Networks & Learning Environments:
Responding to Growing Demands

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ABSTRACT

The nature and roles of campus networks are changing as its usage spreads across the campus, around the world and into an ever-increasing number of offices, dorm rooms, labs and classrooms. Technologically, it is evolving to include new forms of data like voice, image and video, as well as new technologies like FDDI and ATM.

In turn, these vast changes in network infrastructure will pave the way for introducing entirely new forms of management and learning as well as for increasing the effectiveness of the existing models.

How are institutions responding to what has become a seemingly never-ending demand for network access? Based upon the results of five annual surveys of higher education institutions, this paper will provide a trendline analysis of change -- between 1991 and 1995 -- and will focus on the areas of networks, network-based services, distance learning and other forms of technology-based learning environments. All analyses will compare the results for the entire higher education community in contrast to the major Carnegie classes.
Introduction
This paper will examine the changing roles and nature of campus networks as its usage spreads across the campus, around the world and into an ever-increasing number of offices, dorm rooms, labs and classrooms.

The data for this paper are derived from our survey of Higher Education conducted during the spring of 1995, combined with data from four previous surveys conducted annually from 1991 through 1994. The text is further augmented by personal knowledge as well as by comments obtained from interviewing many leading Higher Education trendsetters. We begin by understanding the operational framework, within which the “21st Century Academy” will function.

The 21st Century Academy...
The following model is not intended to imply that we are entering an era in which all institutions will look alike. In fact, it is much more likely that we will enter the 21st century with not one model, but rather many. Further, we should expect a much higher level of differentiation among institutions, as they struggle to operate along the continuum of their core competencies in order to compete in an increasingly competitive market environment. If not now, then in the near future, most institutions will plan and optimize -- to varying degrees -- along the following operational priorities: Ubiquitous Access; World-Wide Reach; On-Line Transactions; Time & Place Independence; Life-Long Learning; Technology-Mediation and Network-Based Operation. Will all institutions be fully engaged across these parameters by the turn of the century? Not likely! Clearly, not all institutions will offer courses on a World-Wide basis, but many students and faculty are likely to extend their research and collaborative undertakings to places outside the United States. Likewise, not all will offer corporate training or complete degree programs through distance learning, but some community colleges will offer English as a second language and skill certification on machine tools and CAD/CAM software. From the President’s desk, to the janitor’s closet, these operational priorities will drive performance and decisions for all stakeholders!

What role will technology play in all of this? Technology provides a base platform -- an infrastructure -- upon which higher education can re-frame itself in terms of both management
practices and the delivery of instruction and research. And there is no technological element more important than the network...

**Networks: The Enabling Infrastructure**

Access to networked-based resources is rapidly becoming the major enabler of the academic mission. Available networking technology is creating an unprecedented facility for sharing and collaboration among educators as well as presenting new expectations for services to students. How are institutions responding to what has become a seemingly endless demand for network access?

The first step in response to the networking challenge is, of course, to implement a campus backbone. Let’s begin our look at campus networks by considering the change, since 1993, in the penetration of campus-wide networks. Overall, the percentage of institutions with a campus network increased slightly from 73% in 1993 to 75% in 1994 and finally to 83% in 1995.

Penetration of campus networks is now quite high, with 83% overall and 100% for universities. But the mere presence of a campus network is just the first step. The next issue concerns the types of buildings -- and therefore functions -- which are connected to the campus backbone. By looking into the types of buildings that are connected, we can understand how fast backbone connectivity is growing in key areas.
We have been measuring backbone connectivity by space category since 1991 and have found that the connectivity of all space categories has grown significantly. The following chart details connectivity growth between 1994 and 1995 in all space categories as follows: Classrooms grew from 29% to 33%; Dorm Rooms from 50% to 62%; Labs from 54% to 59%; Faculty/staff offices from 61% to 71%; Dorm Buildings from 65% to 76% and Libraries from 75% to 86%.

What’s Driving Bandwidth Demand?
Bandwidth and money... who among us will admit to having enough? Campus-wide applications, like CWIS (Campus-Wide Information Services), e-mail, library access, client/server, and Internet applications -- along with increasing volumes of users -- each and all contribute to an ever-increasing demand for more bandwidth.

High bandwidth consuming applications such as multimedia will, by their nature, increase the demand for bandwidth, but the volume expectations of lower applications like e-mail also factor strongly into institutions’ bandwidth requirements. In 1994, Multimedia topped the list, with 68% of all institutions responding. Further, the responses across the major Carnegie classes do not differ dramatically and range from a low of 21% in comprehensives to 29% in universities. In 1995, we decided to divide Multimedia into its two major components of full-motion video and sound. The results indicate that full-motion video placed in the top three applications, while sound is near the bottom of the list, with only 30% of institutions responding. What’s driving
demand for full-motion video? We can only speculate that it is likely driven by the increasing demand for network based instructional and research resources.

That client-server is at the top of the list is not a surprise. It is surprising, however, to find that so many institutions indicated e-mail as a major driver. E-mail was supposed to be a trick question. E-mail, by itself, is not a bandwidth hog, but an exponential increase in the number of e-mail users changes the equation. With just under half of all institutions responding to the e-mail category, we might infer that all institutions are gearing up for essentially ubiquitous access to e-mail. It appears that even the musicologists don’t want to be Luddites!

Demand for bandwidth is an ever-present concern that comes with the territory of networking in higher education institutions today. Given the vast increases in “connected” campuses, along with the demand for high bandwidth applications, such as multimedia and imaging, we would expect to find many institutions planning to increase their network bandwidth... and we did. Overall, 68% are either currently -- or planning to -- increase bandwidth. We have estimated that more than 2,000 institutions are bandwidth shopping.

For those institutions planning to add bandwidth, which technologies are they planning to add?

Fast Ethernet tops the list, with 68% overall -- up from 53% in 1994 -- and its demand is strongest in 2-year (75%) and specialized institutions, with 80% responding. FDDI is next, with 44% responding overall and up from 38% in 1994. It appears to be favored among comprehensive (43%) and specialized institutions (60%). ATM, with 32% -- down from 40% in 1994 -- continues to be favored by the largest institutions, with 59% of those with over 10K enrollment, responding.

The Net
The Internet... the much-touted solution to all problems, large and small... offers an enormous array of opportunities. Which Internet applications enjoy the highest use in higher education? We asked respondents to rate their institution’s usage on a low-to-high scale of 1-5. The following chart describes the proportion of “high” and “highest” responses. For two years in a row, we found e-mail and its companion, file transfer, as the two highest-rated applications. In fact, for all applications -- except bulletin boards -- usage increased. Further, as we looked across the Carnegie classes, we found that Universities had the highest rate of usage, while 2-year schools had the lowest usage, across almost all applications.

... But all Internet access is not created -- or implemented -- equally! And given the 62% “dial-in” response to the question of what level of Internet access is provided, we can assume that “some number” of users -- across all Carnegie classes -- are accessing the Internet, at least some of the time, through dial-in. This results either because it is their only option or because it is the only option which is time and place independent. For example, most students and faculty may have network access to the Internet when in their office or in specific on-site labs, but may be relegated to dial-in when in their dorm rooms or homes. LAN port to the Internet, with 63% responding, was the most frequently mentioned form of Internet access. In general, the frequency of this response was positively correlated with enrollment. As an example, over 80% of all respondents with over 10K students responded. In contrast, only 42% of those institutions with fewer than 1,000 students mentioned this form of access. Dedicated asynchronous access was mentioned by only 30%. The universities and comprehensives lead with somewhat over 42% responding, while only 17% of the liberal arts colleges responded.
So much for the present networking situation. What is the prognosis for the future? From the perspective of campus network users, there is both good and bad news. The good news is that network investments needed to enhance basic infrastructure and to increase bandwidth are likely to continue. The bad news is that demand will continue to outstrip supply as more users “login” and demand more access... to send and receive more data, in more forms, to more locations, across the campus and around the world. The future looks like a continuing game of “catch up!”

And, networks aren’t the only “catch-up” game being played in higher education. Our data suggest that technology integration into the curriculum is on an upward curve. The following section provides a view into what higher education institutions are doing today.

Technology-Mediated Learning: Are We There Yet?

There are many who believe that education across all dimensions will be transformed as the boundaries become more porous -- or even disappear -- between home and school, education and entertainment, K-12 and higher education and formal education and life-long learning, thereby enabling education to become more time and place independent.

Perhaps the first formal step on the pathway to time and place independence is that of technology-mediated learning -- either distance or on-site. Technology-mediated learning means different things to individual institutions and to the individuals within them, and it encompasses many levels of the educational spectrum. In this section, we’ll take a broad look at how technology-mediated learning is used in higher education today.

Distance Learning Involvement

To understand the current -- and planned -- state of distance learning activity in higher education, we begin by asking: How many institutions are either currently or planning to engage in distance learning?
Looking at the overall level of distance learning activity, we found that 45% -- up from 30% in 1994 -- of higher education institutions are currently engaged in some form of distance learning; 34% are planning (up from 28% in 1994) and only 21% -- down from 42% in 1994 -- have no plans. And there are further discernible patterns across the Carnegie classes. Combining the responses for “currently” and “planning,” we find that 79% of all institutions are affected. Not surprisingly, there are marked differences across the Carnegie classes. The comparable responses for all other institutions are: Universities -- 96%; Comprehensives -- 92%; Liberal Arts -- 47%; 2-Year -- 85% and Specialized, with 80% responding.

The commitment to engage in distance learning represents just one dimension of the overall picture of distance learning in higher education. A second key dimension is to understand what proportion of the total student enrollment is affected. As we might have expected, the percentage of students affected ranged widely from a high of 60% down to a low of only 1%. Overall, the mean percentage of affected enrollment was 11%.

**Distance Learning Spending**

Another key element in understanding the magnitude and nature of distance learning involvement is the scale and allocation of funding for this activity. Distance learning funding is not always treated as a separate budget area, but instead, buried within many individual budgets, and, therefore it is difficult to accurately project the total spending in this area. We have estimated spending at $1.2 billion dollars...but it is likely to be understated. Perhaps more important than the total amount, is how distance learning spending will be apportioned. Understanding this split tells us much more than how expenses are apportioned. It provides clues into the nature of the distance learning activities to be offered.
We tested for allocations in six main expenditure categories: communications; computing; production facilities; production personnel; promotional materials; and course development. Finding that 32% will be devoted to communications, or even that 18% will be spent on computing is not surprising. It is enlightening, however, to discover that 42% will be spent on production personnel and facilities and course development. Each of these three areas contributes to the development and production of specific distance learning programming. The ratios do change, however, across the Carnegie classes, and range from a high of 54% in universities to a low of 36% in liberal arts.

How Is Distance Learning Used?

It is particularly interesting to ask what proportion of respondents indicated that distance learning was used in the "real business" of higher education -- that is, to award undergraduate and graduate credits toward degree credentials. We found the following use patterns by institutions that have distance learning programs: 72% grant undergraduate credits (2-year schools lead); 34% grant graduate credits (universities and comprehensives lead); 25% grant undergraduate degrees; and 15% grant graduate degrees (universities lead).

These data present only a baseline understanding of where we stand today. Perhaps the more intriguing issue may be to address the longer-term questions that are beginning to enter into discussions of distance learning: Will distance learning be used increasingly to offer complete undergraduate and graduate degree programs, and if so, will this new medium enable more aggressive and previously unused competitive tactics in the pursuit of new students? Will this result in chaos and unfair competition among educational institutions, or will we perhaps see
educational resources distributed in a manner which better meets the needs of all Americans? Who will win, and who will lose? Stay tuned...

So, Are We There Yet?

The prognosis for the future is rosy, but many would argue that the present, when looking across the entire higher education landscape, is quite bleak and that it will take years -- perhaps decades -- before most institutions will be able to implement new learning models -- either on-site or distance -- across the curriculum.

What are institutions doing today? How is technology used in courses? The following chart describes the mean proportion of course sections using various forms of technology. We might have expected that 51% -- up from 42% in 1994 -- of all lab sections would use some form(s) of technology, but were pleasantly surprised to find that technology was involved in the mainstream instructional activities of approximately 20 percent or more of all course sections for the following uses: in the classroom; on-line materials; on-line testing; instructor presentation, as well as course administration. Further, it was very encouraging to be able to account for a 16-17% presence of emerging activities like on-line testing and on-line access to multimedia materials.

While the data and analyses may not reflect a realization of utopia, it does appear that technology integration is on an upward curve. What are the impediments to faster progress? Certainly, there are legitimate concerns with regard to funding, technological maturity, the cost-benefit analysis of these new learning models, as well as the propensity of higher education to resist change. These are not insignificant challenges. With luck, these challenges will be offset by the vision and leadership of many who believe that funding can be found and solutions can be implemented if institutions -- and their leaders -- are willing to focus more on institutional effectiveness and less on the status quo!