networks can grow to become an important, even dominant, presence in off-campus education. Existing organizations, which specialize in networked education, and newly formed organizations such as fledgling Internet universities, are likely to contribute to this growth. The recently announced Western Governor’s University [16], for example, will most likely feature a computer network component.

The highest potential for large-scale ALNs will, however, come from mainstream, campus-based institutions because of their sheer numbers and overall presence. Not all will participate, but many will see ALNs as an excellent opportunity and will take steps to move beyond the small-scale experiments with Web-based education that are so common today. These institutions are the ones who recognize that there are no technology limitations today for implementing ALNs. Rather, the limitations come from uncertain institutional commitment.

The need is to build a consensus for reaching beyond campus boundaries to develop near-campus or very-far-from-campus ALNs, or both. Institutions will face two prominent obstacles. One is to make time available for faculty to rethink their lecture style -- to turn face-to-face courses into asynchronous ones. This may require the commitment of discretionary funds, since on-campus classes still need to be taught. The second is student recruitment. Explaining an ALN to off-campus learners is often a challenge. The standard expressions of "learn by computer, anytime, anyplace" lead to a perception that the requisite knowledge is in the computer, and the learner's task is to somehow coax it out -- a self-study mode. Attention to effective student recruitment will be a necessity for ensuring reasonably large class sizes and economic viability. Recruiting is only the beginning. Sustaining a significant activity built around ALNs will also require robust and responsive student services. All this requires attention to detail and new budget priorities at the institutional level.

Within institutions participating in Sloan Foundation projects, we see evidence of meaningful institutional commitment. To be more specific, we can assess the degree of institutional commitment by noting answers to four questions: (1) Are more than a few faculty involved? (2) Is the institution contributing a significant amount of its own resources to the ALN effort? (3) Does the institution have a strategic vision for a complete suite of student services, and (4) Does the institution have a strategic vision for making ALN a core, financially viable activity?

Most of the colleges and universities with near-campus and very-far-from-campus ALNs, whose ALN experiences were discussed in the previous sections, score very well in terms of these criteria. Their ALN programs will grow over the coming years; a few could grow to large-scale implementations. In summary, we see that a committed, core ALN group is in place and a start has been made towards the goal of making anytime, anyplace learning available to motivated individuals.

Making quality education available to off-campus learners through ALNs is a primary goal, but other possible outcomes arising from asynchronicity, efficiency and distributed cohorts were also highlighted earlier. We can be quite confident that these outcomes will be explored and exploited by the activities of institutions committed to off-campus education, but serious exploration in the on-campus environment is at a very low level. This might seem surprising, since, as noted earlier, most major institutions have wired campuses with high-speed Internet connections carrying a large amount of traffic. However, exploration of new productivity outcomes, is largely absent, partly because there appears to be little motivation to explore outcomes which could impact costs through larger class sizes, improved student retention, and self-pacing, while at the same time improving learning quality.

More exploration in on-campus environments is necessary so we can gain new insights about proper balance between ALNs, lectures, recitations, laboratories and other on-campus process. Universities such as Illinois, Michigan State, Virginia Polytechnic and Brown, are already exploring these issues, but are still at an early stage. Explorations at many other institutions are also needed. Even the small number of on-campus explorations presently under way are yielding important information about new outcomes and validation of some of the early indicators is likely over the next few years.

V. CONCLUSION

Asynchronous Learning Networks are a relatively new kind of entry into the milieu of technical possibilities that make up the area broadly known as "distance education." They combine elements of self-study techniques and asynchronous interactivity, which along with synchronous interactive television, are the building blocks for most distance education implementations. The appeal of ALNs lies in their ability to enable anytime, anyplace education with high human interactivity for geographically distributed cohorts--and these characteristics could make ALNs the largest contributor to distance education.

Although ALNs do not depend on courseware of any kind, available courseware or commercial application software can be used effectively. We have seen where specialized, faculty-developed learning software played an important role in the Cornell and Illinois examples. However, NJIT, NVCC and Drexel, among others, use only commercial software. ALNs do require asynchronous communication software, which can range from e-mail to bulletin boards to sophisticated groupware, and other asynchronous communications methods such as voice response units, all available as standard commercial products. ALNs need large-scale implementations, and current work is creating an experience base for future large-scale activities. Any substantial teaching experience thus far has been with commercial bulletin board and groupware packages, delivered on the Internet or on private networks. Future implementations will mainly be Internet Web-based. While near-campus and very-far-from-campus ALNs are likely to be important in distance education, the attributes of asynchronicity, increased efficiency and distributed cohort groups open up new options for on-campus education as well. These options, now being investigated at a number of institutions, aim to discover new balance points between traditional on-campus processes and ALN-style learning with a view to improving learning quality and reducing costs.

A number of mainstream institutions are offering degree and certification programs through ALNs. More are preparing to follow. There is evidence of serious institutional commitment to sustain and grow these programs, and we will see large-scale implementations within the next few years. Asynchronous Learning Networks will be an important element of the options offered by many mainstream institutions, best known today for their campus programs.

VI. STUDENT ACADEMIC ACTIVITIES

TRADITIONAL, ON-CAMPUS	ALN ANALOG
Attendance at lectures	Books (on-line or hard copy), Web postings, videotape, Groupware (Text and image or video-on-demand).
Recitation sections	Groupware, Interaction on Web.
Interaction with peers	Groupware, Web, List serve, e-mail.
Self-study, library	Books and Articles (on-line or hard-copy), Web resources
Lab work	Computer simulation, lab kits, remote control of instruments.
Interaction with tutors and TA's	Groupware, Web, List serve, e-mail.
Interaction with faculty	Groupware, Web, List serve, e-mail.
Attendance at seminars and colloquia	Videotape, video-on-demand (over ISDN and groupware or Web).
Enquiries: academic & administrative issues	E-mail, Voice-response Systems
Exams	Timed examinations and submission over computer network or proctored exam at remote site.

Table 1: Typical learning-related activities for a student at a traditional institute of higher learning (left-hand side), and examples of asynchronous analogs (right hand side).

ON-CAMPUS	NEAR CAMPUS	VERY FAR FROM CAMPUS
	Augusta Technical College	
Brown University	Chattanooga State Tech	New York University (1) (2)
Cornell University	Drexel University (1) (2)	Pennsylvania State University (1)
Drexel University	Ferris State University	Pace University (1)
Michigan State University	Lesley College	University of California-Berkeley (1) (2)
University of California (Irvine)	Metropolitan State University (1)	University of Hawaii
University of Illinois (2)	Gadsden State Community College	Stanford University
Virginia Polytechnic & State University (2)	Miami-Dade Community College	University of Maryland (1)
	New Hampshire Tech. College	University Of Minnesota
	New Jersey Institute of Technology (1) (2)	
	Northern Virginia Community College	
	Rio Salado Community College (1)	
	State University of New York	
	Trident Technical College	
	University of Wisconsin-Stout	
	Vanderbilt University	
	Villa Julie College	
	Westchester Community College	
	Western Governors University (1) (2)	
	Wytheville Community College	

Table 2: Institutions participating in Sloan ALN Program

(1) Degrees, Degree completions or Certifications offered or planned.
(2) Potential for large (i.e., more than 1000 enrollees per year) though present numbers are substantially smaller in most cases.

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