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ABSTRACT

This essay addresses the fundamental changes in higher education that make existing models of information technology support inappropriate and insufficient, and it suggests how new models might evolve. The paper discusses three primary issues that define the current crisis: overwhelming demands on the central information technology organization; deteriorating quality of support; and scapegoating of central information technology organizations. It then presents a new, holistic support model with four core characteristics: a "whole-product" focus; a strategic economic model; a focus on customer needs; and a reliable baseline information infrastructure. The paper then suggests various measures for addressing the crisis, such as educating campus constituencies, engaging users in decision making, basing development of an information economy upon a model of federalism, creating effective distributed support models, and mentoring and recruiting new staff. The paper concludes with a brief look at the past and a look to the future. Two tables and a figure summarize some of the ideas presented. (CH)

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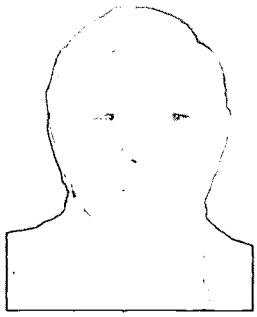

John W. Smith (smith@virginia.edu), Technology Planning Associate at the University of Virginia since 1993, is a true information technology eclectic. Eager to embrace new technologies and study their impact on human culture, Smith writes extensively on technology planning, the ethics of technology, and technology futures (http://poe.acc.virginia.edu/~jws3g). He has served in academic departments and computing support, and managed entrepreneurial start-up projects. Smith's technology career began at Indiana University in the late 1960s, where he helped transition the medical sciences research and instructional environments from kymograph and inductorium to computer-based data acquisition and analysis. He served as the first manager of the Small Computer Support Group and in later positions helped shape the institution's vision of computing as Technical Advisor to the Dean for Academic Computing. He then served as Facilities Director of the computer science department, where he led the department's transition from a time-shared UNIX environment to the far more flexible distributed environment.

Toby D. Sitko (sitko@uh.edu) is Director of Information Technology Customer Services at the University of Houston. To manage demand for broader, deeper, and ever more specialized IT services, she and her colleagues are defining a new IT support structure at UH. Major initiatives include developing an integrated IT Support Center to handle centralized computing, telecommunications, and media support services. Projects also include building a full-service Faculty Technologies Lab to support multimedia development and establishing a distributed support program for IT. As the University makes major investments in the network and workstation infrastructure and in "smart" electronic classrooms, the Customer Services staff is quickly adapting to support them. Sitko's work and collaboration with Polley A. McClure and John W. Smith began during her twelve-year tenure at Indiana University in the 1980s and early 1990s. There she served in various leadership roles and helped guide the integration of the academic and administrative computing centers into a single technology unit. In this new environment, User Services aggressively focused its support effort on providing online tools that enable users to be more self-sufficient.

Introduction

From the day the first computer was installed in an institution of higher learning, technology managers have dealt with increasing demand for services. Continuous growth of 20 or 30 percent per year in various measures, from CPU cycles to help desk calls, were common. The campus periodically entered a crisis state when specific capabilities became saturated. The typical response to the crisis was to present the obvious inadequacies to the institution and ask for additional resources. As soon as enough capacity to last for a few years was added, the cycle began again.

Today we perceive a sense of crisis in information technology support, but it has a different twist. Our conversations with colleagues describe the problems as more expansive, and the old solutions are not working very well. We cannot fix the insufficiencies by buying the next generation computer or by hiring five more people. In virtually every service we provide, demand seems to be growing far beyond our capacity to supply. Yohe sounded the alarm, identifying many factors contributing to the crisis and suggesting some useful immediate steps to lessen their impact.[1]

We think the current crisis is not just a result of increasing numbers. Fundamental changes taking place in higher education make old models of information technology support inappropriate and insufficient. In this paper we describe the current problems and suggest some ways in which they are different from those we faced in the past. We propose some elements of a new support model and suggest how we might evolve to it from our current environment. Finally, we present a brief evolutionary history of information technology support in higher education to put the current situation in historical context and summarize appropriate directions for the future.

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[1] Michael Yohe, "Information Technology Support Services: Crisis or Opportunity?" *CAUSE/EFFECT*, Fall 1996, 6-13.

The Crisis Triad and How We Got Here

For years we have struggled with the need for increased quantity and quality of services and support. What tips the scales now is the degree to which our underlying assumptions are inadequate. Three primary issues characterize the current crisis:

- Demands on central information technology (IT) organizations are overwhelming
- Support quality is deteriorating
- Central IT organizations are becoming the scapegoat

To create a solution, we must understand the mechanisms behind each of these issues.

Central organizations are overwhelmed by demand

Faculty and administrators on our campuses increasingly perceive information technology to be critical to their work, and they want central technology organizations to promptly meet their changing expectations. At the University of Virginia, for example, demand for dial-in lines has increased by more than 100 percent each of the last two years, as have calls to the help desk, network traffic, and requests for UNIX accounts for Web pages. Administrators are demanding electronic forms and information warehouses; we need to replace our legacy systems with modern client/server integrated applications. Faculty need support in introducing technology into their classes; they want properly designed and equipped classroom facilities in which to work. Record numbers of students bring computers to campus, and they want Ethernet cards installed and configured as soon as they arrive. When Internet performance decreased last spring, research faculty demanded improvements in this fundamental resource for their work. Budgets have not increased significantly for the past five years at the University, nor has the number of people to respond to these exploding needs. Many of these problems are common at other campuses, and they are beyond the ability of a single institution to resolve.

Non-linear, exponential growth is not a new phenomenon in information technology. The basic elements driving demand for services, however, provide insight into why today's demand growth curve is so precipitous.

More customers need more services

A decade ago, fewer than 20 percent of our faculty, staff, and students were active consumers of technology services and support. Today, almost all of them are, at least to some degree. Ten years ago, a handful of the campus population was interested in dial-in access. Today, a typical student package includes accounts for e-mail, dial-in, the World Wide Web, and networked file and print services. The educational potential of the Web alone has unleashed a firestorm of support demands, not to mention escalating printing costs in public labs.

Per capita demand for services has increased

Users used to work for months to generate a few tens of thousands of bytes of information. When they moved that information across the network, a few kilobits per second of bandwidth delivered adequate service. Today, a user with a scanner can generate hundreds of megabytes per hour. When a thousand people attempt to view those electronic images via the Web, even 100-Mbps networks are stressed. In forty hours of instruction per semester, we can light the spark that will make a student want to use information technology resources and services forty hours a week to write papers, run lab simulations, and interact with instructors.

New users are mainstream

The factor that has most dramatically escalated

the demand for support is the new breed of user. Two decades ago, our users were a hardy group, knowledgeable about and seriously interested in computing. They were tolerant of system idiosyncrasies and failures. Adequate support meant posting signs in the computer center with examples of the control cards users needed in order to run different kinds of jobs. We wrote documentation and they had the motivation and expertise to decipher it. Recent users of information technology are often not particularly interested in the technology itself, and they are willing to spend only minimal time and effort to learn to use it. How we support the last 20 percent of the population that we are bringing into the technology environment is very different from the way we supported the early adopters. New users want "complete products."[2]

Multivendor, distributed technology requires high-level support

The support burden derives from the increased complexity of desktop applications themselves, and, increasingly, from how those applications interconnect. A typical end-user application today might involve a desktop computer, a departmental network and server, the campus network, and a mainframe information source. The end-to-end information path involves multiple systems and several administrative units. New technologies, such as object linking and embedding, significantly increase the complexity and interdependencies among applications. Users are not satisfied with accessing and manipulating only numbers and text. They expect images, sounds, and full-motion video. Users also demand transparent interoperability between applications, regardless of the operating system or vendor. Two systems that work just fine by themselves can develop problems when interconnected. The number of potential problems increases multiplicatively as more and more heterogeneous components are added to the mix. Simply moving a linked file into a different subdirectory can break applications campuswide. Common user applications, such as library bibliography access, pass through technologies managed and controlled by different administrative units. Thus we must deal not only with technical interactivity, but also cultural and administrative diversity.

Funding models are inappropriate

Many of our institutions are still operating using library models of providing "free" computing resources. This model was probably appropriate when the computer was a fixed-cost mainframe and we were trying to promote use of the network. Now that the value of information technology is well established, many of us still have not shifted into other economic models that will help to better manage demand. Outmoded models cause significant problems, including making it difficult for users to match costs and benefits, promoting excessive consumption of resources, and contributing to the support crisis we are experiencing.

Support quality deteriorates

In the absence of a significant change in approach, the mismatch between demand and capacity produces a death spiral of decreased quality of service and support. Continuing the University of Virginia example, contention for dial-in lines is so fierce that individuals set up attack dialers and then camp on in an attempt to assure continued access. During the first month of the academic year, the call-waiting queue at the help desk is longer than the line at a Grateful Dead concert.

Information technology staff are frustrated because they cannot meet needs, despite the long hours they invest at work. Once viewed as heroes, these same people are now considered

[2] Geoffrey A. Moore, *Crossing the Chasm: Marketing and Selling High-Tech Products to Mainstream Customers* (New York: HarperBusiness, 1991).

incompetent because they cannot handle the flood of requests. In an attempt to serve, help desk staff implement automated solutions to providing help that irritate customers who want the personal touch. We do not have time to plan successful implementation and support of new technologies or to communicate with customers about changes. Instead, we rush new services out the door. Because they are not production-quality services, they further increase pressure on the help desk, and the spiral continues.

It is easy to understand that if demand is drastically increasing and support resources are not, both the quantity and quality of support will diminish. Given the difference between demand and supply on most campuses, perhaps the most amazing observation is that our support mechanisms have not entirely collapsed—perhaps because some users have developed their own support mechanisms.

Some say we are approaching crisis, when the data indicate that we should actually be in meltdown. In addition to the simple mismatch between supply and demand, qualitative changes in the technology environment of our institutions also contribute to the deteriorating level of support. Exploring the mechanisms and characteristics of technology support will provide a better understanding of the problem and will ultimately lead us to a possible solution.

Centrally provided primary customer support does not scale

Primary support consists of answering user questions directly with the customer. This contrasts with secondary or expert support in which a group of staff provides information resources, tools, deep expertise, and backup for those who provide the front-line, primary response.

Historically, when users were fewer and more homogeneous, the computer center provided most of the primary support, often employing expert consultants and programmers to do so. As the population of users has changed, this practice has become both ineffective and inefficient. It is ineffective because no single consultant can possibly know all the answers that the wide spectrum of users requires. The variety of user information needs spans such a broad range of technology services and computing applications that users, especially new users, often have difficulty communicating the critical elements of their environments in terms that experts can use to answer their questions. As we scale up the number of these questions, it also becomes inefficient to use highly skilled experts to provide primary consultation, such as "Have you turned on the power switch?" Instead we need people on the front lines who are trained in diagnosis, more like primary care physicians, rather than specialists. A single pool of staff will be less good at answering front-line questions for a heterogeneous population of thousands of users than the same number of staff who are divided among the users in smaller sets, with the opportunity to learn the capabilities and environments of their individual subsets of customers. Thus, we believe that the current centralized primary support model in many institutions is doomed to collapse.

One exception we see is centrally provided, subject-specific consulting and service centers, such as the Center for Mathematical and Statistical Consulting at Indiana University, the Academic Computing-Health Sciences Center at the University of Virginia, and the High Performance Computing Center that is now getting started at the University of Houston. These centers provide primary and expert consulting and often system and network administration, and they seem to be very successful in meeting their users' needs. However, unlike general help desks or consulting pools, their domain is very focused in content and they serve a small subset of the entire range of users on campus. These centers seem to be the exceptions that prove our rule.

Assignment of support responsibility is ambiguous

As central resources fell behind in their ability to meet demand, users responded in two ways. Those who assumed it was the responsibility of the central technology organization to provide all of the answers and help they required took the position that it was the IT organization's job to teach, rather than their responsibility to learn. Departments and individuals purchased hardware and software that did not meet their requirements and then expected central support to make it all work. In many cases, the IT organization has promoted these misperceptions by attempting to convince the institution that it had complete responsibility. Some distributed units, however, responded by developing their own support mechanisms that functioned quite independently of the central services. Many of these have not been able to keep up with the increasing complexity of technology or to interconnect their idiosyncratic environments with the rest of the campus and world. The central organization's response to these units has often been to simply ignore them, relinquishing the ability to influence users' decisions and learn from their experiences (both bad and good). In either case, both central technology staff and the users perceived the quality of support to be significantly diminished.

Distributed systems need special support

Problems with local area networks, desktop client applications, and remote access are sometimes impossible to troubleshoot from a distance. With no one else to turn to, the user resorts to central technology support providers. This no-win situation causes frustration for the customer and serious demoralization for the support staff who try valiantly to find solutions from afar. Unable to do so, they eventually make office calls or house calls. This wonderfully personalized service typically alienates other customers unless there are enough support providers to handle everyone's needs this way.

Every machine in the institution is different

In the early 1980s, microcomputers were limited in processing capability. Software was likewise very limited in functionality. Under these conditions, the choices we had to make significantly determined the degree to which our machine actually met our needs. No machine could solve all of our problems, so we chose the one that came closest and that we could put on our desk soonest. In addition, we funded our equipment through donations, grants, begging, and every one-time method we knew. Compounded over a decade or so, the result of these practices—especially at large research universities—is an assemblage of equipment, software, and configurations that is nearly insupportable at any reasonable cost.

Central units are merging

There has been a trend over the past five years to consolidate academic and administrative computing organizations and, in many cases, also telecommunications, media services, and libraries into a single organization. These mergers are probably the right thing to do, but they require redefinition of identity and responsibilities for staff and users and major reorientation—both technical and cultural. Precisely how this affects the effectiveness and efficiency of the support staff and the user's ability to get needed support is not clear, but it may contribute to a sense of frustration. On the other hand, there are synergies and new knowledge that result from these organizational changes that promise, at least eventually, to outweigh the transient problems.

Central IT organizations are the scapegoat

Faculty, administrators, and students have followed our lead by incorporating information technologies into their daily work. We provided extensive personal support to enable faculty pioneers to enhance instruction through

technology. Now they have demonstrated what they have been able to do, and they are not about to return to the industrial model of scholarly work. In most institutions, these customers have no idea of the impact of their consumption on the support organization; they mainly know that their own needs are no longer being met. Also, many have no idea of the cost of the services they want because we have set up economic systems that hide that information from them. Under the conditions we have created, it is likely that they will conclude that we are not doing our jobs.

Given the now inappropriate but historically based perception—reinforced at great cost by our central technology organizations—that we are the authorities on all aspects of information technology management, it should not surprise us that we are being given full responsibility for the current problems. In addition to this first-level effect, some other factors are contributing to what appears to be a rash of scapegoating of our central organizations.

Central organization/budget is a big, easy target

When problems occur, human beings seem to need to fix blame, even if, as in this case, the causes are diffuse. Over the past decade, the central IT organization has made itself very visible with its requests for huge levels of new funds and its promises of wonderful new solutions. Those funds, staff, and promises make IT organizations a natural target of criticism. Even the very most progressive such organizations in the most prestigious institutions are periodically subject to loud and angry calls for major change from the user community.

Computing has become truly distributed

Almost everyone today understands that, technically, the information environment is distributed. It is more difficult to grasp that the distribution extends to the authority over, and the responsibility for, that environment. The contemporary information environment is too complex and too interconnected for any individual or unit (departmental or central) to wholly conceive, manage, and maintain. It is not the job of the academic departments to do this. We cannot expect them to understand the complexities of the environment (that, after all, is our job), but we can expect them to hold us accountable if the environment does not work.

Technology and content are more integrated

New types of information products cannot be separated from their underlying technology framework. In the days of data processing, computers performed functions that were simply enhancements to manual operations. Not so today. For instance, a network-based hypermedia "textbook" does not exist if we remove the technology. The integration between form and content means that availability and performance of the technology is fundamental to the existence of the academic content. No wonder those who have spent their lives developing content are becoming less inclined to give complete control over the technology to the technology organization.

New users want authority, but lack expertise to make decisions

Users who have only experienced information systems through a Windows, Macintosh, or Web interface may be inclined to believe that "all it takes is a click" to achieve the power and magic they experience every day. These users do not understand the mechanisms underlying this magic and the complexity required to make it all happen. Technology staff work with tools that most staff, faculty, and administrators do not understand. Nonetheless, these users and administrators assume that they do, and that their decisions are as valid, or more so, than those of the technology professional with twenty years of experience.

Expectations exceed resources

Most information technology organizations in higher education experienced significant increases

in funding during the mid- to late-1980s, but not during the rapid growth phase of the past few years. We contributed to expanded expectations during the 1980s, anticipating that resources would continue to grow. We did not communicate about how technology dollars were being spent, so neither users nor administrators were able to anticipate the current crisis in technology support. The economic and political climate for higher education is very different in the mid-1990s, and we are not in a good position to respond.

User involvement in IT decisions is insufficient

One of the best ways to secure broad "ownership" of a decision is to have those affected involved in making the decision. For very understandable reasons, many of our institutions have been less inclusive than they might have been. In some cases, those outside our business were ill prepared to deal with the technical side of the decisions. In others, users were not interested. In still others, the administrative style of our institutions did not fully support collaborative decision-making. There may even have been a little jealous guarding of our own prerogatives. Whatever the reasons, we have missed many opportunities to educate our constituencies in ways that might have allowed them to be more constructive in their assessment of the current crisis.

Elements of an Ideal Technology Support Environment

How can our institutions respond to this crisis? We propose a new, holistic model of support that includes four core components:

- A "whole-product" focus
- A strategic economic model
- A support mechanism focused on customer needs
- A reliable baseline information infrastructure

Below are examples of how each component might be applied in a college or university. Naturally, the specific implementations will vary across institutions. Of utmost importance is that for the model to work, all four components must be addressed and implemented holistically as part of the redefinition of technology support.

A whole-product focus

The new "average" user

A primary result of ubiquitous information technology on our campuses is a change in the nature of the "average" user. Early adopters of information technology were interested in technology for its own sake and were willing to expend considerable effort to apply it to their academic work. These people still exist on campus, but today's mainstream users simply want to use technology to do meaningful work. For example, they are not fascinated with e-mail, but need it to communicate with colleagues; they think of word processing as a tool for writing papers and grants, not as something they want to spend hours learning to use.

Integrated service, not more technology

In our current support model, the response to increased demand is to supply more capability and capacity (cycles, bandwidth, sectors), offer some training on the use of specific technologies, and provide a source of answers to questions. It is left to the users to integrate these services. For instance, communicating requires more than word processing and e-mail. Users must compose a message, find the right e-mail address, transmit the message over the proper medium, and file the information away for later reference. In today's technology environment, these tasks can require four different applications. With the technology available on the desktops, networks, and servers of our institutions, we can do a much better job of providing fully integrated environments for basic information functions such as correspondence, classroom presentation, grant management, and so on. These are what we call "whole-product" environments.

Consistent and reliable whole-product environments

Early technology adopters were accustomed to inconsistencies. They knew that if the "quit" command did not close an application, "done," "bye," "exit," or "esc" likely would. Today's average users lack this knowledge and experience and are more likely to use the "reset" function of their computers than to try different solutions. If they lose their work by resetting, they may stop using the technology because "it doesn't work," or they will turn to support providers for help.

When technology merely supplements the way we do business, we can tolerate a lower level of reliability. If the computer display system fails at our conference presentation, we can generally use backup optical foils. If our presentation depends upon real-time Web access, however, the technology *must* work. We cannot tolerate problems with data format, projector resolution, noisy phone lines, or an off-line server. When customers find that they cannot depend upon the technology we have been promoting, they suspect us, our organization, and technology itself. We understand the complexity of the environment and may think our service is pretty good under the circumstances. Nonetheless, customers measure our success in terms of results, and if service is unreliable, we have failed to do our jobs.

A strategic economic model[3]

Problems with some current funding models

Many institutions have been willing to make huge investments in information technology, not because they saw the value in it, but because they were afraid not to. This has served us well in the past, since we have been able to respond rapidly to increasing demand for more, better, and different services and technologies. Now, however, customers have come to expect that capability and capacity are "free," and consumption is expanding at an increasing rate. Even when the supply shifted from central mainframes and minicomputers to peripheral personal computers, funding often remained central, i.e., the dean or provost rather than the individual departments supplied the dollars for departmental servers and for faculty workstations. This economic model is functional when 30 percent or 40 percent of the campus uses the technology and the total technology expenditures are proportionally small. It results in crisis when 90 percent or 100 percent of the population needs the technology and institutional expenditures become large and visible.

Although much of the capability and capacity has been provided centrally, the support for its use

[3] John L. Oberlin presents excellent discussions of economic systems in academic information technology in the following articles: "Departmental Budgeting for Information Technology: A Life-cyle Approach," *CAUSE/EFFECT*, Summer 1994, 22-31; "The Financial Mythology of Information Technology: The New Economics," *CAUSE/EFFECT*, Spring 1996, 21-29; and "The Financial Mythology of Information Technology: Developing a New Game Plan, *CAUSE/EFFECT*, Summer 1996, 10-17.

has not. New technology has brought information environments that people can use without having to learn FORTRAN or even DOS commands. It has not, however, delivered an environment in which printers can be fixed, or lost files can be found remotely. Campuses have thus evolved a hidden support economy—the secretary becomes the word-processing expert, the faculty member installs departmental machines, and the undergraduate student creates and maintains the department Web pages.

The true cost of computer support

One of the implications of this hidden economy is that nobody in the institution knows the true cost of computer support. Most support is delivered by people who do not have the word "computer" in their job descriptions. Departments see others making good use of technology. They want the same results, but they are unwilling to invest the same capital and effort. Significant institutional resources are being used inefficiently. The secretary has become an expert through trial and error. The faculty member takes half a day to install a machine that a technician could have running in an hour. The department's elegant and sophisticated Web site has to be discarded three months after the student graduates because nobody can understand its non-standard, idiosyncratic structure. We cannot effectively manage the technology on our campuses if we do not understand its costs.

Achieving a functional economic model

Three important actions are required to achieve a rational, strategic economic system. We must measure and fully understand the true costs and benefits of information technology so that we can make a rational argument for funding. Next we must more directly map the responsibility for costs to the location of the benefits. Finally, funding responsibilities must be assigned appropriately to the central technology organization, departments, and individual faculty.

✓ *Measure costs and benefits to the institution.* Benefits must be measured not in technology indicators, but in terms of institutional goals and priorities. The costs must be derived by looking at the whole institution, not just the technology organization. With an understanding of real costs and benefits, we can design a support structure that minimizes the former and maximizes the latter. With measures of costs and benefits, we can make a rational argument for funding. How many of our institutions provide computers for a department but no additional funding for maintenance, upgrades, and replacement? How much time is wasted because a faculty member has to spend a day appealing to the dean before she can get someone to look at her broken computer? How much extra time is spent at the help desk trying to support software that is three versions old because no one budgeted for upgrades? Any of these situations may be tolerable in isolation, but in aggregate, these inefficiencies are enormously expensive. By budgeting for the true operational costs of supporting information technology, we can greatly improve the quality and efficiency of support.

✓ *Map the responsibility for costs to the location of the benefits.* Since everyone in the institution is expected to correspond, access the library, or write papers, reports, or grants, the institution should create an information environment that handles these functions effectively and efficiently, with costs covered by general technology support funding. Where needs are more specific to departments, costs of meeting those needs should be born by the appropriate department(s). The Spanish department, for example, will benefit from using a Spanish language keyboard that displays accented characters and from having easy access to an online Spanish dictionary and thesaurus. The department should pay the primary costs of this level of functionality. If a faculty member in that department needs to manipulate Spanish text from 14th-century manuscripts, the costs for that specialized service should be the

responsibility of the faculty member.[4]

✓ *Designate appropriate funding responsibilities.* Ultimately, every faculty member requires a unique information environment. Of course no institution can afford to support unique environments for each individual. The old model of subsidizing "technology" must be replaced by one that subsidizes institutionally important functions. The department subsidizes the activities important to its success, and the individual does the same for his or her success.

Table 1 suggests some of the characteristics of services that might point us to centralized subsidy vs. fully distributed costs under our model. In general, if the beneficiary of a service is the common good rather than the individual consumer; if the service requires a large, one-time investment; if the service is seen as strategic by the institution and it is desirable to have it used widely; or if there is no capability for individual users to control their level of consumption, then central subsidy may make sense. Likewise, if a resource is abundant relative to demand, or is self-renewing, we may find it easier to subsidize than account for usage and impose charges.

Economics 101 tells us that there will be unlimited demand for "free" resources. Unlimited demand, however, does not imply unlimited supply. Administrators and customers need to be reminded of this and accept responsibility for defining their fundamental technology needs (benefits). We have the responsibility to help everyone, including ourselves, understand the real cost of information technology. Together, we can generate a rational economic system that directs resources most effectively toward the goals that truly make a difference for the institution.

Table 1

Attributes of services that might indicate central subsidy vs. distributed costs

Subsidize	Distribute
Benefit is common good	Benefit is local
Large, fixed cost	Variable cost
Strategic service	Established service
Encouraged consumption	Constrained consumption
No user control	User control
Plentiful supply	Limited supply
Renewable resource	Non-renewable resource

A support mechanism focused on customer needs

More complex support needs

Information technology requires a vast range of support. For faculty members to deliver successful lectures in technology classrooms, the network router must allow them to get to the servers on which their information is stored. They must understand the impact of compression upon the quality of their displayed images. The computer must come up in the right configuration when they turn it on, and they must be able to find the right Web pages for a particular class. There are many ways the lecture can fail, even when the technology works flawlessly. Our current information technology support model draws a bright line between the responsibilities of the technology organization and those of the user. Succinctly, the central IT organization delivers the means and the users implement them. We have met our responsibility by providing the technology classroom, offering classes in PowerPoint and word processing, and having a multimedia center where instructors can convert slides to images. Our traditional users have the ability and willingness to integrate these

[4] If use of the Spanish language keyboard is also important, for example, to Religious Studies, Art History, and the Institute for Central American Studies, these departments might collaborate with the central IT organization to target this specific functionality.

capabilities into the final product, the classroom lecture. Our new mainstream users, however, are not willing to invest a significant amount of time learning PowerPoint or how to digitize slides, and they are completely intolerant of classrooms that do not work as advertised.

The help desk next door

While mainstream users bring different support challenges to IT, the need for traditional support has not diminished. Someone must know how to use PowerPoint, someone must be able to reset the instructor's PC, and someone must be able to select the right compression ratio for the images. Our new model proposes a distributed support mechanism, with the nexus of support shifted from the central help desk to the department. This offers a number of advantages:

- Support is as close as possible to the user. Most of the questions are answered "next door."
- Department-based support providers—or on-site consultants (OCs)—understand the information issues of the discipline. They know how to configure a keyboard for Spanish characters and which electronic foreign language dictionary is the best. They know what is truly important to the discipline and what is fluff.
- OCs understand the personalities of their customers. They know who wants to be pointed to the manual and who needs to be shown. They know who is too shy to ask for help and who is facing a high-priority deadline.
- Departments can best weigh costs against benefits for their constituencies. If a completely customized desktop environment is essential to a department's success, it can reallocate existing personnel to provide for it. If it is not essential, the department can take advantage of the environment provided as part of the institutional infrastructure.
- Departments can decide when a particular technology should be introduced, and to what extent. If only one person wants a Web page, that can be dealt with one on one.[5] But if half the people want Web pages, it may be more efficient to provide a class.

Many institutions have tried the idea of departmental support personnel with varying results.[6] There are several critical success factors for this part of the model.

- OCs must understand the content and culture of the department. It is easier to teach a linguist about technology than to get a technologist to fully understand the academic issues in the Spanish department.
- We must train OCs how to support the appropriate technologies and how to access the resources and tools they will need to efficiently solve problems.
- The department must have a baseline information environment that is reliable and designed to require minimal support.
- OCs must have tools to make them more efficient and effective. Facing a non-functioning PC, they need diagnostic software to help determine whether the hardware is defective. To present a class on the construction of Web pages, they should have a course outline, handouts, and overheads prepared by professional instructional developers.
- We must be flexible when selecting OCs and determining their job descriptions. We might think that every department needs a master's-level computer scientist. In reality, some may be better served by a part-time graduate student.
- Departments must play by the economic rules of the new model. If their OCs spend all of their time holding the hands of a few faculty, the

[5] Faculty often need "just-in-time" learning. They can shift overnight from complete indifference to a technology such as the World Wide Web to "I need it NOW." Training delivered monthly or on a fixed schedule does not meet their needs.

[6] See, for example, Kelly McDonald and Brad Stone, "Distributed Computing with Centralized Support Works at Brigham Young," *CAUSE/EFFECT*, Winter 1992, 13-18; and Andrea Martin and Vicky Dean, "A Management Perspective on Distributed Support at Rice University," *CAUSE/EFFECT*, Winter 1996, 22-26.

department cannot expect the central IT organization to provide primary support for the rest of the faculty. If departments are only willing to allocate part of a secretary to technology support, they should not expect the same level of service as the department that converts a faculty line to a support position.

- The IT organization must play by the economic rules of the new model. Where it accepts the role of expert, it must be truly expert and deliver expert services.

Implications for central IT organizations

It is fairly obvious from the previous description that our model implies significant changes in the user's department. There are equally significant implications for the IT organization. There are four critical success factors—training, consulting, tools, and baseline environment—for which the central support organization should take the primary responsibility. These elements are all part of a dynamic continuum that must be managed.

When technologies are new, are poorly understood, or are used by only a few within the institution, a consulting service (answering the questions one at a time as they arise) is the only approach. But as the same question begins to be asked repeatedly because more are using the technology, we need to engage training rather than consulting. Likewise, when it becomes possible to provide "automatic" solutions (such as software installers), then we no longer have to take the user's time and mental space for training. And, finally, the same function should eventually be driven into the overall baseline environment and become transparent to the user.

✓ *Getting smarter about training.* The complexity of today's environment makes it virtually impossible to provide full training in even a single common application. WordPerfect 6.0, for example, has a reference manual of 804 pages and over 100 options that can be selected from its primary window. Mainstream users are unwilling to take time to learn all the functions, and they would not remember them even if they did. They do not know they need to understand mail-merge until they have to send out 200 rejection letters. When that need shows up, they want to know how to do it *now*. Classes given once a semester, or even once a month, will not satisfy their needs.

No central organization can afford to deliver this "just in time" instruction. The OC might decide that it is a priority need and attempt to satisfy it, but the time it takes to prepare a class may be prohibitive. Our model proposes a distributed solution to this challenge. Professional instructional developers in the central IT support organization can create a series of instructional modules, starting with an introductory overview and including segments covering special features such as mail-merge, desktop publishing, embedded documents, etc.

Central IT might use these materials to deliver classes at the beginning of the semester, where there is a large demand. OCs would be trained in the use of these materials and would pick the specific content needed by their department. The materials would be designed to allow the training to take place in the department's environment, rather than presenting the trainees with unfamiliar screens and functions. Trainers would be able to choose examples relevant to the department.

✓ *Tailoring consulting services.* The consulting function should be similarly distributed between the department and central resources. OCs should be the first contact for questions. If they need help in solving the problem, they have a direct line to the experts in the IT organization. If the OC is not available, the department might arrange for central support to provide temporary backup. If the same question keeps coming up, the OC can provide, or even impose, training in that area.

Departmental support is the primary source for training and consulting specific to a discipline. An OC assigned to the Spanish department can best develop the training materials for the use of the

Spanish keyboard and dictionaries. In our distributed model, however, the central support staff would be aware of the special capabilities of the department. If, for example, the Institute for South American Studies requested help in installing the Spanish keyboard, central support could refer the Institute to the Spanish department's OC. In this manner, the institution benefits from both the depth and breadth of training and consulting capabilities.

✓ *Developing technology tools for distributed support.* Both consulting and training needs are reduced when the information infrastructure is reliable and consistent. Tools should be developed to navigate this infrastructure efficiently. Even simple information tools can have a large impact on support requirements. For example, if a user can get to the library catalogue by clicking on an icon, many of the details of the communication software, campus network configuration, and library software structure become irrelevant.

The IT organization should take the lead in developing the information infrastructure. It will develop tools of general interest, but it will play a more important role by creating a tool development framework. This will make it possible for departments to develop tools for their unique needs with the levels of expertise they are likely to have. For example, a macro library could be created to make it easy for departmental personnel to extract information from institutional databases and present it in their preferred format.

✓ *Reallocating support responsibilities and staff.* This model implies a significant redistribution of support responsibilities and perhaps personnel. If departmental staff field the primary support questions, central IT staff will have the time to develop the more reliable and robust information environment, which will in turn reduce the number of technical problems the departmental staff must resolve. Departmental staff will be able to spend more of their time addressing problems unique to their discipline, thus directly improving the product of the department. The user departments will have to assume a significant portion of the responsibility for their information environments. The IT organization will have to shift its emphasis from primary customer support to secondary support.[7] These transitions may be difficult to achieve, but once in place, they will provide for a rational economic model and take best advantage of the strengths of constituencies.

A reliable baseline information infrastructure

We have identified one of the key characteristics of the current crisis as the ever-increasing disparity between supply and demand. We assume that in the near future, there will be no significant increase in support resources. The most important contribution we can make to reducing inefficiencies is to establish a highly reliable information infrastructure.

The infrastructure should be defined by user needs, be intuitive and consistent, and require minimal effort to learn and use. It must enable us to do simple things simply and do repetitive things efficiently. Most important, the infrastructure should be available when needed, be engineered not to break, be vigilantly monitored, be quickly repaired when things go wrong, and have minimal resource requirements. It should create a base for:

- the development of solutions for more complex problems
- the exploration of new applications
- the exploration of new technologies

We think that current technology is capable of providing a reliable baseline infrastructure to meet about 80 percent of the needs of 80 percent of the users. The software for this environment includes

[7] We do not think the IT organization will be able to get out of the primary support business completely. Some users, such as freshmen and independent study students, have no departmental affiliation. Their needs, however, can be met by very "generic" environments.

one of the office suites, a robust e-mail package, and a Web browser. The hardware for this environment must run the software with reasonable performance, provide a consistent user interface, and be readily available.

A tidy technology solution would allow a campus to support a single hardware platform and a single software suite. Such an environment would meet the 80 percent criteria, but it is arguably impractical and undesirable for most campuses to implement. From the perspective of what the user sees, however, the differences between Macintosh and Wintel machines have become relatively minor. Similarly, all major applications programs are converging on a similar graphic interface, a common set of functions and functionality, and good import/export capabilities. We can achieve our goals in ways acceptable to most users if we are careful and disciplined in how we design and configure our environments.

Most campuses have specified, or have at least tried to specify, a standard computer environment. These standards have lessened the support problem to a small degree, but they certainly have not solved it. The failure of these standards to resolve the support problems reflects a segmented approach to the support crisis. When developing and implementing a standard information infrastructure, we should consider the following critical success factors.

The infrastructure must be designed

Our current environments have evolved through a process that has yielded satisfactory results but is far too inefficient for the 1990s. An infrastructure design must start with an information architecture that describes the information needs, databases, and information processes common to the entire institution.

The architecture expresses the information and information processes that are most important to the institution in terms that we can translate into technology. It helps us maintain a holistic perspective, so that we do not over-solve some problems and overlook others. Even more important, it prevents us from investing too heavily in technology that is interesting but that has little relevance to real problems. The architecture also provides a set of guidelines for interconnecting environments that address the unique needs of departments and individuals to environments that address institution-wide concerns. For example, a researcher who can add 14th-century characters to a keyboard map and include a 14th-century dictionary in a word processor need not support a unique computing environment to conduct scholarly work.

Architecture designs guide our decisions about which technologies are needed and what they need to do. No longer is it sufficient to install a piece of software on the server and then fix the problems when the customers point them out, or to change the network configuration and reconnect people who were disconnected. To achieve the level of reliability expected of the contemporary environment, we must fix problems without breaking our systems. To do that, our systems must be well designed and monitored vigilantly.

IT staff must manage environments, not fight fires

Providing a reliable infrastructure that continues to meet institutional needs implies changes for our IT organizations. In the past, we rewarded our firefighters. It was okay to break something as long as you could fix it before anyone noticed. We rarely had the time to do things right, but we always seemed to find the time to do them again. Early users of information technology understood this culture and learned to deal with it. Today's mainstream user will not tolerate unreliability. Many IT support providers have the appropriate attitude and aptitude to find a problem and fix it once it occurs. But now we need staff who can understand a complex system well enough to ferret out its weak points and fix them *before* service is affected. Such highly knowledgeable staff will function as infrastructure

managers, responsible for fire*proofing* rather than fire*fighting*—a role shift that is key to success in the new information technology support model.

The infrastructure must be hierarchical

Rather than being flat, the information infrastructure must be hierarchical: an individual's environment is built on top of the departmental environment, which in turn lives atop the institutional environment. (See the diagram on page 16 for a graphic illustration of this model.) The department can create its own environment because it does not have to spend all of its time supporting the basic technology, and the individual faculty member, administrator, or researcher then builds upon both bases. The architecture and design of the infrastructure ensure that these layers interconnect effectively and efficiently. This part of the model also provides a way for the campus to deal with the rapid changes in the technology as well as the ever-increasing expectations of our customers.

It is our nature to explore new applications and push the envelope of technology. If these efforts occur in a common environment, they can be more easily made available to others in the institution. Thus we provide for a migration of new and useful applications from the individual, to the department, to the institution. The electronic versions of the 14th-century manuscripts become available to everyone in the Spanish department. The efforts of the Spanish department to develop Spanish word processing becomes part of the foreign language word processing module in the institutional infrastructure. The mechanism that allows the infrastructure to evolve quickly, and in harmony with user needs, is another critical success factor for the standard environment.

The new architecture must be implemented with support from users

Implementing the standard information infrastructure is somewhat of a chicken-and-egg problem. Customers are reluctant to give up idiosyncratic environments when they do not see the advantage of a standard infrastructure, and it is difficult to implement a new architecture if the customers are not clamoring for it. We think there may also be some reluctance on the part of the IT organization to fully commit to an environment that it does not solely define, develop, and manage. Standard environments, however, can actually deliver the true potential of information technology. A few examples include:

✓ *Return-to-service.* When a desktop computer or server breaks, the most urgent need is to return its functionality to the user. If an OC cannot fix the computer using diagnostic tools within 15 minutes, s/he should be able to replace it from a swap-out pool. With standard environments, a small investment in such a pool provides a great advantage.

✓ *Personnel turnover.* If all its administrative information is in a standard environment, a department will be relatively unaffected by personnel turnover. The new secretary will know how to get the letters out and send notices to all faculty, and the new chair will know where to find last year's annual report and cut and paste from it to generate this year's report.

✓ *Classroom presentation.* When classroom presentation technology is standardized, faculty are confident that they can teach in any classroom.

✓ *"Seat" capacity.* If incoming students are given a description of systems that will work in the college or university's information environment, they can make good purchasing decisions and have less need to use the seats in public computing facilities. This enables an institution to minimize its acquisition of machines that quickly become obsolete.

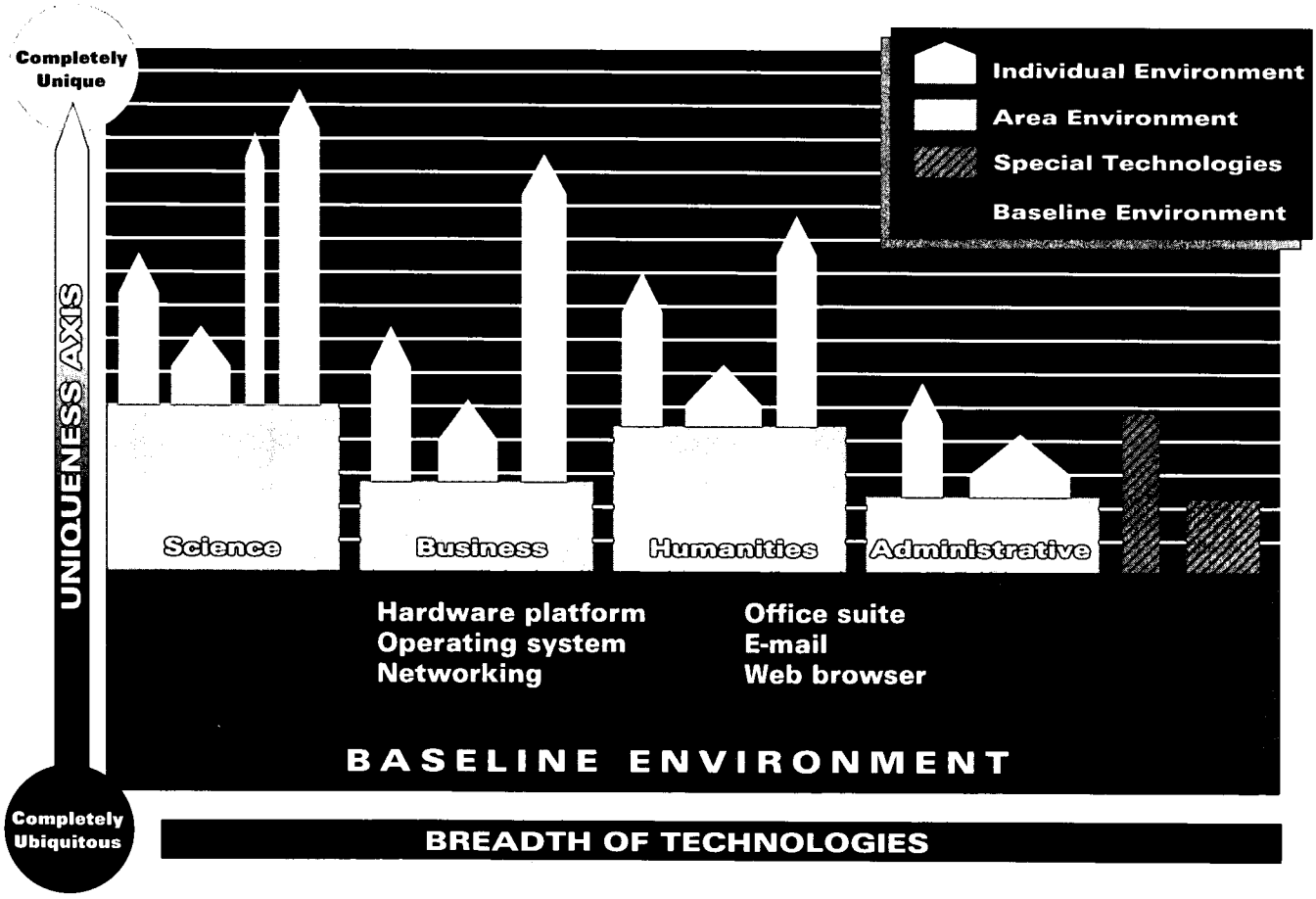
✓ *"Critical mass" support.* With a common environment, one is likely to get a question answered by the person in the next office, in the hall, or at the lunch table. Departmental and central support staff thus have more time to add reliable and robust features to the environment.

The diagram below illustrates the concept of hierarchical standard environments. The lowest level represents the institutional information technology infrastructure. The functional capabilities in this level are made available to everyone in the institution. This environment is designed and managed to be highly reliable, consistent, and easy to use. Since this is an institutional environment, the central IT support organization is responsible for its management.

The technology support group can also sponsor special technology environments (the cross-hatched areas in the diagram). This is where the new technologies are introduced, explored, and tested. The central support organizations might also want to provide assistance to some individual users in the customization of their environment. The selection of technologies and users is based upon the organization's best guess as to which technologies and applications will become mainstream in the future. For example, the central organization might support a special lab/project on real-time video, assuming that video conferencing will be important to the institution in a few years. It might also provide special support to a class that wants to use video conferencing. If this particular technology is both beneficial and supportable, it would be migrated into the baseline environment. Thus we have a mechanism to migrate new technologies into the institution while not burdening all of the users with experimentation.

The second level represents areas or departmental standard environments. The primary definition and management of these levels are the departments, although there might also be coalitions formed for some areas that are multidisciplinary. Ideally, these environments build upon, rather than replace, the institutional standard environment. The extent to which a department customizes its environment is a function of its need for unique capabilities and its ability to design and support the additional features.

The third level represents individual user technology environments. Many people will be content with the institutional or departmental environment, hence will require no special support. Others will need or want an environment tuned to their specific needs. They will be expected to pay the cost of the uniqueness.



We Can Get There From Here

We have no doubt that we can transcend this crisis in information technology support. The question is, are our IT organizations willing to do the work required? Here is some of what we must do.

Educate campus constituencies

This really is a process of helping our institutions collectively discover and learn how to manage information technologies. When we are in the trenches with the pushing and shoving and finger-pointing, it is not always easy to see the process in that light. As leaders we must search for and identify every opportunity to be educators and to make sure that the lesson of our experiences is as clear as it can be. If faculty and students complain that they cannot get their work done because the dial-in lines are always busy, we need to be sure they understand how many lines we have, how much each line costs per year, how their own behaviors contribute to the problem, and how a change in their behavior can help fix it. They now want continuous, Ethernet-like connections from their homes, which would ultimately require almost one incoming line per person. People are capable of learning and accepting new economic models and/or constraints on behavior if they understand the underlying issues and are involved in the processes of deciding on the regulations.

Engage users in decisions that affect them

If we have done our jobs in educating the institution, we ought to be able to use the collaborative process that our institutions know well to create the standards and rules necessary to support our functioning together as a community. Thomas Jefferson said:

> I know of no safe depository of the ultimate powers of society but the people themselves; and if we think them not enlightened enough to exercise their control with wholesome discretion, the remedy is not to take it from them, but to inform their discretion by education. *Letter to William C. Jarvis, 1820*

There may have been a time when computers were so mysterious to ordinary people that customers were willing to let the experts decide the important issues. Those days are gone. Our only option is to educate and collaborate.

Redefine roles toward a federal model

At many institutions, the central IT organizations and their users collude in perpetuating the view that the central organization is responsible for most technology, service, and support, even in the face of facts to the contrary. Departmental support mechanisms have developed in most institutions without a clear definition of how they articulate (or not) with the central support function. Under these conditions we often see many people doing the same jobs, stepping on toes in the process, while important jobs go undone. We suggest that an institutional dialog about these roles be undertaken with the goal of improved efficiency and effectiveness. All parties need to be a part of this dialog, with upper-level administration lending official status to the solution proposed.

It may be helpful to frame these discussions about changing roles in political and economic terms, as the development of an information economy based upon the model of federalism.[8] In

[8] Robert W. Zmud, Andrew C. Boynton, and Gerry C. Jacobs, "The Information Economy: A New Perspective for Effective Information Systems Management," *Data Base* 18 (1): 17-23.

this model, the central IT organization retains a role similar to the federal government, but encourages and supports a quasi-open market economy in information services. The central role in this model does not include providing all IT services and support or dictating to individuals or departments what they can or cannot do. It focuses instead on influencing the actions of distributed units through policies and standards necessary to the smooth functioning of the whole, operating some key functions critical to all (such as institutional data management), and providing a basic technical infrastructure that supports the departmental and individual applications. Beyond these "reserved powers," the federal model leaves great freedom for departments to exploit technology in ways that maximize their own effectiveness.

Create effective distributed support models

We must experiment with new organizational models to find ones that provide a sufficient level of decentralization without destroying the fabric upon which we can build an integrated environment. This will be easier to do in institutions that still have a relatively centralized structure. Some possible approaches include:

- Establishing a group within the central organization whose clients are departmental support personnel
- Creating discipline-focused, physically dispersed sub-centers, such as Dartmouth did with its Humanities Center and Science Center
- Establishing a free-standing central department to support and coordinate departmental support personnel
- Setting up expert information bases and online training materials for use by departmental support providers
- Providing incentives for departmental support providers to participate in the educational and integrative activities made available. Incentives might include such things as paying a salary supplement, providing equipment and/or software, or formal certification.
- Transferring staff from the central IT organization out to departments.

There are many possible approaches, but all involve significant changes to the current roles and self-image of our central IT staff and to the approach and mindsets of staff currently in distributed support activities.

Another challenge of setting up an effective distributed support system is ensuring the ownership by department managers of technology support responsibilities. Even if we have done a good job of educating constituencies at our institutions, some individuals at the departmental level may resist taking responsibility for managing their unit's IT environment, either because they think it is the job of central IT or because they lack resources to do so.

Mentor individual staff

Enlisting the enthusiastic participation of some traditional technologists on our campuses in the personal transformation required for the new support model can be a significant challenge. Our current organizations still have plenty of people who "grew up" with an earlier paradigm and really like how it was then. This reluctance to change applies to technical staff at both the central and departmental levels.

In addition to attitudes toward change, there are in many cases serious limitations to the skill sets of these support providers. Training can recast skill sets if the trainee is willing to learn and grow. Training is needed not only to develop new technical skills that are more appropriate to the distributed technologies of today, but also to develop communication and diplomacy skills and the systems-level viewpoint needed to be maximally effective in the future roles for our organizations. We continue to need the very best technical experts we can find, but that alone will

not guarantee success in the new context.

Reorientation of our central staff should occur along two lines. The most technical roles in the future should be oriented to designing for robustness and manageability. Less technical roles need to focus on designing institutional processes, structures, tools, and incentives to accomplish certain user behavioral outcomes. Both groups need good communication skills and diplomacy. The reorientation of departmental support people should include their new roles as partners with the central group, with the responsibility and authority that implies. We have found no formal training aimed at these transformations. This leaves personal mentoring—a very slow process.

Recruit and replace, if necessary

There are institutions for which the need to transform the information technology support function is so urgent that the process of motivating and mentoring referred to above cannot produce results in time. There are some individuals who just will not engage the new model. If the organization is growing and can add new skills and attitudes that way, change by addition is a possibility. If not, our only option may be to replace some existing staff with new people who are more adaptable. Sometimes it is only necessary to do this a few times. The savvy new staff can help with the accelerated mentoring process. Outsourcing the functions that have the highest priority for change is a variant of this strategy.

Seeing Our Future in an Evolutionary Context

The paradigm shift that we are currently navigating is, of course, not the first such change our institutions have experienced, nor, probably, will it be the last. The leap forward we need to make now is not unique to higher education or to information technology, but is related to a set of changes working their way through all organizations in our society as we pass from the Industrial into the Information Age. To understand where we need to go, it is helpful to put our current changes into historical perspective.

Where we have been

Table 2 provides such an historical perspective, describing our views of at least three phases in the evolution of information technology support within higher education institutions. We see these stages as developmental, requiring a passage through the Industrial Age, for example, before entering the Information Age. They are also cumulative in that an Information Age support structure contains the elements listed in the last column, in addition to those in the first two columns. For the Information Age, the focus of new development is on the institutional processes, but such organizations of course still rely on technology and customer focus as well. Passage through these stages seems to be partially independent of "calendar time," in that there are still organizations exhibiting many of the Iron Age attributes today at the same time that others are emerging into the Information Age.

In the Iron Age (or, perhaps better, the Age of Craftsmen), individual technology artifacts were created one at a time by individual, highly skilled

Table 2

The three ages of academic information technology support

	Iron Age	Industrial Age	Information Age
Focus	Technology	Individual customer	Institutional process
Approach	Explorer and missionary	Caretaker; respond to needs	Partner, anticipate needs, architect and manage environment
Product	Neat technology, crunched numbers	Excellent service	Superb environments
Modus operandi	Build fires	Put out fires	Prevent/manage fires
Personnel value	Technical expertise	Customer orientation	Whole-systems thinking
Scope	Individual	Institutional	Global
Organization	Centralized	Dispersed	Distributed, integrated

workers. Their products were uniquely and beautifully attuned to the specific requirements of an individual user. This era was typical of the mainframe, time-sharing style of computing. Information technology organizations were called computer centers, and users went to the center to do most of their work. The computer centers were usually the province of expert scientists and engineers and administrators. Their focus was technology and making it work. They were exploring new frontiers and proselytizing about the wonders they found. Their products were neat technologies, interesting in their own right, and masses of numbers manipulated in various ways. Staff in computer centers were often breaking systems as fast as they fixed them, but this was more or less tolerable because the users were hearty and forgiving. The single most prized attribute of staff was brilliance. The focus of computing was on individual users projects. All of this was well supported by one or two centralized organizations.

The focus of the Industrial Age changed with the arrival of personal computers and networks. Instead of a total focus on technology, we realized that we also should be thinking about customers. No longer was it sufficient to explore and bring home neat tools. We also needed to spend time taking care of groups of users and being responsive to the needs they identified. We became driven by customers and technologies, rather than technology alone. Excellent service, such as the help desk, was required in addition to neat technology and the results of number crunching programs. Our users expected us to be wizards at putting out fires and fixing the environment when

it broke. We still valued our technical experts, but new staff entered our organizations. They brought little technical knowledge, but they had a keen sense of service and responsiveness to customers and they were excellent communicators. Managers worked on structures and processes that spanned our institution. Because of the proliferation of personal computers, computer support organizations sprouted all over the place. (Remember the epidemic of VAXes and little centers to tend them?) Mostly this process was driven by whoever had the money to invest.

Where we are going

Today, many of us are teetering between the Industrial Age and the Information Age. In order to facilitate the transformations going on in our institutions, we need to get our organizations to focus on institutional processes, such as learning or managing a department. We will have to accomplish this by partnering with faculty or administrators—those with the content and functional expertise. Reacting to demonstrated needs is both insufficient and impossible. It is insufficient because the problems that surface are so seriously damaging that the best hope for resolving them is to prevent them in the first place. It is also impossible because the number of needs, taken singly, is completely beyond our ability to respond. This requires designing environments to be managed rather than fixed. Our products are whole, institutional environments that work in an integrated fashion. Many of the resources we "manage" are not under our control and may be located anywhere in the world. Our support organizations need to be distributed broadly, but they cannot be composed of anarchic fiefdoms.

The Information Age challenge is to conceive and manage a whole, complex system in which most of the human and technological parts do not "belong" to us. Doing so requires very different organizational models and personal skills. The greatest challenge in making this leap is to bring our Industrial Age mind sets forward, either by expanding the way individuals see themselves and their roles, or by instilling respect and tolerance for the roles and skills of others that are very different from our own. We doubt that any professions have experienced the dramatic transformation within the lifetime of individual workers that ours now faces. Given the massive change and progress of the last twenty years of information technology in education, we are confident that we, and our institutions, will rise to the challenge.

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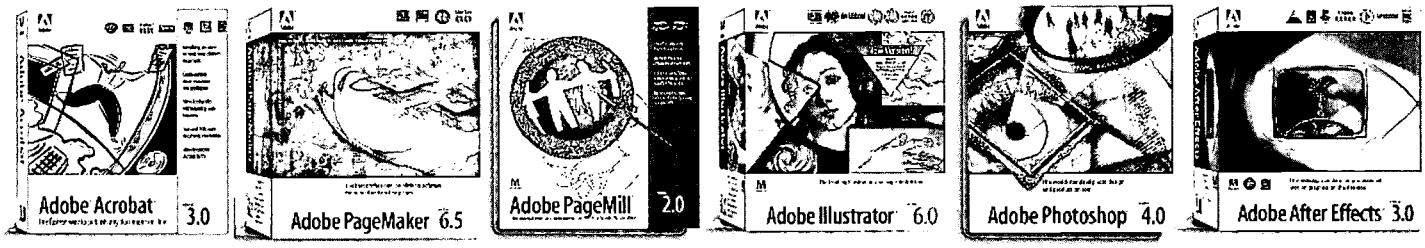

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