CAUSE/EFFECT

A practitioner’s journal about managing and using information resources on college and university campuses

Technology and Change: An Interview with John Gage

Transforming the University to Serve the Digital Age

Information Technology as a Transformation Agent

True Partnerships: The Key to Technology Infrastructure Challenges

University of Colorado Acquisition Card Project: A Successful Partnership of Program, Process, and Systems

Plus:

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I saw a promotion recently for *Great Expectations*, the modern-day film version of the Charles Dickens novel. The title brought to mind two of the topics spelled out by the CAUSE Current Issues Committee as being key “emerging or ongoing issues” in information technology and resources management.

As the article on page four makes clear, the consumers of higher education have and will continue to have “great expectations” when it comes to the various methods for acquiring knowledge. Under the headings of “Student Expectations for Technology Support and Services” and “Managing Expectations in the Face of Rising Demand and Declining Budgets” are outlines of the problems faced by information technology organizations today when it comes to delivering the goods.

It’s easy to understand why these issues should be of interest and concern to any faculty member and administrator in higher education. Students entering college today have a better knowledge of computers and technology than most of the educators they’ll meet. I watch as my nieces and nephews, none of whom are beyond their sophomore year in high school, trade e-mails with their friends, send files of words and images across the country, surf the Net, and entertain themselves with a variety of games and multimedia. They don’t think about the medium, and they are certainly not in awe of it. They don’t really care how it works; they just expect that it will.

Transfer this thinking to the campus and the same expectations exist. Students today are no longer impressed that they have a data port in their dorm room; they’re more likely to be appalled if they don’t. Having an e-mail account or their own Web site is also expected, as is teaching that incorporates multimedia and interactive learning.

With the demands to produce the type of interactive teaching and learning environment the students will expect, faculty too will have expectations. While their departments may finance the hardware and software, they’ll look to the information technology and resource personnel for guidance and support. With the addition of each computer comes the addition of at least one more person who needs to learn how to use it effectively, and who will expect it to work flawlessly on demand.

This puts tremendous pressure on IT personnel. As the number of computers and networks on campus continues to increase, so do the expectations of technology financing, support, and education. The driving force behind the recent vote to consolidate CAUSE and Educom was the realization of these expectations. It’s obvious that campus computing is no longer restricted to managing information for the registrar or bursar, or simply providing a network for electronic communications, but is deeply entrenched in all areas of higher education.

CAUSE is dedicated to gathering and disseminating information to help you cope with these expectations. Throughout the year we publish articles and papers, both in print and on the Web, that address the critical issues of the day. Take advantage of your membership and use the many resources available to help find solutions to your technology problems. The CAUSE Web ([http://www.cause.org/](http://www.cause.org/)), with its Information Resources Library, Constituent Groups, publications, corporate and institutional profiles, and such, is rich with information. Also, take advantage of the opportunity to network by participating in the many professional development opportunities CAUSE sponsors. National and regional conferences are a great way to share information with your peers, learn from the experts, and see firsthand the latest products and services.

To borrow from another Dickens novel, whether you view these as the best of times or the worst of times, they are the times. Let us know how we can help you meet the great expectations that confront you.

*James Roche, Editor*
The 1997-98 CNI Program

by Richard P. West

For the last few years, the Coalition for Networked Information has published a formal program of activities for the upcoming year. Clifford Lynch, the recently appointed executive director of CNI, has prepared the 1997-98 program under the direction of the CNI Steering Committee. Many of the themes of this year’s program are familiar. How to find information on today’s high-speed performance networks, how to handle commercial activities around the use of scholarly materials, and how new information technologies affect our institutions and our jobs in those organizations are all part of this year’s activities.

The three organizing themes for CNI’s 1997-98 activities are developing networked information content; transforming organizations, professionals, and individuals; and building technology, standards, and infrastructure. Within each of these areas are specific initiatives that help advance our knowledge and tools in networked information.

The content area has projects that develop new information resources on the Internet, but also concentrate on examining ways to improve finding information on the Net. This year, CNI continues its emphasis on the arts, the humanities, and cultural heritage. National Initiative for a Networked Cultural Heritage (NINCH) was founded jointly in 1996 by CNI, the Getty Information Institute, and the American Council of Learned Societies.

NINCH acts as a forum for bringing together scholars and technologists in universities with individuals from museums, historical societies, and state humanities councils to help develop new content, and CNI is also active in helping develop standards for the arts and museum areas through the Computer Interchange of Museum Information (CIMI). Initiatives in digital preservation and new ways of describing networked information are also being supported by CNI using metadata. Metadata describing information resources is recognized as an essential element in organizing content to ease its discovery and use.

(continued on page 20)
“How can we hire our own graduates before the outside industries hire them?”

Current Issues for Higher Education Information Resources Management

The CAUSE Current Issues Committee is responsible for proposing a list of current or developing issues and trends that are important to the future of information resources management and use in higher education. The following topics have been identified by the committee as key emerging or ongoing issues. We encourage articles for CAUSE/EFFECT on these and related topics.

Retaining, Retraining, and Recruiting Information Technology Staff

Our colleges and universities depend on effective use of information technology for instruction, research, and administration. With high demand for technology professionals, it is critical that we continue to recruit, retain, and retrain competent staff. Recruiting challenges include reduced numbers of graduates in computer-related fields, lack of competitive salaries in the higher education environment, and increasing market demand for information technology skills. The continuing explosion of technological change also forces existing staff to continually upgrade their technical skills. As the demand for information technology professionals continues to exceed the supply, our institutions will face even greater staffing challenges. Key issues we will need to discuss, if not resolve, in the next few years include these:

- How can we make our salaries more competitive with the industry? What non-salary benefits can we offer and promote?
- How can we promote our institution as a good place to work? What changes can we make to our environment, both physical facilities and culture, to make it more appealing to existing staff and recruits?
- What other tools can we use for recruitment and retention incentives?
- How can we improve our recruitment processes to enable us to respond more quickly to the changing market demands for information technology professionals?
- Are there better ways for titling/classifying staff? How can we restructure our compensation systems to be more skill- and performance-based?
- What staff development/training programs are needed to adequately keep existing staff abreast of technological change and develop their professional skills?
- How do we put together trainee programs that work? With whom should we partner?
- How can we hire our own graduates before the outside industries hire them?

Identification, Authentication, and Authorization: Policy and Technical Issues

College and university initiatives in enhanced networking connectivity and in advanced applications development are the basis for building new knowledge communities of researchers, faculty, and students. Application areas include digital libraries, distance-independent instruction and collaboration, access to remote scientific instruments, remote medical diagnosis, and others. For reasons of security, licensing, etc., people and resources will need unique identities that are properly authenticated and au-
Authorized for access. Since application users will connect with people and resources at both local and remote campuses, both campuswide infrastructures and inter-campus communication mechanisms will be necessary. Policy challenges include establishing where access control is determined in the environment (e.g., in the case of digital publications, by publishers or by the university). Technology challenges include identifying and deploying the appropriate solutions (e.g., private key and/or public key). Other issues include:

- Determining access rights (who gets access to what and who decides)
- Establishing standards across networks and multiple locations
- Assessing risk and liability
- Creating scalable solutions to support millions of users in the overall environment
- Defining interoperability guidelines
- Identifying providers for such services as inter-campus certificate authority
- Addressing international issues around encryption export
- Evaluating when firewalls should be used
- Identifying new roles (e.g., who’s responsible for maintaining network and data integrity)
- Evaluating the government’s role in setting policies, such as with encryption standards
- Dealing with ethical issues that occur, for example, around privacy

**Growing Complexity and Cost of Enterprise Systems**

For many institutions the approach of the Year 2000 has provided the impetus needed to replace legacy enterprise software systems with new, client/server-based, Year-2000 compliant systems. For this reason, growth has been phenomenal among the manufacturers and consulting firms that provide higher education with systems for human resources, financial records, and student information. Each of them has an unprecedented number of implementation projects under way at colleges and universities worldwide. This means that a bonanza of data is available on the cost, both predictable and hidden, of new system implementations. We can all benefit from open discussion of the many questions that are arising:

- Do we have enough data now to predict the costs of implementing specific systems?
- What strategies can we adopt to minimize licensing costs and the costs of data conversion and system implementation?
- How can we ensure that campus leadership will continue to back a project when faced (perhaps mid-way into the implementation) with the true financial and human costs?
- Which vendors are best able to carry an implementation through to completion on schedule? Which vendors will succumb to the consequences of too-rapid growth?
- What strategies permit the quickest implementations?
- What’s the right software decision: Best of breed or integrated? “Vanilla” implementation or tailored to the campus?
- How realistic is the idea of a vanilla system implementation—one that involves very little customization of the vendor’s system? Does such an implementation work at cross purposes to business process redesign (BPR) and the identification of best practices?
- How tightly should BPR and system implementation be linked? Can they be separated at all?
- Enterprise systems cover a lot of territory. How can an implementation be kept manageable? Is “scope creep” avoidable?
- How can we best meet the technology challenges (scaling, interoperability, security, database selection)?

**Student Expectations for Technology Support and Services**

Increasingly, new students come to our campuses prepared with a broad range of computing skills and viewing computing as...
a tool fundamental to their education. Many students consider on-campus and remote access to common computing resources such as e-mail, Internet, and popular software packages as a free commodity. Students have also begun to expect colleges and universities to provide more online services similar to those offered by other industries (such as banking and retail). Furthermore, the use of network and distance learning technologies are helping higher education create an anytime, anywhere, interactive, and collaborative learning environment. While these new technologies hold promises, we urgently need new planning and service models and funding strategies to support student expectations in these areas. Key issues we need to address in meeting these challenges include:

- What constitutes a base level of technology support and tools for students?
- How can we develop a process to define appropriate standards for student technology support and services?
- What roles should students play in developing and communicating such standards?
- What are appropriate organization models for meeting student technology needs?
- What new technology support should be considered for students served by distance learning technology?
- How do we address student training needs for new technology?
- How do we increase student use of existing technology resources?
- How do we communicate the costs and benefits associated with new online student services?
- What costing models should be considered for different types of services and support?
- What pricing strategies have been successfully employed by different types of colleges and universities?
- What criteria should we use to measure the return on investment for technology support to meet student expectations?

**Distributed Learning and Distance Education Challenges**

More higher education institutions are getting serious about reaching out beyond their walls and providing distributed learning or distance education opportunities. Traditional models of teaching — classroom-bound, faculty-centered, degree-focused, “brick-and-mortar” expansions — are losing ground as the sole option for educating the 21st century student. There are many factors fueling this redefinition of education as distributed learning. These include business demand for reskilling employees, growth of the non-traditional student market, remote interactive technologies, and new brokering arrangements such as the Western Governors University. Gartner Group estimates that by the year 2000, more than 75 percent of traditional colleges and universities will use distributed learning technologies in one or more traditional academic programs. Statistics from the U.S. Department of Education indicate that Americans twenty-five or older will account for five of every eleven college students. DOE numbers suggest that the number of students thirty-five or older will exceed those who are eighteen and nineteen. Gartner also claims that by 1999, an increasing number of general education and core requirements will be delivered to undergraduates via distance technologies. As information technology professionals, we will need to be a part of the discussions undertaken on our campuses to discuss, if not resolve, a number of issues in the immediate future:

- How will the institution sustain a network and desktop infrastructure to support a robust distributed model?
- What are the real costs of the new technology-based distributed learning environment, and how will it be financed?
- How will the institution deal with faculty issues such as training, rewards, resistance?
- What roles will change, i.e., who will do what in a distributed environment?
- What administrative policies will need to be revamped to handle such things as credit, fees, transfers, partnerships, degree source?
• What new operations issues will need to be supported, e.g., privacy and security?
• How will the support issues be addressed (technical support, help desk)?
• How will our institutions deal with competition from business entities?
• What implications are there for community and student life activities, e.g., recreation centers and fee-based campus services?
• Which courses are viable candidates for new modes of delivery?
• What are the implications for curriculum development and new learning models?
• How will outcomes be assessed?

**INTELLECTUAL PROPERTY ISSUES IN A NETWORKED ENVIRONMENT**

The digital revolution is dramatically changing the ways we create, store, and distribute information and has precipitated a re-examination of law and policies governing intellectual property. As both creators and consumers of information, institutions of higher education need to provide leadership in addressing the questions that concern intellectual property policy in the digital age. Can the current balance between proprietary rights and exceptions for educational and scholarly purposes be preserved in the digital environment? As beneficiaries of the free flow of information, universities and colleges need to be active advocates for keeping at least some types of instructional and scholarly information affordably accessible. Issues include:

- As more information is produced only in digital form, how will this material be preserved for future scholarly endeavors? Who will be charged with preserving our intellectual heritage of the digital age? How might changes in copyright law hinder access to and copying of information for preservation purposes?
- With the increasing digitization of instructional and scholarly information, what role will higher education play as producer and distributor of electronic information?
- If higher education institutions expand their roles as producers and distributors of information, will they expect more control of faculty-produced material? If so, will they be in direct conflict with faculty who expect to profit from their own intellectual property?
- With regard to developing course material electronically, what model of ownership should be followed? Should the traditional textbook model be used, or should different models of ownership, such as the patent model, be developed?
- Should universities and colleges be more actively involved in creating new, more competitive marketplaces for research information by providing new opportunities for electronic publishing? This is especially compelling in light of the industry trend toward consolidation of commercial publishing firms accompanied by rapidly escalating prices for both print and electronic publications.

**MANAGING EXPECTATIONS IN THE FACE OF RISING DEMAND AND DECLINING BUDGETS**

Most information technology organizations continue to be challenged by the rising support costs associated with the distributed computing environment. Early in the personal computer lifetime most information technology offices tried to encourage “early adopters” to use technology solutions in the classroom and administrative offices. In doing so we tended to give away the resource or at least didn’t charge a fee for services. The ubiquity of campus networks has changed the landscape radically. Computers are now being connected to campus networks at ever increasing rates. Most campus environments now include networks in residence halls which, for some, doubled the number of computers connected to the campus network. Customers expect central support units to support extremely complex desktop environments, based on the traditional “free” paradigm. Exacerbating this situation are:

- increased opportunities for campus cus-

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Identifiers and Their Role in Networked Information Applications

by Clifford Lynch

Identifiers are an enormously powerful tool for communication within and between communities. While it is easy to think of many identifiers—social security numbers, credit card numbers, bank account numbers and the like—that are ever more indispensable as commerce becomes increasingly computerized and networked, the focus of this article will be on identifiers for information objects rather than for components and artifacts of business processes. Information object identifiers are of particular significance because of the role that they play in structuring and managing our cultural heritage and intellectual discourse, because of their very public and general domains of use, and because of their potentially very long lifespans.

For example, the International Standard Book Number (ISBN) has played a central role in facilitating business communications between booksellers and publishers; it has also been important to libraries in identifying materials. The International Standard Serial Number (ISSN) plays a pivotal role in facilitating commerce among publishers, libraries, and serials jobbers; it is also vital to libraries in managing their own internal processes, such as serials check-in. Bibliographic utility identifier numbers such as the Online Computer Library Center (OCLC) or Research Libraries Information Network (RLIN) numbers are used in duplicate detection and consolidation in the construction of online union catalog databases; they are also used in providing "virtual" union catalogs through client result-

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pose) among versions of the same work. A great deal of scholarship involves the development of identifier systems that allow scholars to name things in a way which makes distinctions and recognizes logical equivalence—ways of identifying editions of major authors or composers, variations in coinage having numismatic significance, or the identification of chemicals, proteins, or biological species. Often the rules for assigning identifiers to objects are the subject of ongoing scholarly debate and form a key part of the intellectual framework for a field of study.

Identifiers take on a new significance in the networked environment. To the extent that a computational process can allow a user to move from the occurrence of an identifier to accessing the object being identified, identifiers become actionable. For example, World Wide Web links can be constructed between the entries in an article’s bibliography and digital versions of the cited works, links that can be traversed with a mouse click. The significance of making a citation actionable is so great that it has been the subject of several recent lawsuits—for example, the litigation between Microsoft and Ticketmaster about the inclusion of links to Ticketmaster’s Web pages in Microsoft’s Web service over Ticketmaster’s objections, which remains pending as of this writing. Another interesting case involved a service on the Web called Totalnews, which included citations and offered access to many other services, “framed” by the Totalnews service. The case was recently settled out of court and failed to establish a precedent.

If one translates these practices under legal challenge, particularly in the Microsoft v. Ticketmaster case, into analogous practices in the print world, one can view this litigation as questioning whether one author remains free to cite the work of another without permission—which is certainly a well established practice in print, and a profoundly important right to protect in the networked environment. Of course, this is just one interpretation of the Microsoft v. Ticketmaster case—it is complicated by a number of commercial factors. Yet it helps illustrate what is at stake in establishing identifier systems, the control of the use of identifiers, and the practices surrounding them.

Identifiers also take on new power in the digital environment in another way. In the print world, if you don’t know the identifier of a work (or do not know it precisely), browsing—or perhaps, more accurately, sequential searching—is available as a last resort. Often this search is aided or constrained by memories about an approximate location or other characteristics of the physical artifact; for example, you may not remember the exact name of a paper but know that it is somewhere in the ten feet of papers stacked on your desk. We really have no analog of this kind of search in the networked environment; while it is possible to go through all the files on one’s personal computer looking for something, there is no analog in the Web that allows you to go through all of the Web pages on a given server—you can only identify pages by the URL (if you know it) or by following links from pages you have already found. Literally the only way to find some objects in the digital environment will be through knowledge of the object’s name.

In the networked information environment, we have recently seen the emergence of a framework for defining identifier systems—Uniform Resource Names (URNs)—as well as work (at various levels of maturity) on several important new identifiers. The remainder of this article first outlines the URN framework and then briefly discusses a number of these identifiers. The Coalition for Networked Information is actively engaged in work in all of the areas described below except for PURLs.

**URLs and URNs**

Uniform Resource Locators (URLs) are a class of identifiers that became popular with the emergence of the World Wide Web. We first saw them on Web pages, later in newspaper advertising and on the sides of buses, and then everywhere; currently they serve as the key links between physi-

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1 OCLC is a nonprofit, membership, library computer service and research organization dedicated to the public purposes of furthering access to the world’s information and reducing information costs. [http://www.oclc.org/](http://www.oclc.org/)

2 Hundreds of libraries, mostly in the United States and Canada, but also in Europe, use RLIN as their bibliographic utility. Even though RLIN is primarily intended as a technical processing tool generally accessible to library personnel only, many libraries make RLIN available to patrons either at the reference desk or as an adjunct to their catalog. The other two major bibliographic utilities in use in the United States are OCLC and WLN. [http://www-lib.usc.edu/Info/Schoen/rlin.htm](http://www-lib.usc.edu/Info/Schoen/rlin.htm)
“URLs were never intended to be long-lasting names for content; they were designed to be flexible, easily implemented, and easily extensible ways to make reference to materials on the Net.”

3 SGML is an internationally agreed standard for information representation. SGML can be used for publishing in its broadest definition—from single medium conventional publishing on paper to online multimedia database publishing. SGML can be used to produce files which can be read by people, and exchanged between machines and applications in a straightforward manner. This URL provides an introduction to the main features of SGML, using non-technical language: http://info.ex.ac.uk/SGML/whysgml1.html

cal artifacts and content on the Web, as well as providing linkage between objects within the Web.

URLs have clearly been very effective; yet they are unsatisfactory in one very major way. They are really not names, in that they don’t specify logical content, but, rather, are merely instructions on how to access an object. URLs include a service name (such as “FTP” for file transfer or “HTTP” for the Web’s hypertext transfer protocol) and parameters that are passed to the specified service—most typically a host name and a file name on that host, both of which may be ephemeral. From a long-term perspective, the service name is also ephemeral—for example, content may well outlive a specific service (as has already been the case with the Gopher service). It is important to recognize that URLs were never intended to be long-lasting names for content; they were designed to be flexible, easily implemented, and easily extensible ways to make reference to materials on the Net.

The Internet Engineering Task Force (IETF), which manages standards development for the Internet, realized the limitations of URLs for persistent reference to digital objects several years ago, and as a result began a program to develop a parallel system called Uniform Resource Names (URNs). The IETF URN working group recognized that the URN system must accommodate a multiplicity of naming policies for the assignment of identifiers. Roughly speaking, the syntax of a URN for a digital object is defined as consisting of a naming authority identifier (which is assigned through a central registry) and an object identifier which is assigned by that naming authority to the object in question; the specific content of the identifier may have structure and significance to users familiar with the practices of a given naming authority, but has no predefined meaning within the overall URN framework. Note that the URN syntax does not specify an access service for the object, unlike a URL.

The second key idea in the URN framework is that of resolution services or processes—which may be as complex as new network protocols and infrastructure (analogous to the Domain Name System, for example) or processes as simple as a database lookup—which translate a URN into instructions for accessing the named object. Systems that provide resolution services are called “resolvers”; sometimes the IETF work also refers to “resolution databases” which provide the mapping from names to object locations and access services. URNs are resolved to sets of URLs that provide access to instances of the named digital object. A URN may resolve to more than one URL because there are copies of the digital object that have been replicated at multiple locations such as mirror sites, or because the URN (as defined by the relevant naming authority) specifies the object at a high degree of abstraction, and multiple manifestations of the object (for example, in different formats, such as ASCII, SGML3 and PDF) are available. There is no explicit requirement that the URN-to-URL resolution process expose the mapping from an abstract definition of content to a variety of specific manifestations; it is equally legitimate for the choice of format to be made as part of a protocol negotiation in evaluating a URL when using a sophisticated protocol such as the Z39.50 Information Retrieval Protocol which supports such negotiation. As the location and means of access for objects change, the resolver’s database is updated; thus, resolving a URN tomorrow may return a different set of URLs.

A given resolution service will define one or more “query” interfaces that are used to resolve URNs to URLs, and perhaps also one or more “maintenance” interfaces that can be used to update its databases as content migrates around the network. The URN framework does not specify the protocols used at these interfaces, although there are a number of documents produced by the IETF URN working group that describe the interfaces being used in various experimental resolution systems.

Today’s standard browsers do not yet understand URNs and how to invoke resolvers to convert them to URLs, but hope-
fully this support will be forthcoming in the not too distant future. One can reasonably view the URN framework as the means by which both existing and new identifier systems will be moved into the networked environment. The URN framework is intended to be sufficiently flexible to subsume virtually all existing bibliographic identifiers (sometimes referred to as “legacy” identifier systems); for example, the IETF working group documented how the ISSN, ISBN, and the Serial Item and Contribution Identifier (SICI)⁴ might be implemented as URNs.

The IETF uses the term Uniform Resource Identifiers (URIs) as a generic name to cover both URLs and URNs, along with the still immature concept of Uniform Resource Characteristics (URCs), which can be thought of as structures that allow one or more URNs (perhaps from different naming frameworks) to be related both to sets of URLs and to metadata describing the objects identified by the URNs and URLs. As of the end of 1997, the work of the IETF URN working group is almost complete, with the URN syntax and URN functional requirements issued as Requests for Comments (RFCs), and a number of other RFCs in the editorial process describing experimental resolvers, use of the framework with existing identifiers, and also services to help locate resolution services for naming authorities. The major unresolved issues relate to the management of the registry for naming authorities; the primary complications here involve the use of character-based (sometimes called “vanity”) naming authority identifiers and raise trademark and other legal issues reminiscent of those surrounding domain name assignment. It is unclear what will happen in the URC area in the near term, as this is beyond the charter of the IETF URN working group, and there is no currently active working group in the URC area.

**The OCLC Persistent URL (PURL)**

As a stopgap measure to address some of the problems with the persistence of URLs, about two years ago OCLC deployed a system called the PURL (Persistent URL). Basically, PURLs are HTTP URLs where the usual hostname has been replaced with the host “PURL.ORG” and the filename is an identifier for the “real” content being referenced. The PURL.ORG host will be maintained for the long term by OCLC under that name. When someone registers an object with this PURL server, they provide the current hostname and filename for the object, and the PURL server creates a database entry linking this hostname and filename to the identifier that will appear in the PURL. When the PURL server is contacted because someone is evaluating a PURL, it looks up the identifier in its database, finds out where the object in question currently resides, and uses the redirect feature of the HTTP protocol to connect the requester to the host housing the object. Content providers are responsible for sending updates to the PURL server when the content file name and/or location changes.

PURLs share the idea of indirection—looking up an identifier in a database to find out where the object is currently stored—with URN resolvers as a means of achieving persistence. They are a clever and practical design, in that they work with the existing installed base of Web browsers. However, they are not truly names, since they only permit content to be accessed through a specific service, namely HTTP. PURLs will probably no longer work as new protocols appear that supersede HTTP, and as content migrates to access through such successor protocols.

**The SICI code and related developments**

SICI code was recently revised by a standards committee under the auspices of the National Information Standards Organization (NISO), the ANSI-accredited standards body serving libraries, publishers, and information service providers; it is described in American National Standard Z39.56-1996. The SICI relies in an essential way on the ISSN to identify the serial, and can be used to identify a specific issue of a se-

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⁴ The SICI standard provides an extensible mechanism for the unique identification of either an issue of a serial title or a contribution (e.g., article) contained within a serial, regardless of the distribution medium (paper, electronic, microform, etc.). [http://sunsite.berkeley.edu/SICI/](http://sunsite.berkeley.edu/SICI/)
“The DOI provides a method for collecting revenue for access to material... if the organization that owns the rights to the object wishes to do this.”

The Digital Object Identifier (DOI)

Over the past year, the Association of American Publishers (AAP) and their technical contractor, the Corporation for National Research Initiatives (CNRI), have issued a great deal of publicity about a new identifier called, rather grandly, the Digital Object Identifier (DOI). The DOI is based on CNRI’s “handle” system™, a very general identifier system that fits roughly within the URN framework, and which provides a mechanism for implementing naming systems for arbitrary digital objects. Thus far, the DOI has been demonstrated within the context of online consumer acquisition of intellectual property, and perhaps for this reason it is some-what difficult to disentangle the proposed DOI standard, the demonstration implementation of the DOI, and applications enabled by it. Major demonstrations of the DOI system took place at the Frankfurt Book Fair in October 1997. Recently, work on the DOI has taken on a much stronger international dimension with the participation of the major worldwide scientific, technical, and medical publishers in the effort and the moves to establish a DOI foundation to manage both registries and resolution services related to the DOI.

There are a number of misconceptions surrounding various aspects of the DOI. Its development does not mean that everything on the Web will become pay-per-view; rather, the DOI provides a method for collecting revenue for access to material that is described by a DOI (either on a one-time license or pay-per-view basis), if the organization that owns the rights to the object wishes to do this. Some objects described by DOIs may be accessible without charge. DOIs in and of themselves are only identifiers, and do not imply that any sort of copyright enforcement mechanisms (like an “envelope” or other secure container) will be bundled with the objects that they describe; the presence or absence of such copyright enforcement technologies is an entirely separate issue. These copyright enforcement technologies can be used with objects described by all sorts of identifiers, not just DOIs.

I believe there are some legitimate concerns about the use of DOIs as a means of implementing actionable citations among works on the Web, since this is likely to mean that the author of the citing work is going to need to obtain the DOI of the work that he or she wishes to cite either from the owner of the cited work or from some third party, and following a citation would then involve interaction with the DOI resolution service, raising privacy and control issues. But the notion that the use of DOIs will make the networked environment “safe” for proprietary intellectual property in a way that it is not today is as improbable as the idea that the introduc-

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5 The Handle Management System was developed as part of the ARPA-funded CS-TR project, as a naming scheme for digital library objects. http://www.cnsr. reston.va. uolstr.html In this project, particular emphasis has been given to creating a framework for managing digital objects that incorporate intellectual property rights over very long periods of time. http://www. acl. nati. govt/URI/archive/uri-95q1. messages/0264.html Another reference from the Library of Congress: http://rs6. loc. loc.gov/ammem/award/docs/h- 12.html
tion of DOIs, as one type of commonly used
URN, will somehow convert the entire Web
into a pay-per-view environment.

Discussions with the DOI developers
suggest that the DOI’s role will be as an
identifier of content that is available for
acquisition; there is currently some ambi-
guity as to whether it actually identifies
content directly or simply identifies a
method of acquiring content (such as an
order screen). It is also extremely unclear
under what circumstances similar objects
are assigned distinct DOIs. Current plans
seem to be to carefully control what orga-
nizations are permitted to assign DOIs, lim-
iting the groups to “legitimate” publish-
ers; thus, a DOI might offer some “brand
name” confidence to consumers purchas-
ing content on the Net. DOIs will be
assigned to content as it is made available for
acquisition, and perhaps removed from the
DOI database as content is withdrawn from
availability for acquisition. There does not
seem to be consensus on most of these is-
ues within the DOI developer community,
which underscores the uncertainties about
the potential roles and utility of the DOI
outside of its use as a means for consumers
to acquire content.

In general, one cannot determine the
DOI assigned to a digital object, or even
whether the object has a DOI, unless the
object carries it as a label. However, this
can be confusing, because some publishers
use, for those digital objects which are
within the scope of the SICI, the SICI code
as their (publisher-assigned) identifier. The
implications of this practice will require
careful examination and analysis. It is also
unclear what role the DOI can usefully play
in identifying material outside of acquisi-
tions—for example, to identify material that
is already licensed and is part of a library’s
collection, where it would be desirable to
resolve “bibliographic” links to this mate-
rial, but when it is inappropriate to con-
nect library patrons to the acquisitions ap-
paratus defined by the DOI. These kinds
of usage scenarios illustrate the importance
of separating out identifiers from resolu-
tion services: in the library environment one
might want to search a DOI in a local re-
solver that tracks locally held material, and
go to the global resolution service only if
the local resolver could not resolve the DOI
in question (meaning that the library did
not hold the material, and wanted to find
out how to acquire it).

It appears that DOIs can be imple-
mented within the IETF URN framework,
though there are a few messy details hav-
ing to do with character coding; to the best
of my knowledge no documentation has yet
been developed which spells out these de-
tails.

Recently, representatives of the DOI
developer community have asked CNI to
work with them to help increase under-
standing of the DOI’s objectives and roles,
particularly as they relate to library services,
and to suggest ways in which the DOI
might be made more useful to the broader
bibliographic community. NISO has also
been active in trying to relate the publish-
ing community work on DOIs to the
broader needs of the full NISO constitu-
tency, and held invitational workshops in
June and November 1997 to begin devel-
oping requirements for general-purpose
bibliographic identifiers in the networked
environment.

The DOI as it currently seems to be
evolving is likely to be a useful tool to per-
mit consumers to acquire content from
publishers on the Net with some confidence
about who they are doing business with.
My present concerns with it relate to the
lack of clarity surrounding many aspects of
this identifier, the very broad applicability
implied by the name DOI, which doesn’t
seem to be consistent with its actual de-
fnition (something like Publisher Object
Access Identifier might be more accurately
descriptive), and the very real potential
dangers that are raised if this identifier is
pressed into broader uses, such as a means
of implementing navigable citations in digi-
tal documents. It is important to recognize,
however, that the DOI is still a work in
progress, and that efforts are under way to
address many of the issues I have raised here.

The DOI is an excellent illustration of

“

A DOI might
offer some ‘brand
name’ confidence
to consumers
purchasing
content on the
Net.”
an identifier that appears to fill a real marketplace and community need, but that could be problematic if attempts are made to extend its use beyond its design envelope.

Conclusions

Many new identifier systems are appearing; some have been developed specifically for the networked information environment, while others are long-standing identifiers that are being brought into the digital context. I have mentioned only a few here; there are a number of additional identifiers being proposed by various organizations. When evaluating a new identifier system, we must ask a number of essential questions:

1. What is the scope of the identifier system—what kinds of objects can be identified with it? Who is permitted to assign identifiers, and how are these organizations identified, registered, and validated?

2. What are the rules for assigning new identifiers? When are two instances of a work the same (that is, assigned the same identifier) within the system, and under what criteria are they considered distinct (that is, assigned different identifiers)? What communities benefit from distinctions that are implied by the assignment of identifiers?

3. How does one determine the identifier for the work, and can one derive it from the work itself, or does one need to consult some possibly proprietary database maintained by a third party? To what class of objects do the identifiers apply? Within this class of objects, is there an automatic method of constructing identifiers under the identifier system, or does someone have to make a specific decision to assign an identifier to an object? If so, who makes this decision, and why? Note that if the identifier cannot be derived from the identified work, it is unsuitable for use as a primary identifier within any system of open citation. The act of reference should not rely upon proprietary databases or services.

4. How is the identifier resolved—that is, how does one go from the identifier to the identified work, or to other identifiers or metadata to permit the instances of the work to be located and accessed? Again, what is the role of possibly proprietary third-party databases in resolving the identifier? Do the operator or operators of these resolution services have monopoly control over resolution? What are the entry barriers for new resolution services? What are the policies of the resolution services in areas such as user privacy and statistics gathering?

5. How persistent is the identifier across time? Can one still resolve it after the work ceases to be commercially marketed? Identifiers that rely on the state of the commercial marketplace are very treacherous for constructing citations or other references that can serve the long-term social or scholarly record.

Resources on Identifiers

URLs are defined in Internet RFC 1738. Functional Requirements for URNs are defined in Internet RFC 1737, and the syntax details are defined in RFC 2141. A number of experimental resolver systems are currently being deployed on an prototype basis on the Internet, and some details are defined in RFC 2168. There are also a number of Internet drafts that are moving toward RFC status (see under “draft-ietf-urn” in Internet drafts on sites like [http://www.ietf.org/](http://www.ietf.org/)) that cover areas such as resolver system requirements and the use of bibliographic identifiers as URNs.

Information on PURLs can be found at [www.purl.org/](http://www.purl.org/). There is extensive material on DOIs at the site [http://www.doi.org/](http://www.doi.org/); information on the underlying CNRI handle system technology can be found at [http://www.handle.net/](http://www.handle.net/). The Book Industry Council site ([http://www.bic.org.uk/biccl](http://www.bic.org.uk/biccl)) also contains a good deal of useful material on identifiers. See [http://sunsite.berkeley.edu/SICI/index.html](http://sunsite.berkeley.edu/SICI/index.html) for information on NISO and its standards.
Technology and Change: An Interview with John Gage

John Gage, Director of the Science Office at Sun Microsystems, was the opening session speaker at CAUSE97. After his presentation, he and Ken Klingenstein, Director of Information Technology Systems at the University of Colorado at Boulder, sat and talked about a number of technology-related issues. Following are excerpts of that conversation.

Klingenstein: I’ve come to believe that managing complexity is going to be the biggest task at the turn of the millennium, in terms of technology and our personal lives. Do you see any way to manage complexity?

Gage: The tools we’ve always used, personal relationships with people you respect, are going to be what we rely on. But managing, where you’re trying to understand where things are going, is different than judging what’s amusing or personally beneficial.

In the management world, complexity is a complexity of people, and it’s becoming far more complicated. If you look at the structure Sun has built as an industrial company, we have people who came from Taiwan, or from the Indian Institute of Technology in Delhi. They come to California, they make friends, they leave. They become part of an American company for awhile. The Taiwanese pass through two or three years in Silicon Valley, meet everybody, then go back to Taiwan and start companies there, using these friendships and links.

Suddenly, we’ve been relying upon friends and co-workers. Now it’s five or ten years later, and we’re relying on this web of people for parts, technical predictions about what they’re going to do. We’re telling them what we need, but they’re in different time zones, speak different languages, and have different reliance on governmental policies. That kind of complexity, we’re beginning to layer, as we break up this centralized notion of who’s in charge. It’s a bit like the original Internet in the academic days when one smart graduate student would post code and someone in New South Wales would fix it in an hour and send back a fix. It’s a distributed global environment.

The tools we have to make this work must be the same tools that, in theory, we in education develop. We need the ability to tell the good from the bad. Good taste is what is required to manage complexity. Without good taste, the cacophony will rule.

Klingenstein: We don’t have a course in good taste or critical thinking anymore.

Gage: That’s a shame. When I look at how we manage, 90 percent of what’s presented in management meetings is either wrong or not thought through. The way the company works globally, you have to instill in people some way of judging what each action does in relation to the mission of the overall organization. If you have no coherent mission, then there’s no coherent behavior. People just go off and do things.

How do you pay people in a way that gets them to do certain things that are profitable overall for the company? This is art. I used to think this was boring. Turns out it’s not boring. It’s motivating people. The Sun ethos of open access is more believed in the remote ramparts of the Roman empire than it is in Rome. In Rome, you have...
people who came from DEC and want to charge you for everything. In China and Ireland are the true believers in the Sun way of life, and they're saying it's not proprietary. It's open. You like the source code?—here's the source code. That overall sense of direction is the one way you can use as a touchstone. Do I raise the price to the customer, or do I decrease the price and help them so it seeds something else? Little distinctions can change overall behavior enormously.

Klingenstein: How do you create openness out of proprietary attitudes? How does one take a Microsoft and reintroduce competition?

Gage: The pathway we've embarked on relies on breaking up all the large monolithic pieces of software into smaller objects. Recently I saw a Web page of a series of calendar JavaBeans that this company is now offering for sale. You incorporate them into your application. They've done a very sophisticated job of keeping track of dates on many different calendar systems. You don't have to learn any of that. You just take their Bean and incorporate it into your application and pay them a little bit.

As we build an object economy, which goes down through the operating system, a scheduler could be an object you could use. You don't need to use Sun's. We'd begin to build new markets in components. That's the pathway that will allow us to break up the existing software monopolies. Because the software provides functions that are multifaceted, you can break them up into things that are useful. For example, I'd love to be able to take the full-text indexing systems that exist, and index by meaning the natural language that allows you to break words up. That should run in conjunction with the word processor. As I'm writing something, in the background, the words I'm writing are being broken out, morphologically the endings are taken off and it's compared. Now I get a deeper kind of help in writing in a literate way. It would point out a certain word isn't really in a right spot. I can't do that today in any easy way on a word processor.

If they're defined properly, the interfaces allow add-on capability. Java is the particular vehicle for this. We'll bring out something that allows you to put a layer into your existing system that deals with all services provided to your system, whether disk storage services or networking services. They all will come to you in this distributed system. Software talks to them. It slowly eats away the functionality that's now embedded in a large operating system.

Klingenstein: The politics of technology is very hard. I'm wondering if the Justice Department has the wherewithal to understand this and go in carefully with scissors and snip apart the monopolies?

Gage: I'm a technological determinist in the sense that I think that if we have the framework for the breakup of the existing monolithic software into objects, then there's an economic and technical inevitability. We'll want to be sure that the objects we compose to make a particular application are from people we trust, that have some kind of a liability link, some way we believe that this will all work. That structure will be a survivable commercial structure.

Today, you buy from Microsoft because you've heard of them, they do a pretty good job. If you're confronted with someone with a similar piece of software and you've never heard of them, you're much less likely to buy from them.

Klingenstein: It's an interesting premise that the fruit will fall from the tree and we don't have to cut it.

Gage: That's our hope; it may be naïve. On the politics of technology, the poor lawyers only have blunt scissors. There's no mecha-
nism they have to get inside this world. In some sense, we’ve just got to do it ourselves.

Klingenstei: I’m curious about how we’re going to preserve interoperability against proprietary standards. It feels like the standards processes are breaking down.

Gage: It turns out it’s really quite painful. In things you can define clearly, it’s not changing. To pick twenty-three core objects that must be shipped, that seems pretty clear but is becoming more fuzzy. Each of the objects could have inside it some changes, which is what Microsoft did. They altered some of the methods to do things, which just don’t work. You expect the object to behave one way and it doesn’t behave that way. Then they eliminated a couple of objects from what they shipped. The remote method indication object, which is one they left out of Internet Explorer 4, you have to get into your own machine and embed it in the class hierarchy. This is definitely subverting the ad hoc standards process.

The parallel track is to put the standards under International Organization for Standardization (ISO) control with existing mechanisms for countries and companies to participate. That was redone when ISO recognized that eight years to standardize C++ was a crime. ISO, to develop standards in a rapidly changing world, must alter its procedures.

How do you do this? We plan to let anybody submit a standard and let everybody vote and we’ll argue about maintenance of the standard. However, we want the cycle time to be a year or six months, not eight years. Sun will play. OMG [Object Management Group, a consortium of software vendors and end users] said they’d play. A variety of different groups went into this procedure and submitted the work they’d already done as a standard and found it accepted by an international standards body. We want to figure out a way to maintain it. That’s the language we’re trying to work out now. We’re all in agreement, pretty much, about the directions, with the possible exception of the part of Microsoft that’s trying to derail the whole thing. It seems we can move together collegially. The benefit to people will be of such a magnitude that there’s no reason to fight it.

Since we beat Microsoft thoroughly, globally, on this first-round vote, they’ve learned now that people really do want to have something that is not under any particular company’s control, including Sun’s.

Klingenstei: This ISO process is kind of the equivalent of the Request for Comments (RFC) used in the development of the Internet. It may be that the RFC process, this meta discovery mechanism, is the enduring legacy of the Internet.

Gage: That’s exactly right. The brilliance of the RFC mechanism, the populism of it, the openness of it, is the model for all of this. When we went to ISO, we said, “You must modify how you behave. When we followed the pattern of all requests for information the way the Internet worked, when we did that with Java and put code up, anyone could comment. What we discovered in that process was the student at Upsala had a comment that was more valuable than the comment from Microsoft, or

“Do I raise the price to the customer, or do I decrease the price and help them so it seeds something else?”


International Organization for Standardization: http://www.iso.ch/
We need you, ISO, to alter your procedures to allow comments from anyone, not just a country committee.” ISO blinked twice and said, “We’ll do it.” We’ve altered procedures for establishing global standards by allowing any person to comment.

Klingenstein: When they talked about creating a footprint in the floor of a telephone company, it was a visible thing they could understand. How do you create a footprint inside an operating system?

Gage: Sun Vice President Ivan Sutherland has a wonderful idea. What we should do is eliminate all restrictions on wiretap, so it’s completely legal. You can wiretap your wife, your wife can wiretap you, you can wiretap your neighbor. However, also make it perfectly legal to have completely powerful encryption to protect yourself. That will create a market overnight. You get a little device you plug in to your phone. Now you’re secure.

We’re in this current plunge toward massively accessible…it’s just a boon to law enforcement beyond anything they ever dreamed. Law enforcement doesn’t know how much power they have. My cell phone, I turn it on, you know where I am. We’re locating ourselves, every call we make. This phone stores in it my last ten calls and how long they were. I call somebody or they call me, their phone number pops up on the screen. There are a lot of instances where you don’t want somebody to have your phone number, but you’re not going to go through the mechanism of having the call cut off at the phone company. We’re weaving a web of complete disclosure.

Privacy and knowledge of your environment, the boundaries of civilized behavior, are being eroded. It used to be possible for the two of us to talk to each other, with complete certainty that no one else could hear. The walk in the woods is your only alternative now. However, with parabolic microphones or with any number of devices, you can’t even do a walk in the woods anymore. Your location, every interaction you have with this expanding web of electronic commerce, every interaction you have with any component of technology, is now being marked. I saw a number recently that in New York City a typical working resident has his or her picture taken twenty times a day. It can happen at a street intersection, when entering an office building, in an elevator, or through a fire alarm system. These video surveillance systems are everywhere for reasons of security.

The major move forward in image processing capability means your face could be recognized fleetingly at the bank, the ATM, or any number of places during the day. Every time you do a transaction they’re going to take your picture, or scan your iris.

This web of information can be used for good or for evil. Law enforcement loves it because they can catch the bad guys, but the fundamental, ideological conviction of law enforcement is that everybody is a bad guy, or a potential bad guy, so they want to know. It leads to these extraordinarily restrictive environments, as biological, genetic analysis becomes more powerful. It leads to a breakdown of society’s absorbing responsibility, spreading the risk. I can now identify people who have genetically very advanced risk. If I can identify them, why should the rest of us pay for those people? You lead into some very difficult ethical and political environments. Knowing too much about each other can be a very serious danger to being able to hold a normal conversation. There’s a reason why our thoughts are not transferred to everyone else.
Klingenstein: There’s a story about Enrico Fermi walking the grounds of the Institute for Advanced Studies at Princeton a couple of years after the bomb. He saw a turtle crossing his path in the woods, and picked it up to take home to his children. Fermi walked a few feet down the path, stopped, turned around, left the turtle where he found it and explained to a friend, “I think I’ve done enough to disturb the universe for one man’s lifetime.” What turtles would you put back?

Gage: The turtles are out of the bag. We’ve unleashed this capability. The American ethos, the engineering ethos, were pragmatic: Here’s a new tool, use it. That is carrying us in a path towards, I don’t want to call it invasions of privacy, but enormous accumulations of information about things, which can destroy completely the universe, the balance, the harmony that’s hard enough to create.

Two people attempting to get along is a serious problem. Now with information about everyone easily accessible, it lets the fringe components of our society have leverage and power over institutions and people in ways that have never been possible before. In some sense, you want to cut the power and pull the plug.

There’s a second side to it that is good. In attempting to understand the power of the industrial mechanisms we’ve built, we never took into account emission of chlorine atoms, or any number of things that resulted in ozone holes or the global carbon monoxide and dioxide. Alterations will kill you fast or kill you later. These off-the-balance-book results of people multiplying and industrial growth, if made visible, can cause behavior that could counterbalance them. In that sense, knowing more about the processes of environments we create and are involved in can be very helpful.

Given the existing technologies of powerful encryption, I believe we can regain the control over information about us, restrict the amount that is usable to others, and focus on the good side of all this information, which might allow us to truly account for all of our activities in a healthy way. Every time there’s a polluter, there’s a polluter who’s not paying the cost of the pollution. It’s the others that bear the brunt. It’s these off-the-book expenditures which are supported by the society as a whole. Now we can get a grip on some of these things and perhaps manage them better.

Klingenstein: It’s pretty clear that we’re a technology-driven society. How do you get away from this personally? How do you escape?

Gage: I have simple routines that remove me from this. I find that it gets to a point—and the point is arriving more and more frequently—where I simply push away all this. The 200th e-mail in a day. My fiftieth voice-mail message. This constant sense of equal priority for everything. It forces you to distinguish things. I just turn it off. I don’t listen to my voice mail. I don’t read my e-mail. I go to the coffee shop near my house and I read something. I’ll go to a lecture or a concert.

It’s very different ideas and rhythms, dance and harmonies, different language and vocabularies, that let me suddenly think of something new. It’s odd juxtapositions and richness of culture that lead me to think of something new. The environment of e-mail and quotidian messaging of day-to-day life, it’s all the same. I don’t get that richness and mixture.

I’ve begun to learn that it’s vital to mix in your life the ability to go out and confront the unexpected by breaking out of all the established patterns and being a hu-
man being, trying to see how other human beings live. That is the renewing experience. Often I’ll go to a lecture and I’ll listen to the words but I use them as a counterpoint to stimulate something that I’ve been thinking about. C. Wright Mills did a wonderful thing. He would write, think, ponder some question. He’d work out some theory. Yearly, he’d take all his files and writings, everything filed chronologically or by subject, and dump them on the floor. All the clippings; he’d dump them on the floor. For a week, he’d get on the floor and pick up a piece of paper. The juxtaposition, completely serendipitous, would cause him to think of something new. That was almost mechanical, but very powerful in source of inspiration. It’s like poetry, where an odd juxtaposition of words has an incredible power to invoke new thought.

I spent a lot of time with contractors. I discovered they have eyes I don’t have. They can look at a wall, a room, a building and see exactly what’s behind the wall. They know what is needed. They know what they’ll find in what to me is a perfectly impenetrable surface. They see through it. I began to see as they do. Then I began to watch still photographers and video photographers. They’re very different. The people taking color pictures will move to a certain place to take pictures. Other people will move to a different place, the ones with the black and white motorized cameras. You begin to watch their positioning. I’m not there. Even if I were physically there, I wouldn’t be in the same place. They have an amazing fusion of seeing things and this ability to get these pictures. I began to appreciate those plays where some character will describe what happened and the next character describes it very differently, and the third character is very different again. That’s our lives. If we pay attention to the most minute detail, there’s an enormous richness. It comes from accident.

“I’ve begun to learn that it’s vital to mix in your life the ability to go out and confront the unexpected by breaking out of all the established patterns and being a human being.”

1997-98 CNI Program...

(continued from page 3)

The Institution Wide Information Strategies (IWIS) project is a way for CNI to assist member organizations in determining best practices in the use and management of networked information on an organization-wide basis. Based on these projects, documentation of best practices is expected to aid other institutions in changing their practices and approaches to support an information world that relies on the Net for a majority of its scholarly information. Workshops in forging new work relationships among librarians, technologists, and university administrators will be continued this year.

Finally, technology initiatives focus on new types of applications and also on the role of standards in ever-improving data communication networks. As work on Internet2 infrastructure proceeds, applications that can benefit from the new high-speed network need to be developed. CNI is working with the applications group within the Internet2 project to explore these new applications.

If networked information resources are to improve on existing print resources, commerce in scholarly resources must be as easy to accomplish on the Net as it has in print. Authorization and authentication efforts are another task in this year’s CNI program. These efforts will try to define methods, approaches, and standards to determine if an individual networked user is allowed to use a particular information resource and what use of a particular information resource has been approved.

The 1997-98 program is an ambitious one. It continues CNI’s tradition of being a catalyst in determining the most promising ways that high-speed networks can be used for the dissemination of scholarly material. The complete CNI program can be reviewed at: http://www.cni.org/docs/CNI_prog_overview.html
Transforming the University to Serve the Digital Age

By James J. Duderstadt

James J. Duderstadt is President Emeritus and University Professor of Science and Engineering at the University of Michigan/Ann Arbor. This article is adapted from his address at the 1997 Seminars on Academic Computing (SAC)\(^1\) in Snowmass, Colorado.

The future of the university has been a subject of great interest in recent years. A case in point: the reaction to Peter Drucker’s interview in Forbes last spring when he speculated,

Thirty years from now the big university campuses will be relics. Universities won’t survive. It’s as large a change as when we first got the printed book.\(^2\)

Particularly amusing was the flurry of e-mail traffic among our deans at the University of Michigan. Some comments blasted Drucker, although past experience suggests that people do this at their own risk. Others were simply moot.

Over the past couple of years, town hall meetings of faculty have been sponsored by the National Science Board and the National Academy of Sciences on dozens of university campuses. The key issues raised by the faculty and administrators were, for the most part, the obvious ones:

• fears about the future funding of research;
• the stresses of grantsmanship;
• the loss of a sense of scholarly community with increasing specialization;
• the imbalance between the rewards for research versus teaching;
• and a host of technical issues, such as indirect costs, facilities support, government reporting and accountability requirements, and so on.

Interestingly enough, the impact of information technology on the academy did not even appear on the radar scope.

Yet from these meetings, it was also clear that concerns expressed were simply symptoms of the impact of more fundamental forces driving change, many of which relate directly to emerging digital technology.

The Forces of Change

There are many ways to group the challenges of change in higher education. For the purpose of this article, consider the drivers of change to be financial imperatives, societal needs, and technology.

Financial imperatives

Since the late 1970s, higher education in America has been caught in a financial vise. The magnitude of the services demanded of our colleges and universities has increased considerably. Enrollments have grown steadily; the growing educational needs of adult learners have compensated for the temporary dip in the number of high school graduates associated with the post-war baby boom/bust cycle. University research, graduate education, and professional education have all grown in response to societal demand. Professional services provided by colleges and universities also continue to grow in areas such as health care, technology transfer, and extension—all in response to growing needs.

1 For more information about SAC, see http://www.cause.org/sac/sac98/sac98.html

In his article, James J. Duderstadt has defined the challenges higher education institutions face today and in the future. Presented are examples of what the University of Michigan is doing to position itself for higher education in the 21st century.

The Importance of Experimentation

For the past decade we have led an effort at the University of Michigan to transform ourselves, to re-invent the institution, if you will, so that it better serves a rapidly changing world. We created a campus culture in which both excellence and innovation were our highest priorities. We restructured our finances so that we became, in effect, a privately supported public university. We dramatically increased the diversity of our campus community. We launched major efforts to build a modern environment for teaching and research using the powerful tools of information technology. Yet with each transformation step we took, with every project we launched, we became increasingly uneasy. As we came to understand better the forces driving change in our society and its institutions, we realized that these were stronger, more profound than we had first thought. Change was occurring far more rapidly than we had anticipated. The future was becoming less certain as the range of possibilities expanded to include more radical options.

We came to the conclusion that in a world of such rapid and profound change, facing a future of such uncertainty, the most

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The costs of providing education, research, and service have also grown, and at an even faster rate, since these university activities are dependent upon a highly skilled, professional workforce (faculty and staff); they require expensive new facilities and equipment; and they are driven by an ever-expanding knowledge base. To be sure, higher education has yet to take the bold steps to constrain cost increases that have been required in other sectors of our society such as business and industry. This is in part because of the manner in which our colleges and universities are organized, managed, and governed.

Even though the demand for educational services has grown and the operating costs to provide these services have risen, public support for higher education has flattened and then declined over the past two decades. The growth in state support of public higher education peaked in the 1980s and now has fallen in many states, in the face of limited tax resources and the competition of other priorities such as entitlement programs and corrections. While the federal government has sustained its support of research, growth has been modest in recent years and is likely to decline as discretionary domestic spending comes under increasing pressure from federal budget-balancing efforts. There has been a significant decline in federal financial aid programs over the past two decades, with a corresponding shift from grants to loans as the predominant form of aid.

To meet growing societal demand for higher education at a time when costs are increasing and public support is declining, most institutions have been forced to sharply increase tuition and fees—substantially faster than the Consumer Price Index. While this has provided short-term relief, it has also triggered a strong public concern about the costs and availability of a college education, along with growing forces to constrain or reduce tuition levels at both public and private universities. As a result, most colleges and universities are now looking for ways to control costs and increase productivity, but most are also finding that their current organization and governance makes this very difficult.

Societal needs

Yet the needs of our society for the services provided by our colleges and universities will continue to grow. Significant expansion will be necessary just to respond to the needs of a growing population that will create a 30 percent growth in the number of college-age students over the next two decades. Beyond this traditional role, we should recognize the impact of the changing nature of the educational services sought by our society.

Today’s undergraduate student body is no longer dominated by eighteen- to twenty-two-year-old high school graduates from affluent backgrounds. It is composed also of increasing numbers of adults from diverse so-
cioeconomic backgrounds, already in the workplace, perhaps with families, seeking the education and skills necessary for their careers. Once it is recognized that the magnitude of this need for higher education may be significantly larger than that for traditional undergraduate education, it is clear that either existing institutions will have to change significantly or new types of institutions will have to be formed. The transition from student to learner, from faculty-centered to learner-centered institutions, from teaching to the design and management of learning experiences, and from student to a lifelong member of a learning community—all suggest great changes are ahead for our institutions.

The students entering college today require a different form of education in which interactive and collaborative learning will increasingly replace the passive lecture and classroom experience. The student has become a more demanding consumer of educational services, although frequently this is directed at obtaining the skills directed toward more immediate career goals.

We are beginning to see a shift in demand from the current style of “just-in-case” education in which we expect students to complete degree programs at the undergraduate or professional level long before they actually need the knowledge, to “just-in-time” education in which education is sought when a person needs it through non-degree programs, to “just-for-you” education in which educational programs are carefully tailored to meet the specific lifelong learning requirements of particular students. So too the shift from synchronous, classroom-based instruction to asynchronous computer-network-based learning, to the provision of ubiquitous/pervasive learning opportunities throughout our society will demand major change.

**Technology drivers**

As knowledge-driven organizations, it is not surprising that colleges and universities should be greatly affected by the rapid advances in information technology—computers, telecommunications, networks. This technology has already had dramatic impact on campus research activities, including the creation of an entirely new form of research: computer simulation of complex phenomena. Many of the administrative processes have become heavily dependent upon information technology—as the current concern with the approaching date reset of Year 2000 has made all too apparent. There is an increasing sense that it will have an even more profound impact on the educational activities of the university and how we deliver our services. To be sure, there have been earlier technology changes such as television, but never before has there been such a rapid and sustained period of change with such broad social applications.

Most significant here is the way in which emerging information technology has removed the constraints of space and time. We can now use powerful computers and networks to deliver educational services to anyone at any place and any time, no longer confined to the campus or the academic schedule. The market for university services is expanding rapidly, but so is competition, as new organizations such as virtual universities and “learning-ware” providers enter this marketplace to compete with traditional institutions.

Emerging information technology is a driver of change in higher education, and we can consider its impact in two areas: (1) the changing nature of our fundamental academic activities, and (2) the changing nature of the higher education enterprise.

**The Changing Nature of Academic Activities**

It is common to refer to the primary missions of the university in terms of the honored trinity of teaching, research, and service. But these roles can also be regarded as simply the 20th-century manifestations of the more fundamental roles of creating, preserving, integrating, transmitting, and applying knowledge. If we were to adopt the more contemporary language of computer networks, the university might be regarded as a “knowledge server,” providing knowledge services (i.e., creating, preserving, transmitting, or applying knowledge) in whatever
form needed by contemporary society.

From this more abstract viewpoint, it is clear that while these fundamental roles of the university do not change over time, the particular realization of these roles do change—and change quite dramatically, in fact.

Teaching

Consider, for example, the role of “teaching,” that is, transmitting knowledge. We generally think of this role in terms of a professor teaching a class of students, who in turn respond by reading assigned texts, writing papers, solving problems or performing experiments, and taking examinations. We should also recognize that classroom instruc-
content and more focused on inspiring, motivating, and managing an active learning process by students. Here we should note that this will require a major change in graduate education, since few of today’s faculty members have learned these skills.

**Research**

One can easily identify other similarly profound changes occurring in the other roles of the university. The process of creating new knowledge—of research and scholarship—is also evolving rapidly away from the solitary scholar to teams of scholars, perhaps spread over a number of disciplines. Indeed, is the concept of the disciplinary specialist really necessary—or even relevant—in a future in which the most interesting and significant problems will require “big think” rather than “small think”? Who needs such specialists when intelligent software agents will soon be available to roam far and wide through robust networks containing the knowledge of the world, instantly and effortlessly extracting whatever a person wishes to know?

There is also increasing pressure to draw research topics more directly from worldly experience rather than predominantly from the curiosity of scholars. Even the nature of knowledge creation is shifting somewhat away from the analysis of what has been to the creation of what has never been—drawing more on the experience of the artist than upon the analytical skills of the scientist.

**The library**

The preservation of knowledge is one of the most rapidly changing functions of the university. The computer—or more precisely, the “digital convergence” of various media from print to graphics to sound to sensory experiences through virtual reality—has already moved beyond the printing press in its impact on knowledge. Throughout the centuries, the intellectual focal point of the university has been its library with its collection of written works preserving the knowledge of civilization. Yet today such knowledge exists in many forms—as text, graphics, sound, algorithms, and virtual reality simulations—and it exists almost literally in the ether, distributed in digital representations over worldwide networks, accessible by anyone, and certainly not the prerogative of the privileged few in academe.

**Service**

Finally, it is also clear that societal needs will continue to dictate great changes in the applications of knowledge it expects from universities. Over the past several decades, universities have been asked to play the lead in applying knowledge across a wide array of activities, from providing health care to protecting the environment, from rebuilding our cities to entertaining the public at large.

**THE CHANGING NATURE OF THE HIGHER EDUCATION ENTERPRISE**

Universities have long enjoyed a monopoly over advanced education because of geographical location and their monopoly on certification through the awarding of degrees. However, today all of these market constraints are being challenged, as information technology eliminates the barriers of space and time and as new competitive forces enter the marketplace to challenge credentialing.

In the current paradigm, our colleges and universities are faculty-centered. The faculty has long been accustomed to dictating what it wishes to teach, how it will teach it, and where and when the learning will occur. Students must travel to the campus to learn. They must work their way through the bureaucracy of university admissions, counseling, scheduling, and residential living. And they must pay for the privilege. If they complete the gauntlet of requirements, they are finally awarded a certificate to recognize their learning—a college degree. This process is sustained by accrediting associations, professional societies, and state and federal governments.

Yet this carefully regulated and controlled enterprise could be blown apart by several factors. First, the great demand for advanced education and training simply cannot be met by such a carefully rationed and controlled enterprise. Second, the expanding market-
of Information.

Put simply, this school is committed to developing leaders for the information professions who will define, create, and operate facilities and services that will enable users to create, access, and use information they need. It intends to lead the way in transforming education for the information professions through an innovative curriculum, drawing upon the strengths of librarianship, information and computer science, business, organizational development, communication, and systems engineering. Its activities range from digital libraries to knowledge networks to virtual educational structures.

EXPERIMENT #2: THE MEDIA UNION

At the University of Michigan we have launched another such experiment to create the type of physical environment that might characterize the future of education: a fascinating new center known as the Media Union. This is designed to be a laboratory, a testbed, for developing, studying, and perhaps implementing the new paradigms of the university enabled by information technology.

More specifically, this 250,000 square foot facility, looking like a modern version of the Temple of Karnak, contains 600 workstations, along with thousands more network jacks for students. The facility contains a million-volume science and engi-

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As a result, we believe education represents the most fertile new market for investors in many years. It has a combination of large size (approximately the same size as health care), disgruntled users, lower utilization of technology, and the highest strategic importance of any activity in which this country engages. Finally, existing managements are sleepy after years of monopoly.

**Unbundling**

The modern university has evolved into a monolithic institution controlling all aspects of learning. The most significant impact of a deregulated higher education “industry” will be to break apart this monolith, much as other industries have been broken apart through deregulation. As universities are forced to evolve from faculty-centered to learner-centered, they may well find it necessary to unbundle their many functions, ranging from admissions and counseling to instruction and certification.

An example might be useful here. Consider the rapid growth of cyberspace or virtual universities, institutions without a campus or faculty, that provide computer-mediated distance education. The virtual university might be viewed as the “Nike approach” to higher education. Nike, a major supplier of athletic shoes in the United States and worldwide, does not manufacture the shoes it markets. It has decided that its strength is in marketing, and that it should outsource shoe manufacturing to those who could do it better and cheaper. In a sense, the virtual university similarly stresses marketing and delivery. It works with the marketplace to understand needs, then it outsources courses, curriculum, and other educational services from established colleges and universities—or perhaps individual faculty—and delivers it through sophisticated information technology.

There are many other examples. While we are very good at producing intellectual content for education, there may be others who are far better at packaging and delivering that content. While in the past universities have had a monopoly on certifying learning, there may be others, whether they be accreditation agencies or other kind of providers, more capable of assessing and certifying that learning has occurred. Many of our other activities, e.g., financial management and facilities management, are activities that might be outsourced to specialists.

Clearly higher education is an industry ripe for the unbundling of activities. Universities, like other institutions in our society, will have to come to terms with what their true strengths are and how those strengths support their strategies—and then be willing to outsource needed capabilities in areas where they do not have a unique competitive advantage.

**The emergence of a commodity market**

Throughout most of its history, higher education has been a cottage industry. Individual courses are a handicraft, a made-to-order product. Faculty members design from scratch the courses they teach, whether they be for a dozen or several hundred students. They may use standard textbooks from time to time—although many do not—but their organization, their lectures, their assignments, and their exams are developed for the particular course at the time it is taught. In a very real sense, the industrial age has largely passed the university by. Our social institu-
neering library, but perhaps more significantly, it is the site of our major digital library projects. There is a sophisticated teleconferencing facility, design studios, visualization laboratories, and a major virtual reality complex. Since art, architecture, and music students work side by side with engineering students, the Media Union contains sophisticated recording studios and electronic music studios. It also has a state-of-the-art sound stage for “digitizing” performances, as well as numerous galleries for displaying the results of student creative efforts. The Media Union is a facility open twenty-four hours a day, seven days a week, primarily designed for students.

**Experiment #3: The Michigan Virtual Automotive College**

Last year we launched a venture known as the Michigan Virtual Automotive College (MVAC) as a private, not-for-profit, 501(c)3 corporation aimed at developing and delivering technology-enhanced courses and training programs to the automobile industry. The MVAC is a college without walls that serves as an interface between higher education institutions, training providers, and the automotive industry. Courses and programs can be offered from literally any site in the state to any other technologically connected site within the state, the United States, or the world. Although technologies are rapidly emerging, it is expected for learning, schools, colleges, and universities, continue to favor programs and practices based more on past traditions than upon contemporary needs.

The nature of higher education will be changed by our ability to introduce new, more effective avenues for learning, rather than just new media in which to convey information. This will bring with it new modes of organization, relationships among universities and between universities and the private sector. The individual handicraft model for course development may give way to a much more complex method of creating instructional materials. The standard packaging of an undergraduate education into “courses” in the past was required by the need to have all the students in the same place at the same time. This may no longer be necessary with new forms of asynchronous learning.

As we have noted, universities—more correctly, faculty—are skilled at creating the content for educational programs. Indeed, we might identify this as one of their core competencies. But they have not traditionally been particularly adept at “packaging” this content for mass audiences. To be sure, many faculty have written best-selling textbooks, but these have been produced and distributed by textbook publishers. In the future of multimedia Net-distributed educational services, the university may have to outsource both production and distribution from those most experienced in reaching mass audiences—the entertainment industry.

As distributed virtual environments become more common, one might even conceive of a time when the classroom experience itself becomes a “commodity,” provided to anyone, anywhere, at any time—for a price. You want to take Vincent Scully’s course in history of architecture? Just sign up here and become an “avatar” student, as Professor Scully leads you and other virtual classmates on a fascinating journey through the ages, touring through 3-D simulations of great architectural masterpieces. How about Stephen Jay Gould’s “Life on Earth” course? Available as well. If students could actually obtain the classroom experience of these talented teachers, why would they want to take classes from the local prof—or, in many cases, the local teaching assistant?

In such a commodity market, the role of the faculty member would change very substantially. Rather than developing content and transmitting it in a classroom environment, a faculty member might have to manage a learning process in which students use an educational commodity, e.g., the Microsoft Virtual History of Architecture Course. This would require a shift from the skills of intellectual analysis and classroom presentation to those of motivation, consultation, and inspiration. Hello, Mr. Chips!
Mergers, acquisitions, and hostile takeovers

The perception of the higher education enterprise as a deregulated industry has several other implications. There are over 3,600 colleges and universities in the United States, characterized by a great diversity in size, mission, constituencies, and funding sources. Not only are we likely to see the appearance of new educational entities in the years ahead, but as in other deregulated industries, there could well be a period of fundamental restructuring of the enterprise itself. Some colleges and universities might disappear. Others could merge. Some might actually acquire other institutions.

A case in point: The Big Ten universities (actually there are twelve, including the University of Chicago and Penn State University) have already merged many of their activities, such as their libraries and their federal relations activities. They are exploring ways to allow students at one institution to take courses—or even degree programs—from another institution in the alliance in a transparent and convenient way. Could one imagine the Big Ten universities becoming a university system “of the heartland of America”?

One might also imagine affiliations between comprehensive research universities and liberal-arts colleges. This might allow the students enrolling at large research universities to enjoy the intense, highly personal experience of a liberal arts education at a small college while allowing the faculty members at these colleges to participate in the type of research activities only occurring on a large research campus.

One might even imagine a Darwinian process emerging with some institutions devouring their competitors in “hostile takeovers.” All such events have occurred in deregulated industries in the past, and all are possible in the future we envision for higher education.

Perhaps the most profound question of all concerns the survival of the university in the face of the changes, the emergence of new competitors. Could an institution such as the university, which has existed for a millennium, disappear in the face of such changes?

If you have doubts, just think of the family farm, a social institution existing for centuries which has largely disappeared over the past three decades.

Evolution or Revolution?

In spite of the growing awareness of these social forces, many within the academy still believe that change will occur only at the margins of higher education. They stress the role of the university in stabilizing society during a period of change rather than leading those changes. This too shall pass, they proclaim, and demand that the university hold fast to its traditional roles and character.

Leading in the introduction of change can be both a challenging and a risky proposition. The resistance can be intense, and the political backlash threatening. As one who has attempted to illuminate the handwriting on the wall and to lead an institution in transformation, I can attest to the lonely, hazardous, and usually frustrating life of a change agent. I am reminded of the quote from Machiavelli:

“There is no more delicate matter to take in hand, nor more dangerous to conduct, nor more doubtful of success, than to step up as a leader in the introduction of change. For he who innovates will have for his enemies all those who are well off under the existing order of things, and only lukewarm support in those who might be better off under the new. Amen!

Yet, history suggests that the university must change and adapt in part to preserve these traditional roles. It is true that many, both within and outside the academy, believe that significant change must occur not simply in the higher education enterprise but in each and every one of our institutions. Most of these see change as an evolutionary, incremental, long-term process, compatible with the values, cultures, and structure of the contemporary university.

There are a few voices, however, primarily outside the academy, who believe that both the dramatic nature and compressed time scales characterizing the changes of our times will drive not evolution but revolution.

“One might even conceive of a time when the classroom experience itself becomes a “commodity,” provided to anyone, anywhere, at any time—for a price.”
They have serious doubts about whether the challenges of our times will allow such gradual change and adaptation. They point out that there are really no precedents we can draw upon. Some even suggest that long before reform of the educational system comes to any conclusion, the system itself will have collapsed.

The forces driving change in higher education, both from within and without, are far more powerful than most realize. It seems likely that both the pace and nature of change characterizing the higher education enterprise in America and worldwide will be considerably beyond that which can be accommodated by business-as-usual evolution. As one of my colleagues put it, while there is certainly a good deal of exaggeration and hype about the changes in higher education for the short term—meaning five years or less—it is difficult to stress too strongly the profound nature of the changes likely to occur in most of our institutions and in our enterprise over the longer term—a decade and beyond.

A GLIMPSE OF THE FUTURE

Clearly, as knowledge and educated people become key to prosperity, security, and social well-being, the university, in all its myriad and rapidly changing forms, has become one of the most important social institutions of our times. Yet many questions remain unanswered. Who will be the learners served by these institutions? Who will teach them? Who will administer and govern these institutions? Who will pay for them? What will be the character of our universities? How will they function? When will they appear? The list goes on.

Perhaps the most profound question of all involves the survival of the university, at least as we know it. And that, of course, is the question that Drucker raised. Of course, most of us disagree quite strongly with Drucker’s contention that the university as we know it will cease to exist. On the other hand, I certainly believe there will be forms of the university that you and I might not recognize from our perspective today.

It is difficult to suggest a particular form for the university of the 21st century. The great and ever-increasing diversity characterizing higher education in America makes it clear that there will be many forms, many types of institutions serving our society. But there are a number of themes that will almost certainly characterize at least some part of the higher education enterprise:

• A shift from “faculty-centered” to learner-centered institutions, joining other social institutions in the public and private sectors in the recognition that we must become more focused on those we serve;

• Affordable, within the resources of all citizens, whether through low cost or societal subsidy;
• **Lifelong learning**, requiring both a willingness to continue to learn on the part of our citizens and a commitment to provide opportunities for this lifelong learning by our institutions;

• **A seamless web**, in which all levels of education not only become interrelated, but blend together;

• **Asynchronous** (anytime, anyplace) learning, breaking the constraints of time and space to make learning opportunities more compatible with lifestyles and needs;

• **Interactive and collaborative learning**, appropriate for the digital age, the “plug and play” generation;

• **Diversity**, sufficient to serve an increasingly diverse population with diverse needs and goals.

There is one further modifier that may characterize the university of the future: **ubiquitous**. Let me explain:

In today’s world, knowledge has become the coin of the realm, determining the wealth of nations. It has also become the key to one’s personal standard of living, the quality of one’s life. We might well make the case that today it has become the responsibility of democratic societies to provide their citizens with the education and training they need throughout their lives, whenever, wherever, and however they desire it, at high quality, and at a cost they can afford.

This has been one of the great themes of higher education in America. Each evolutionary wave of higher education has aimed at educating a broader segment of society—the public universities, the land-grant universities, the normal and technical colleges, the community colleges. But today we must do even more to serve an even broader segment of our society.

For the past half a century, national security was America’s most compelling priority, driving major public investments in social institutions such as the research university. Today, however, in the wake of the Cold War and on the brink of the age of knowledge, one could well make the argument that education will replace national defense as the priority of the 21st century. Perhaps this will become the new social contract that will determine the character of our educational institutions, just as the government-university research partnership did in the latter half of the 20th century. We might even conjecture that a social contract, based on developing the abilities and talents of our people to their fullest extent, could well transform our schools, colleges, and universities into new forms that would rival the research university in importance.

Once again we need a new paradigm for delivering the opportunity for learning to even broader segments of our society. Fortunately, today’s technology is rapidly breaking the constraints of space and time. It has become clear that most people, in most areas, can learn and learn well using asynchronous learning, that is, “any time, any place, anyone” education. Modern information technology has largely cut us free from the constraints of space and time, and has freed our educational system from these constraints as well. The barriers are no longer cost or technology but perception and habit. Lifetime education is rapidly becoming a reality, making learning available for anyone who wants to learn, at the time and place of their choice, without great personal effort or cost.

But this may not be enough. Instead of asynchronous learning, perhaps we should instead consider a future of “ubiquitous learning” learning for everyone, every place, all the time. Indeed, in a world driven by an ever-expanding knowledge base, continuous learning, like continuous improvement, has become a necessity of life.

Rather than “an age of knowledge,” could we instead aspire to a “culture of learning,” in which people were continually surrounded by, immersed in, and absorbed in learning experiences? Information technology has now provided us with a means to create learning environments throughout one’s life. These environments are able not only to transcend the constraints of space and time, but they, like us, are capable as well of learning and evolving to serve our changing educational needs. This may become not only the great challenge but the compelling vision facing higher
education as it enters the next millennium.

**Concluding Remarks**

The 1990s will represent a period of significant change on the part of our universities, if we are to respond to the challenges, opportunities, and responsibilities before us. A key element will be efforts to provide universities with the capacity to transform themselves into entirely new paradigms that are better able to serve a changing society and a profoundly changed world.

This time of great change, of shifting paradigms, provides the context in which we must consider the changing nature of the academic research enterprise itself. We must take great care not simply to extrapolate the past but to examine the full range of possibilities of the future.

From this perspective, it is important to understand that the most critical challenge facing most institutions will be to develop the capacity for change; to remove the constraints that prevent institutions from responding to needs of rapidly changing societies; to remove unnecessary processes and administrative structures; to question existing premises and arrangements; and to challenge, excite, and embolden all members of the university to embark on what I believe will be a great adventure.

Those institutions that can step up to this process of change will thrive. Those that bury their heads in the sand, that rigidly defend the status quo—or even worse, some idyllic vision of a past that never existed—are at very great risk. Those institutions that are micromanaged, either from within by faculty politics or governing boards, or from without by government or public opinion, stand little chance of flourishing during a time of great change.

There is no question that the need for learning institutions such as the university will become increasingly important in a knowledge-driven future. The real question is not whether the higher education will be transformed, but rather how... and by whom. It is my belief that the challenge of change before us should be viewed not as a threat, but as an opportunity for a renewal, perhaps even a renaissance in higher education.

The decade could be—should be—one of the great adventures of our times. And those of you who are leading the understanding and application of the emerging information technology that is driving the revolution in learning, should be right in the center of this effort.

"We must take great care not simply to extrapolate the past but to examine the full range of possibilities of the future.”
Information Technology as a Transformation Agent

by Charlie Tuller and Diana Oblinger

The essential process of higher education is the transformation of information into knowledge, and knowledge into insight. With technology catalyzing such massive changes in how we manage information, and with cognition, communication, and collaboration helping us transform information into knowledge and insight, the implications for higher education are immense.

Information technology (IT) is a defining force affecting all areas of society well into the next century, changing every institution, every business, and every individual in profound ways. Technology itself has changed dramatically in the past fifteen years. Anticipate even more rapid change in the future, changes that impact organizations and society.

Within fifteen short years we have on the order of one thousand times better algorithms, five hundred thousand times more computing power per individual and five hundred million times more mobility of information. We do not begin to understand the technical significance of all this, let alone the societal change it has unleashed or the institutional change it demands.1

During the next decade, a variety of enabling technologies will be important, as will advances in their form and function. More important, however, is the ability of these technologies to transform individuals and institutions.

Three shifts in computing

For most of us, computing today is radically different from our early experiences. In fact, we have seen three major waves of computing: host-centric, client/server and network-centric.

Host-centric, or “tops-down” computing, dominated the environment for the past twenty years. The focus was on the physical enterprise, with a specific behavior pattern:
- buy a computer system;
- write applications;
- define the reports needed;
- develop fixed screens to display the results;
- operate over a private, wire network.

We still see a dominance of host-centric computing among administrative applications in higher education. Many institutions operate their institutional research or registration offices with a specific computer, using applications written in-house. Creation of reports is fixed by the application: a new program must be written to generate a new report.

Today a distributed client/server model dominates. The focus is the distributed enterprise with a different behavior pattern:
- buy individual “client” units;
- purchase applications;
- use windowing to view information;
- operate over private wire local area networks or mixed private and public switched networks.

The client/server architecture has enabled organizations to do a great deal of “mixing and matching” to suit individual needs. An example of this pattern is in purchasing client machines. People are buying CPUs separate from memory. Specific hard drive sizes are ordered. Memory modules may be different. Connectivity is a mix. Customization is the rule rather than the exception. Appli-

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Campus Profile

Cedarville College

Located on 350 acres in the rural town of Cedarville, Ohio, Cedarville College is closely affiliated with the Baptist Church. Established in 1887, the institution enrolls more than 2,500 students, most of whom live on campus. It is a college of arts, sciences, and professional programs, offering seventy-five areas of study.

Over the last five years, Cedarville has seen admissions applications and enrollment increase dramatically, and has welcomed campus visits from more than one hundred institutions. Much of this increased attention on the small college is due to its establishment of a successful network.

Cedarville officials explain that what people applaud is that the community actually uses the extensive infrastructure that Cedarville put into place. David Rotman, director of Computer Services, says that it didn’t take long for everyone to see value in the network. He explained, “We had strong support from the president, faculty bought in early, and students quickly followed.”

Setting priorities

Consistent with its objectives to “prepare students to knowledgeably participate in society,” and to “provide sufficient opportunities for students to practice the skills of communication,” Cedarville has long made networking a priority. In the 1989-90 academic year, President Paul Dixon appointed a task team of fifteen members, including faculty, staff, and administration, to evaluate Cedarville’s technology needs and formulate a plan to address them.

In an intense planning effort, the task team gathered input from its community as well as outside institutions, and was impressed by large-scale networking projects that incorporated residence halls. The team proposed that the college set up an integrated, broadly accessible information, voice, and video communications technology infrastructure, and that proposal was validated through a survey of the student body, a study project with the faculty, and administration, to evaluate Cedarville’s technology needs and formulate a plan to address them.

Through CedarNet, students have access to learning and research materials twenty-four hours a day, thanks to the convenience of computer workstations.
Virginia Tech

With a 2,500-acre main campus surrounded by rolling pastures and the Blue Ridge Mountains, the Virginia Polytechnic Institute and State University enrolls more than 25,000 students. This land-grant university, commonly known as Virginia Tech, was founded in 1872. Through the last thirty-five years it has changed from a small military school known for agriculture and traditional engineering to a major scientific research center.

Virginia Tech boasts 200 degree programs and $148 million in research projects each year, and ranks among the top institutions in industry-supported research. The university has twenty-three interdisciplinary research centers—some among the best in their fields—ranging from the Fiber and Electro-Optics Research Center to the Virginia Center for Coal and Energy Research, in addition to dozens of research institutes and hundreds of research laboratories.

Today, a state-of-the-art communications system—including nearly 2,000 miles of optical fiber, 15,000 Ethernet connections, and more than 14,000 data and voice devices—links almost every dorm room, lab, office, and classroom to computers, audio, and video data, as well as to the Internet and to national research networks. Virginia Tech's expansive campus is the nucleus for a statewide network called Net.Work.Virginia.

State-of-the-art history

Virginia Tech has consistently held a lead position in the field of technology while maintaining a cost-effective approach. The campus began networking in the mid 1970s, providing mainframe access for a select group of researchers and administrators with the installation of the first automatic data switch in North America, Develcon DataSwitch. The school began to install Sytex LocalNet20 in the early 1980s, giving connectivity to around 3,000 users, the largest such installation of its time.

A major tunnel fire took out part of the LocalNet system in the mid 1980s, but at that time the university was installing a pilot Ethernet system for a portion of the campus. LocalNet was supplemented by UNINET, offering network access to the campus from anywhere in the state. The progressive campus soon became one of the first institutions in the nation to provide off-campus access to an on-campus mainframe.

Judy Lilly, Director of Communications Network Services (CNS), notes that an important economy of scale took place when CNS was created in 1984, consolidating voice, data, and video communications. This move, combined with the addition of a vice president for information systems, created an effective organizational structure able to rapidly and efficiently evolve and integrate systems.

In 1986, CNS documented every piece of existing cable on campus, and university personnel installed a structured cable plant, planning to fulfill future requirements. In 1988, CNS implemented an ROLM CBX voice/data system, which became the largest system of its type. In the early 1990s, a Fiber-Distributed Data Interface Backbone was installed.

Today Virginia Tech continues to lead the field with effective, strategic network design. In 1996, CNS completed implementation of one of the first campuswide Asynchronous Transfer Mode (ATM) backbones, built on a foundation of fiber laid in the 1980s. With this infrastructure, CNS can match the desktop connection to application requirements extending 10-100 Mbps Ethernet, 25 Mbps ATM, or 155 Mbps ATM wherever needed.

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PRESIDENT PAUL DIXON  
CEDARVILLE COLLEGE  

Recalling that students were initially skeptical of the proposed network at Cedarville College, President Paul Dixon describes CedarNet as pervasive and notes that everyone in the community, students included, is applauding its benefits. “Few of our students—or faculty or staff, for that matter—see a day go by without using the system. Using the network at Cedarville has become as essential as using the telephone or post office.” In his twenty years at the college, he hasn’t seen interpersonal communications better than they are today. He says: “CedarNet has actually enhanced, rather than replaced, the close faculty-student relationships for which Cedarville is known.”

Dixon attributes Cedarville’s success in networking to a progressive, long-term commitment to technology while maintaining a theological approach. He explains that CedarNet is in sync with the college’s mission, which embraces the objective “to increase the student’s awareness of the world of ideas and events which are influencing our contemporary culture, and to prepare the student to knowledgeably participate in our society.” To boost even further the exceptional quality of CedarNet, Dixon says the focus for the next few years will be on people—helping everyone make even better use of the technology at their fingertips.

Cedarville… (continued from page 34)

mobile, and several LCD projection panels and large-screen monitors are available for presentations. Four classrooms are configured as computer laboratories, in which all computers can be controlled by the instructor.

Students and faculty also have access to digital cameras, a slide scanner, a film recorder, several flatbed scanners, and video-capture equipment, as well as color printing for a fee.

To fund the network, students pay an additional $750 per academic year, which is now included in their general fees. The funding plan includes a four-year equipment replacement cycle, maintenance of hardware and software, and hiring of network personnel. The college spent more than $1.6 million on the network in 1996-97, or 4.6 percent of its annual expenditures, and expects to match that figure for 1997-98.

Pervasive use

CedarNet’s impact on the college community is most apparent in communications and in instruction, says college administrators. Rotman notes that 95 percent of faculty and 90 percent of students use e-mail every day, which has enhanced faculty-student communications. In addition, targeted information is often accessed through the network, including both general information, such as course-section availability, and individual data, such as transcripts.

Technology in the classroom has caught on quickly due to the high quality and accessibility of equipment and the Internet. Faculty are incorporating Internet use into course require-ments, and students are following suit by including Internet materials in research papers and presentations. With the help of faculty incentive grants, several professors are developing extended resources for classroom use in areas such as plant taxonomy and communications in the information age.

Dixon notes that another popular area of CedarNet is the library resources section, explaining, “Through OhioLINK, students can access library catalogs and order materials from more than fifty Ohio college and university libraries from their dorm rooms twenty-four hours a day.” Access is also provided to a variety of CD-ROM-based indexes, including full-text newspapers and application-specific databases. He adds, “Since CedarNet is based on a microcomputer architecture, these CD-ROM applications function at all workstations with the same full graphics as computers in the library itself.”

Looking toward the future, Rotman says Cedarville will maintain its existing infrastructure and pursue and promote software variety. The college will work “to develop in-house operations for use on the network, and will enhance faculty use of the network by providing additional skills and background,” he says. A former chapel is currently being converted to a technology center that will include several labs and computer classrooms.

As the community continues to investigate opportunities within the existing infrastructure, the influence of the network deepens. For example, Rotman says, “faculty are experimenting with using distance learning methodologies in their classrooms.” Professors place class notes online and require students to review the notes on their own time. This allows more classroom time to be devoted to the communication that Cedarville is proudest of: faculty-student interaction.

G/E
High-tech service

Meeting individual needs within an entire university is a big job, Lilly explains, and the key is keeping in touch with all areas of the community. Free e-mail service, Web hosting services, and access to support personnel are offered to all members of the university community. She says that technology has had an enormous impact on instruction at Virginia Tech, assisted significantly by the Faculty Development Initiative. This effort to increase computer literacy among faculty has reached approximately 90 percent of its intended audience through summer institutes over the past five years.

But the institution believes good service is important to more than its immediate community. Combining its leadership in technology with its motto, “Ut prosim,” or “That I may serve,” Virginia Tech is well known for its network outreach programs.

In collaboration with Old Dominion University and the Virginia Community College System, Virginia Tech led a project to develop statewide access to advanced digital communications services. The project resulted in the high-capacity ATM network, Net.Work.Virginia. The broadband network includes an Internet gateway open to all participants, and can handle simultaneous transmission of interactive voice, data, and video services. The network brings the citizens of Virginia into a new era of teaching and learning. With the establishment within Net.Work.Virginia of perhaps the first operational Internet2 gigaPOP with operational gateways to the National Science Foundation’s vBNS network and the Department of Energy’s ESnet, Virginia Tech extends its leadership in next-generation communications systems on a national scale.

In 1991, exploring ways to bring its campuswide network to off-campus homes and offices, Virginia Tech decided to offer Internet access to everyone in its home town. Together with the Town of Blacksburg and Bell Atlantic of Virginia, the institution created the world’s first electronic village, offering access to all the town’s citizens in 1993 and garnering international attention. Today, Virginia Tech President Paul Torgersen says, two-thirds of the town’s 36,000 residents use the Internet.

Virginia Tech is consistently involved in research initiatives, such as a recent study conducted with the Information Technology Association of America on information technology worker shortages. The university, together with eight other institutions, is also researching strategies for assessing an academic networked environment, a project led by the Coalition for Networked Information.

On the horizon

In mapping its future, Virginia Tech plans to remain a leader in the world it knows so well. Torgersen hopes that the institution will soon break ground on an Advanced Communications and Information Technologies Center, which will combine communications teaching and research with instructional technology research and development. And for the fall 1998 semester, students will be required to purchase PCs and software packages.

Lilly notes, “We have a great deal of visibility with peer institutions around the world, and we welcome visitors one to three times a week who come to see what we’re doing. It’s been really exciting and rewarding. We don’t set limitations on what we can do; we just look to the horizon.”
The network is, in fact, your application.

The capacity of data storage devices is growing by 60 percent each year, and data access rates are increasing dramatically. Digital magnetic storage is already cheaper than paper and will continue to be the dominant medium for the storage of active data. The trend is toward smaller, less costly, more rugged disks, with more bits per unit area. For example, in 1995 IBM researchers demonstrated a new world record in magnetic data storage density—3 billion bits per square inch—using advanced magnetoresistive recording heads. At this density, the text of 375 average-sized novels could be stored in a single square inch of disk surface.

CD-ROMs are rapidly becoming the preferred storage and publishing medium for text, images, full motion video, electronic catalogues, games, and software. Current prototypes of multilayer optical disks, (with ten disks), a high-density CD, has the capability of storing 6 billion bytes of information, equivalent to more than one million pages of text. In addition, small form factors will enable CD-ROMs to be incorporated in mobile computers.

Speech recognition technologies, an example of “hands-free” computing, can recognize more than 30,000 words at a rate of seventy words per minute. In addition, researchers are currently developing a large- vocabulary, speaker-independent continuous speech recognition system for multiple languages.

These paradigm shifts in computing are not restricted to hardware platforms and networks (mainframe, client/server or network-centric). As technology matures, there is an evolution in its use. As a new technology is introduced, its early uses are likely to be found in niche areas. For example, when CPUs were introduced, they were first incorporated into accounting functions. Cal-
endar and mail functions were promoted with the introduction of laptops. The early applications of voice-recognition showcase the use of voice, but do not reach everyday activities.

The second phase of technology introduction is characterized by a migration to general-purpose uses. Personal computers are in this phase today. PCs are used for many purposes: word processing, electronic communications, spreadsheets, graphics, multimedia, etc. The PC is highly adaptable because of the range of applications used to tailor its functionality. Yet to obtain this functionality, users are required to purchase specific software packages as well as upgrade hardware and operating systems, and keep up with new versions of the applications. Over the next few years, the PC will move into the third phase of evolution, that of being an “appliance.”

The “appliance” phase is characterized by a “thin-client, fat-server” model. In this scenario, code does not permanently reside on the client, it resides on a server. When the user needs an application, it is accessed through the network and executed on the client machine.

This move will be motivated by a growing frustration with the fundamental limitation of general-purpose use: constant upgrading. Today’s general purpose computer use can be described as a “fat-client” model. The client machine must have increasing memory and processing capacity, and more and more software with a seemingly endless procession of upgrades. As computers and software improve, fatter and fatter clients will be required. From an individual user perspective, this can be a frustrating experience. Installing and integrating new versions of software, reconfiguring hardware, and ensuring compatibility require time and skill that the average user may not possess.

For large organizations with hundreds or thousands of users, the fat-client model is becoming insupportable. Many in higher education experience the inherent limitations of the fat-client model for even simple activities. Have you used one version of a word processor at home, only to find you cannot print that version at the office? Has a colleague sent you a file that you must spend hours converting into a format you can read or use?

A much more efficient model is that of the “thin-client, fat-server.” An organization would invest its resources in ensuring that the network is up to date and that its users have information appliances. Changes would be made to the network, not to individual client machines. Actually, this evolution is under way. Java, Internet plug-ins, and compound documents are the emergence of the appliance model.

A “thin” client does not imply anemic personal computers. It means that the code does not have to reside on the local hard disk, instead it is delivered just in time to be executed dynamically. The logistics of keeping thousands of individual systems at the same level of platform, word processor, spreadsheet, messaging, graphics, etc., software is daunting. This “thin” model takes advantage of the power of the personal system without the burdens of systems management and logistics that affect every user community, from individuals through large enterprises.

**Rate of change**

Over the next decade, profound and inexorable advances in technology, particularly

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**Microprocessor Performance**

There will be continued rapid growth in microprocessor performance, which is expected to double every eighteen months. Clock rates will continue to move ahead rapidly, exceeding 1 GHz or billions of instructions per second by the next decade. By the year 2000, a typical client microprocessor will have the capability of today’s large servers. This performance improvement is enabled by advances in technology such as continued linewidth reduction, increased chip density, and architectures such as Very Long Instruction Word (VLIW).
in computing capability, connectivity, bandwidth, software development, and digitized content, will continue to be change agents. To help you plan for the rate and direction of change, anticipate that:

• computer technical capability will progress at a 2x-per-year rate;
• bandwidth will grow at faster rates than compute power;
• object technology will transform application delivery;
• digital forms of data will explode capabilities and access;
• computing, communications, content, and entertainment will converge; and
• vendor-independent standards will become dominant.

Microprocessor performance has been increasing at a relatively constant rate, doubling approximately every eighteen months. This trend is expected to continue. Its impact, however, is a perceived time compression, which will cause a change in the business model of computing.

A steady rate of growth (2x per period of time; as in 2, 4, 8, 16, 32...) will yield progressively larger increments of growth as the rate continues. The result is that it takes less time to cover the same increment of technological advancement. This perceived time compression stresses our established models.

Consider word processing as an example. We have had word processors since the 1980s. Initially, it did not seem that word processing changed much as we moved to new generations of technology. The word processor used on an 8088 machine was not radically different than the one used with a 286 machine. By the time 386 machines became common, users began to see a point-and-click interface instead of keystroke commands. Microprocessor performance was doubling every eighteen months to two years; the rate of change was the same as it is today. The base was relatively low, so the increment of change remained small, and function did not appear to change radically or quickly.

With today’s technology (Pentium and above), it is possible to “type” using voice dictation as well as opening or closing applications through voice commands. This is a sizable change from a manual interface. The next generation of technology will double the capacity of a Pentium Pro MMX processor. What functionality will we have available after the next doubling of microprocessor capacity? The pace of change, as we have moved from keystrokes to a point-and-click interface to voice commands, seems to be increasing. It is not. The rate of change is still 2x. Our perception, however, is that the expanding capabilities of technology seem to be occurring in a shorter and shorter time frame. Imagine extrapolating processor performance for four years; it will have doubled twice. Will word processing have migrated from voice recognition to mind reading?

The result is that we sense a breathless pace of change. The impact is felt on organizations, as well as individuals. Asset volatility is high. Neither organizations nor individuals can purchase the “right” machine. As soon as it is bought, it is out of date. No one can keep up with the current version of software. Organizations are spending enormous energy, time, and money churning hardware and soft-

Application Development

In application development, framework-based composition will replace monolithic design. This trend is driven by object technology, which facilitates the design of application frameworks and reusable parts. The availability of domain-specific parts will enable faster and less costly development of new applications, and this will be done by domain experts, instead of programming experts.

“What functionality will we have available after the next doubling of microprocessor capacity?”
ware in an attempt to remain current. In spite of large investments, institutions find themselves with two or three levels of technology that are now obsolete, but which they cannot afford to discard.

The increment of change between generations of technology is becoming too large for this purchase-based model to survive. The emerging model is that of network station management—a subscription model. For both individuals and organizations, it makes better business sense to pay a monthly “subscription” or “rental” fee for access to an information appliance as well as the software and storage needed on the network rather than to continue the upgrade cycle.

**Social Changes**

In addition to the exponential changes in technology, two social forces will drive change: (1) the increase in the value of time, and (2) the recognition that information technology is a competitive differentiator.

Information is being digitized. The significance is that the conversion of text, graphics, images, and video into bits gives information a digital passport to travel across global networks. Powerful new communications technologies are giving networks the bandwidth needed to handle rich but space-consuming content like video, MRI (magnetic resonance image) scans, or great works of art. Networks are developing the speed to support interaction, enabling two-way communication and collaboration. Together, digital content and high-speed networks make the once-improbable entirely possible.

In this decade, we will move beyond client/server computing and packet-based Internet connections to global connectivity, which will be embodied in a worldwide, highly distributed computing *infrastructure*. Connectivity enabled by the *infrastructure* will profoundly change access to content, services, and communications. Consider the explosive growth of the Internet in just the past few years. In May of 1996, the Alta Vista search engine had indexed more than 33 million articles and Web pages. Today, it would take more than five years to read the new listings added each month. Today, there are approximately 30 million Internet users. This number is expected to grow to 200 million users by the year 2000. The Internet enables individuals to get connected and stay connected.

There are likely to be three paradigm shifts that result from the *infrastructure*: (1) Everyone will become a technology user because costs will be low enough and compatibility will be high. New software will allow the broader population of users to easily deal with ever more complex systems. (2) Inter-enter-

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**Wireless Communications**

Wireless communications and increasing bandwidth will change the landscape, enabling transparent access across all networks. Things will work together without being wired together. Personal area networks (PANs) will be pervasive. With a bandwidth of about 10 Mbps, these transceivers will be built into most products. The only “wire” required for a personal workstation will be the electrical cord. Local area networks, or LANs, will be ubiquitous, with integrated voice and data. Radio frequency will be used within individual buildings or small campuses, and infrared will be used within rooms or other enclosed spaces. Wide area networks (WANs) will provide worldwide universal access through technologies such as Cellular Digital Packet Data, satellite networks, and two-way paging. Communication device form factors, i.e., the size of the “computer,” will decrease, while function increases, resulting in wearable computers such as wrist watches that can receive messages and send an acknowledgment.

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prise integration will become pervasive. We already see this in the form of electronic links among suppliers, distributors, and customers. (3) We will process and transport bits, instead of things and people; information will displace the physical. Working this way will be faster and less costly, as well as less harmful to the environment.

Technology enables the transmission of information. But fundamentally, the critical process is people interacting with other people. Technology enables us to develop a much more participatory and collaborative society.

The societal implications of participation and collaboration could be immensely powerful. Drawing on research in collaborative learning, we know that there are significant cognitive and non-cognitive effects of collaboration. For example, delivery of education through a collaborative, computer-mediated environment alters the relationship of the instructor, the students, and the course content. The many-to-many, asynchronous nature of the medium democratizes access and encourages student input.  

The basis of the non-cognitive benefits appear to be that cooperative learning is a social method where learners work together as equals to accomplish something of importance to all of them. There are positive effects on students’ self-esteem, social relations, cross-cultural relationships and attitudes. Retention is improved. If the power of technology can be harnessed to bring such benefits to society as a whole, it may engender a new era.

**Transformations**

Technology is a transformation agent. Through technology, higher education can enhance information access that can be used to develop better relationships. Alternatively, institutions can enhance their competitiveness by finding “relationships” in the information they collect. Information empowerment, getting connected, and the apparent compression of time will impact individuals, institutions, and society. Our analysis is that higher education will be transformed by several factors, one of which is the influence of consumers.

**Consumers**

One of the most significant transformations resulting from these technological changes will be in the consumer market. In many ways, networked consumers are beginning to drive information technology.

First, the consumer market is enormous. By the year 2000 there may be more than 400 personal computers for every thousand people in the seven major industrialized countries. At present, 37 percent of U.S. and 26 percent of worldwide households have PCs. Put into perspective, 26 percent of all PC shipments go to consumers.

Networking

Asynchronous transfer mode (ATM) will be the predominant networking technology, enabled by standard interfaces. Its use will be driven primarily by multimedia applications, which require high bandwidth to the desktop for digital video. It will also integrate voice and data over the same network. The cost of ATM adaptors is expected to drop, making them cost effective for office and campus use. High-speed ATM to the desktop will transform computing, since for many applications, it will no longer matter where data and the computing resources are located.


not the business or the academic community. Increasingly, the de facto architectural standards will be determined by consumer adoption. The result is that consumers will influence higher education, both directly and indirectly.

First, as technology becomes more prevalent among consumers, entering students will expect that technology will be part of their environment. We are already seeing students behave as more astute consumers. For example, those institutions that have adopted policies where computers are required for all students have seen their applicant pools double or triple, faculty report that students work harder and learn more, and students and employers believe they are better prepared for careers.7

This consumer movement also implies that students entering colleges and universities will have grown up on computers and the network. Sometimes called “Generation Y,” these children will soon be on campus. As the first generation to take the Internet for granted, Generation Y’s very orientation in space and time will be different from its predecessors. Some are growing up with online pen pals in Europe or Asia. Far more than today, their world will be global, connected, and around-the-clock.8 Generation Y views computers and the network as basic equipment, no more puzzling or remarkable than a refrigerator. Are our campuses, our personnel, or our processes ready?

As consumers acquire and use technology more and more extensively, it will be used to shop online, to make payments, to seek advice, and to eliminate wasted time and travel. With a population comfortable doing comparison shopping over the network, how will students and their parents “shop” for a college or university? The explosion of Web pages for colleges and universities is an early indicator of this trend. However, the use of the network does not stop with looking for information. Students are able to apply to college via the network, order books, get course packs, and pay tuition via the Web. Why wait until college? Why not begin preparing for college by seeking advice from prospective institutions in the eighth or ninth grade?

Distributed instruction, the explosive growth of networks, and the trend to move bits instead of people and things will continue to erode the geographic hegemony of higher education institutions. One potential impact will be on the competition for students. Students will be increasingly likely to select educational institutions based on offerings, convenience, and price rather than on geography. This competition will not be limited to the United States or North America; it will be global.

Getting connected

Another impact may be on the sharing of courses and instructional content. As common formats, increased network bandwidth, and rights management improve, institutions

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**Display Technology**

Display technology will change significantly within the next decade. Liquid crystal displays or LCDs will become dominant across a wide range of sizes and will displace the CRT display for most applications. Thin film transistor LCD displays will allow tremendous power savings over CRTs. Projection technology will allow very large, very high resolution displays, reaching display size of nearly 50” in diagonal and exceeding eight million picture elements. At the other end of the spectrum, very small, very high resolution displays will be used in personal viewing systems, such as those used today in immersive virtual reality applications. In addition, we will see the emergence of paper-like displays which will be reflective, very-high-contrast and resolution, and low power.
Appliance Phase
By 2000 or 2005, the network will have changed from a connectivity and transport mechanism to a destination in its own right. Software and some content will become imbedded into the network instead of only into the connected end points.

with educational content are increasingly likely to share courses and content. The sharing of authentic information brings students closer to the level of scholarship that faculty experience. Working with authentic material, coupled with learning the “way of thinking” of a particular scholarly community, allows students to enhance their learning.

The ability of students to connect with experts around the world, as well as their peers, opens new opportunities for learning and enrichment, as well. Most students and faculty find these opportunities motivating. In addition to the uniqueness of the experience, contact with other cultures and with individuals from the work place tends to broaden cross-cultural awareness and fosters an appreciation of real-world, complex issues with which students will wrestle upon graduation.

Expanding options
In addition, communication, computing, and networking technologies expand the reach and range of traditional residential colleges and universities, enabling students to synthesize on-campus with online experiences. Some learners seek a mixture of face-to-face experiences and networked-based education. For example, the on-campus student who wishes a more individualized, self-paced, self-directed learning experience can achieve that desire through technology.

With a goal of reducing the time to degree, students may choose to complete courses in residence while simultaneously fulfilling other graduation requirements online. The network expands options for interaction among faculty and students. External experts are more easily accessed; opportunities for faculty to individualize and personalize contact with students is increased.9

Risk to the middleman
Information technology places pressure on the “middleman.” Computer networks offer the possibility of the consumer accessing services and information directly rather than going through an intermediary. We have already seen these pressures in business. A common thread among automated teller machines, travel information, and online stock transactions is that the network makes the “middleman” potentially superfluous.

One of the challenges to higher education will be to identify those “transactions” where humans are “in the middle” as opposed to those in which they add value. For example, some higher education institutions are finding that a large percentage (up to 60 percent) of student inquiries for information (e.g., financial aid, overdue parking tickets, etc.) can be handled by an information system; only a modest percent require human intervention. “One-stop-shopping” service centers allow students to get the information they need through a convenient, customer-oriented approach. Institutions using such philosophies are discovering that the result is a reduction in the amount of time students need to conduct business transactions as well as an improvement in customer services. In addition, staff time can be refocused on higher value activities such as establishing a long-term financial plan for the costs of a student’s education or determining how to incorporate an internship into their program of study.

Enables rethinking
The final point to remember about information technology as a transformation agent is that it is a critical enabler for reengineering. Many institutions are finding ways to enhance efficiencies, reduce cost, and apply those human and financial resources to the core activities of higher education. A common approach is to reengineer administrative processes, to reduce bureaucracy but also

to identify cost savings that can be applied to instruction or research.

New ways of conceptualizing a process can reduce time and expense. For example, consider a typical travel-expense reimbursement process with an average cycle time of three weeks. Problems within the process include mathematical calculation errors, currency conversion problems, missing signatures, travel expense coding errors, and incorrect routing. Analysis of the travel-expense reimbursement process often reveals a high degree of “non-value-added” activity—steps in the process that have no value in the eyes of the customer. This process can be redesigned by eliminating the steps that contribute no value, and by introducing new technology and work policies to expedite the process. The redesigned travel expense reimbursement process reduces cycle time from three weeks to three days, reduces errors, eliminates unnecessary reviews and approvals, and places the money directly in the employee’s account.10

**Change is imminent**

Skeptics still question whether technology will have an impact on higher education. Even though many are calling for the transformation of higher education, an equal number see no reason to change. These “traditionalists” often cite how stable higher education has been for hundreds of years. Since the Gutenberg Bible was printed in 1456 using movable type, the technology of information storage, retrieval, and transmission—the university’s basic technology—has remained essentially constant until the current era. Indeed, the use of written records to supplement oral teaching goes back to the fifth century B.C. Since their inception, universities and colleges have relied upon lectures, discussions, and the written word because these were the only technologies available.11

Information technology has opened new, fundamentally different options for higher education, both in how to run “the business of higher education” as well as in teaching and learning. History demonstrates that fundamental technological change ultimately begets significant structural change, regardless of whether the affected participants choose to join or resist the movement. The changes that universities have weathered over the centuries did not upend their basic technology. Information technology does.12

Within the next decade, information technology and its effects as a transformation agent will have dramatic impact on our lifestyles and work styles. Technology will become ubiquitous. Its presence and power will be taken for granted. We will have an increasing capacity to enhance a variety of relationships because of the meaning we derive from information. We will transform data to information and knowledge; knowledge will lead to insight. Our world will be transformed by information technology—the insight we gain will lead to a world of enormous opportunity.

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12 ibid.
True Partnerships: The Key to Technology Infrastructure Challenges

by Bruce A. Metz

Colleges and universities must build and maintain a robust, comprehensive technology infrastructure to provide the foundation for services required today and into the next century. The reality is that significant financial, technical, and human resource challenges pose formidable obstacles, preventing many institutions from succeeding. Rider University solved the problem by forming a true partnership with Bell Atlantic Corporation, a leading communications vendor with extensive experience integrating advanced information technology into academic environments.

The Rider-Bell Atlantic collaboration produced a $4 million state-of-the-art campuswide fiber-optic information and communication network offering an array of video, voice, and data services to all faculty, staff, and students. This article describes how Rider developed and fostered its partnership with Bell Atlantic, and how this way of doing business provides significant benefits to the university.

Background

Rider University is a comprehensive institution composed of four colleges that serve 5,200 students in a central, suburban New Jersey location between New York City and Philadelphia. In 1993 the university recognized the necessity of making a substantial institutional commitment to information technology in order to achieve vital strategic objectives. By integrating information technology into teaching, learning, and research across the curriculum, Rider looked to strengthen its competitive position and become more distinctive as a teaching institution.

A campuswide task force formulated an information technology strategic plan to realize the goal that was endorsed enthusiastically by all constituencies. Initially, more than $6 million was allocated for the pervasive deployment of information technology to support instruction, research, scholarly and creative activity, academic and administrative decision-making, and campuswide communications.

At the time of the funding commitment, Rider’s technology environment included a very limited and aging physical infrastructure insufficient for the university’s current, much less its future, needs. Data services were based on a minimal optical fiber backbone connecting only ten of the thirty-nine buildings on the main campus, and none of the residence halls. Wiring within buildings proceeded according to no formal distribution systems. This wiring consisted of homegrown expanses of Category 3 unshielded twisted pair copper that proved quite difficult to maintain. A small minority of users had network-level desktop connections at 10 megabits per second (Mbps) using 10Base-T shared Ethernet. Most users had terminal-level connections with a data rate of only 9.6 kilobits/second. Moreover, the data network infrastructure included no empty conduit space for expansion.
Voice services were also limited. A separate copper cabling plant supported the telephone system, served administrative and academic buildings only, and was deteriorating. The university's analog private branch exchange (PBX) was over ten years old and well past its useful life. In addition there was no video capability or video network, and only basic audio-visual services were provided.

There was wide agreement that a completely new campuswide information and communication infrastructure formed the key to establishing Rider as a leading, state-of-the-art interactive teaching institution. Owing to the significant role envisioned for information technology at Rider, the requirements for a new physical infrastructure went well beyond the typical project. Specifically, the following principles guided Rider's initial project planning:

- The new infrastructure must be as robust and extensive as possible, integrating voice, video, and data services and incorporating the latest technologies without becoming "bleeding edge."
- The new infrastructure must be flexible and open to accommodate rapid technological change and to maintain the infrastructure's "leading edge" capabilities by readily incorporating new technologies when appropriate.
- Methods and procedures must be defined to assess and test emerging network technologies in a controlled environment to minimize technical risk and avoid potential service disruptions prior to the adoption of these technologies in a production setting.
- Creative funding approaches to infrastructure installation and maintenance must be devised to overcome constrained financial resources and to free capital resources for technology investments that make use of the infrastructure.
- A core, highly skilled technical staff dedicated to the infrastructure must be made available within fixed operating budgets to ensure a successful installation and a high level of ongoing service.

These requirements led Rider to pursue a strategy of partnering with a top-flight networking and communications vendor. The university expected that a partnering strategy would add significant value and benefit by improving infrastructure design, implementation, and performance, giving Rider staff as-needed access to sophisticated technical expertise not available internally; allowing Rider to keep pace with rapid technological change while controlling technical risks; freeing internal technical staff and resources to focus on core competencies and new priorities; and controlling, and possibly reducing, infrastructure operating costs following installation.

To meet its needs, Rider envisioned a partnership that went well beyond the typical outsourcing arrangement. The university was prepared to make significant commitments to an external partner, so that the vendor would not have to spend time seeking Rider's business at each turn. In return, Rider expected that the selected vendor would continually understand the university's evolving requirements, provide the best solution at a fair price, and further Rider's vision for the use of technology in all areas of the institution.

**Beginning the partnership**

To find its partner, Rider elected to follow a more open-ended and informal approach than normally associated with campus networking projects. The standard method typically involves the development of a lengthy Request for Proposal (RFP) that once completed is released for bids by interested vendors. The RFP is often based on extensive analysis and design work performed by university technical, administrative, and academic personnel, assisted by consultants experienced in networking and related technologies.

Rider's approach started with some of the usual steps. First, a core project team was
formed consisting of members of the technology organization, facilities department, and key administrative and academic organizational units. An external consultant with a strong track record of successful infrastructure installations was selected to join the team. As an initial task, the team produced a brief general requirements statement that contained three major parts: (1) campus infrastructure needs identified by various constituencies and departments throughout the Rider community, (2) nature and status of the aging infrastructure that was in place, and (3) university partnership goals, objectives, and expectations.

Subsequently, the project team engaged in a research effort to reduce the vast number of potential vendors to a group of reasonable size. The team targeted vendors who had extensive experience integrating voice, video, and data networks, and applying advanced communication technologies to academic enterprises. The team looked for vendors who offered a range of services that encompassed network installation, management, and maintenance. Other factors researched in a preliminary way included the quality of a vendor’s management and technical personnel, and the company’s financial strength. Where possible, customer references for similar projects were identified and interviewed. In some cases, site visits were made to gain first-hand knowledge of the work that was performed.

At the conclusion of the research phase, the project team contacted a targeted group of vendors about Rider’s impending infrastructure project. Each vendor was invited to engage in a collaborative proposal development process with the project team. Since the infrastructure project was highly complex, vendors were informed that the process could carry on at varying degrees of frequency over a period of six to nine months. Initially, several vendors contacted chose not to participate. Other vendors began the process but withdrew at different stages along the way. In some cases, it appeared that vendors were reluctant to invest a significant amount of time in a potentially lengthy process that did not guarantee any business at the completion.

In other cases, vendors seemed to decide that they could or would not meet the terms and conditions the project team described.

The general requirements statement served as the starting point for the initial series of meetings between Rider’s project team and representatives of participating vendors. The initial meetings had two primary purposes. First, the project team made certain that each vendor clearly understood the university’s expectations for the chosen partner. Second, the meetings provided a mechanism for both Rider and each vendor to make sure there was a common basis to proceed before any in-depth collaboration began.

The ongoing dialogues that followed the screening period provided Rider’s team with a number of benefits. At a technical level, the team had an opportunity to learn about different infrastructure solutions, each with their own advantages. Ultimately, the project team used this knowledge to ensure that different aspects of separate recommendations were incorporated in the final infrastructure solution, significantly improving the end product. At an organizational level, the team was able to assess what partnership dynamics might be like with each vendor. Communication, problem solving, and conflict resolution issues arose frequently during many meetings in the proposal collaboration period. By working through the issues, the project team learned which vendor best fit the university’s culture and organizational style.

Some vendors proved more customer-focused, showing a greater desire to understand customer needs and act in a responsive, accessible, and service-oriented manner. These companies tended to propose solutions that met Rider’s current and future needs. In contrast, the less customer-focused vendors were more interested in selling particular products or their “solution.” Vendors also differed in the flexibility and breadth of their organization. Some vendors were better able than others to bring in the right people at the right time to develop different parts of the overall solution. In addition, vendors tended to project varying degrees of credibility. In some cases, vendors acknowledged their limitations.
as well as capabilities by describing what they could not do in an up-front way. Other vendors tended to over commit and maintain that they could do everything Rider needed.

By the end of the discussion phase, three vendors prepared and submitted detailed proposals for the university's campus-wide infrastructure. Rider's project team carefully reviewed each proposal. The review process triggered a new series of discussions that led to proposal revisions. Ultimately, the proposal from the Bell Atlantic Corporation was selected based on its superiority in seven critical areas: (1) quality, clarity, and completeness of solution; (2) partnership opportunities; (3) quality of management and technical personnel; (4) overall quality of Rider-vendor working relationship; (5) vendor flexibility; (6) breadth of vendor services and knowledge; and (7) competitive pricing.

In order to deliver the optimal infrastructure in support of Rider's vision, several Bell Atlantic companies contributed to the proposal and would be involved in its implementation. Bell Atlantic—New Jersey, Inc. had primary responsibility for the networking portion and overall accountability for ensuring that all other Bell Atlantic entities satisfied or exceeded the university's requirements. Bell Atlantic Network Integration, Inc. (BANI) had primary responsibility for the information infrastructure, including cabling and data network hardware as well as the video services portion. Bell Atlantic Meridian Systems, Inc. (BAMS) had primary responsibility for the telecommunications or voice services portion.

In retrospect, the frequent contact between Rider's project team and Bell Atlantic representatives provided important benefits for infrastructure installation and beyond. Each group got to know each other, developed trust and confidence in the other party's abilities, and learned how to work together. Bell Atlantic staff had the opportunity to understand Rider's needs in depth and the nature of the university's organization prior to starting a large-scale implementation. Ultimately, this understanding was reflected in the extent to which the Bell Atlantic infrastructure proposal met Rider's short- and long-term project objectives. Indeed, the smooth manner in which the formal contract for the project was completed provided an early sign that a partnership was already formed.

The infrastructure project

The infrastructure project linked thirty-nine buildings on a 353-acre campus at a total cost of approximately $4 million. All told, the network included approximately 10,000 connections: 4,000 data, 4,000 voice, and 2,000 video. The project proceeded in two phases.

In the first phase, which took place from June to August of 1995, an optical fiber backbone was installed underground to interconnect all thirty-nine buildings. Cabling, wiring distribution systems, and associated equipment were installed in all residence halls and fraternity houses. Video, voice, and data services were then made available to all resident students in time for the fall 1995 semester. Off-campus connections to the data network were also put in place.

The second phase of the installation involved cabling, wiring distribution systems, and associated equipment for all academic and administration buildings. This phase was completed between August 1995 and January 1996, while the campus was busy. The tight deadlines formed a big challenge for all involved in the project. Nevertheless, the project was completed without major or unexpected difficulties. Rider successfully cut over to the new network for all faculty and staff in early January 1996, right on schedule.

Full-time project management services provided by Bell Atlantic proved to be a key factor in the project's success and keeping the project on track. The sense of teamwork that developed during the proposal phase carried over throughout the implementation. Staff from the Bell Atlantic companies and members of the Rider campus community worked in a total spirit of cooperation. Changes that are inevitable in a complex project were always discussed and performed if necessary, providing a level of flexibility in the implementation that is difficult to capture in a formal contract. Since staff from all Bell com-

“The sense of teamwork that developed during the proposal phase carried over throughout the implementation.”
panies were already very familiar with Rider’s campus, work proceeded quickly and smoothly.

Composite fiber of both multi-mode and single-mode fiber was used for present and future needs. Fiber was terminated in closets in each of the buildings. From those points, Category 5 copper was installed to carry data to every end node. Category 3 copper wiring was used for voice, and coaxial cable was installed for cable television. Every office, classroom, and conference room was connected to the voice and data networks. Video was installed everywhere except offices. In the residence halls, each of the approximately 1,800 students involved was provided with individual Ethernet and voice connections in their rooms, along with a single video connection per room.

The data network was based on both fiber data distributed interface (FDDI) and asynchronous transfer mode (ATM) technologies, with data rates in the backbone as high as 155 Mbs. All users have network-level connections at the desktop, with data rates of 10 Mbs from both shared and switched Ethernet, and 100 Mbs from fast Ethernet. In a few cases, users have ATM speeds—155 Mbs—at the desktop.

ATM was selected as the primary transport for Rider’s multimedia instructional network. It is used for the delivery of multimedia instructional materials prepared by faculty, including images, audio, and video. The plan is to use ATM to send digitized materials stored on network servers to electronic lecture halls, selected public access labs, the library, and advanced technology centers throughout the campus. The ATM network will also be used for videoconferencing applications on- and off-campus.

A special feature of the new infrastructure is its fiber-distributed, digital private branch exchange (PBX) switch—the Northern Telecom Meridian 1 Option 81 PBX—supplied by BAMS along with the Meridian Voice Mail System. In a traditional campus environment, a PBX is located in a central switch room, and voice service is distributed over a copper backbone. The Meridian system, however, took advantage of Rider’s fiber backbone to distribute voice service. At Rider, 14 Meridian Fiber Remote/Intelligent Equipment Modules were positioned on wall-mounted shelves in IDF closets. Each Fiber Remote delivers voice services to 256 telephone stations, using Category 3 UTP in the buildings. Money was saved in infrastructure costs since a separate copper backbone for voice was not needed. And since the optical fiber backbone is immune to electromagnetic interference, the distributed PBX eliminated virtually all worry over communication disruptions due to electrical storms. This benefit was important, since the Rider campus is situated in an area that is lighting prone, and in the past storms occasionally knocked out phone service.

Video capabilities of the new infrastructure include a 50-channel system that delivers cable television channels around the campus including all residence halls. Off-air channels, satellite downlinks, videoconferences, distance learning, and multimedia can be integrated into the system and distributed throughout campus as the university’s video applications require.

In addition to a new campus infrastructure, the university completed other major technology initiatives to make use of the new capabilities, benefiting all members of the campus community. Academic technology initiatives included new public access computing laboratories, multimedia technology centers across academic disciplines, a faculty resource center, a new library information system, and electronic lecture halls in each college. The successful integration of technology has transformed Rider’s academic programs, library services, campus life, and administrative operations. For example, the Middle States Association of Colleges and Schools evaluation team concluded in their May 1996 re-accreditation report that Rider’s new library information system “is one of the most advanced and technologically sophisticated integrated library systems in the country. When linked with the new campuswide information technology infrastructure, these two systems provide one of the most powerful pedagogical tools available anywhere.”

“The successful integration of technology has transformed Rider’s academic programs, library services, campus life, and administrative operations.”
Continuing the partnership

Since conclusion of the infrastructure project, the Bell Atlantic companies provide a broad range of services critical to the success of information technology at Rider. The services include:

- enterprise network management with operational support and maintenance of the complete infrastructure on a twenty-four-hour, seven-day-a-week basis;
- enterprise network hardware support for all data network components;
- on-site network engineering services to ensure smooth and proper functioning of the data network and the voice system;
- planning, acquisition, and installation services for new and emerging infrastructure technologies;
- infrastructure cabling services to install, test, and certify new video, voice, and data outlets as additional connections are required; and
- general on-site technical support services during times of peak demand, such as the start of each semester, to connect resident student computers to the network.

The ongoing relationship with Bell Atlantic enables Rider's information technology organization to better serve faculty, staff, and students by concentrating its resources on core competencies and responding to new priorities. With Bell Atlantic personnel responsible for most of the infrastructure, the university's technology staff can focus largely on other areas that directly benefit customers, such as communication applications, instructional uses of technology, distributed computing resources, training programs, technical support services, and help desk functions.

University expenditures for infrastructure operation and support have increased in keeping with the substantial growth in capability. The additional costs are funded by a portion of new revenue derived from two sources: (1) the resale of video, voice, and data services to resident students; and (2) the establishment of a technology fee for all students. Full-time students pay a fee of $75 per semester; the fee for part-time students is $10 for each three-credit course enrolled. The balance of the revenue is used for academic technology projects, providing students with visible, new facilities for their fee and giving the university an ongoing opportunity to enhance its technology environment.

Since Bell Atlantic provides vital infrastructure services to Rider at a lower cost than possible in-house, the level of expenditure increase is significantly lower with the partnership. Some services, such as twenty-four-hour, seven-day-a-week network monitoring, would prove cost prohibitive for the university to implement on its own. Multi-year agreements with Bell Atlantic enable Rider to fix certain infrastructure costs for an extended period of time. This degree of cost control over critical functions leads to better short- and long-term financial planning for other major technology areas.

The single most important factor contributing to the current success of the partnership is that both parties put a significant amount of time and energy into managing the relationship. Rider technical managers oversee the functions performed by Bell Atlantic personnel, ensuring that the activities of both organizations are well integrated. The university retains the right to approve or reject on-site Bell Atlantic staff assignments to make certain there is always a good fit between people working together. In addition, Bell Atlantic's responsibilities are performed and evaluated in accordance with detailed service-level agreements. The agreements specify the tasks to be accomplished as well as performance metrics, such as how quickly network hardware repairs are to be done. Regular meetings between Rider and Bell Atlantic personnel ensure that services are always delivered in the most effective ways possible. The meetings typically involve the right people who are empowered to make decisions about the particular issues at hand. Open communication channels at technical and management levels enable both parties to work through inevitable problems, differences, and changes over time.

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University of Colorado Acquisition Card Project: A Successful Partnership of Program, Process, and Systems

by Kathe D. Graham and Paula J. Vaughan

In 1995, the University of Colorado at Boulder accepted the opportunity to pilot a procurement card program for small-dollar purchases. To meet objectives of maximizing purchasing efficiency, minimizing costs, increasing customer service, and providing appropriate control, it was imperative that the purchasing power be in the hands of the department cardholders while card-usage information be readily available to program participants and administrators.

A cross-functional project team from a variety of departments developed the program and policies, and called upon Information Technology Services to develop a system to work with the data. Since the pilot implementation in November 1995, the program has grown campuswide at both the Boulder campus and the University of Colorado’s Health Sciences Center campus in Denver, and is in the planning stages at the Colorado Springs campus. The program is also being adapted by other Colorado state agencies. Current volume is now over 3,000 transactions and $500,000 per month per campus.

Background information

In 1994, the State of Colorado Internal Audit Department recommended that the Division of State Purchasing implement a procurement card program to decrease the administrative costs of small-dollar procurement. In response to this recommendation, a task force was formed to pilot a program at three state agencies. The state task force includes the University of Colorado at Boulder (UCB), University of Colorado Health Sciences Center (UCHSC), and the state’s Government Support Services Division.

The resulting program at UCB is formally known as the Acquisition Card Program. Traditional purchasing procedures at UCB involve handwritten purchase requests, purchase orders produced by Buying and Contracting, individual merchant invoices, individual receiving reports, and checks cut by Accounts Payable—regardless of the size of the purchase. The acquisition card program offers the university a new way of doing business by providing MasterCard credit cards to departmental end users for university-related small-dollar purchases (up to $1,000). The card provides staff and faculty with an easy, familiar purchase method that greatly improves customer service by reducing order time and “middle-man” paperwork. The payment side of the small-dollar purchase transaction benefits as well. Card-related payment processing in the Finance Office requires only ten minutes per month and involves simply reconciling one MasterCard bill and making one electronic transfer to the bank for the month’s acquisition card purchases. Merchants also benefit, as they are paid within two days of submitting the card purchase information to the bank versus the traditional net-thirty payment terms for most university purchases.
Beginning the project

As a result of a successful Request for Proposal, the state task force signed a contract with First Chicago NBD, whose purchasing card program included many features that served as the building blocks for the design and development of the acquisition card program. These features included:

- card controls (dollar and transaction limits by cardholder and merchant type),
- default transaction account code per card,
- a hierarchical structure that could be used for reporting and security, and
- the university's full liability for card transactions.

First Chicago NBD offered three options for delivering data to the university: hardcopy reports, ProValue Services’ local-area-network-based software, and ASCII files. The hardcopy reports are produced and delivered by First Chicago NBD daily, by cycle, monthly, quarterly, or annually, depending upon the report. These reports can be used as the primary method for program management and administration or may be used to supplement the second and third choices. ProValue Services’ LAN-based software, from ProCard, Inc., is used for receiving, reviewing, and reporting on transaction data. The ASCII files consist of daily transaction data, and are sent as an electronic download or on disk. The institution develops its own application system to work with the downloaded data.

Defining mission and design

The UCB project team was charged with the tasks of defining program mission and design criteria and carrying out the mission. To ensure widespread input and commitment for the program, the project team included representatives from five user departments with a vested interest in the program, process, or system, and reflected the variety of departments on campus (large and small academic departments, large and small administrative departments, and one “problem” department). These five departments were the “test pilots” and were the first to implement the program.

The project team also included representatives from Buying and Contracting, the Controller’s Office, Information Technology Services (ITS), University Management Systems (UMS), Business Process Transformation (BPT), Financial Services, Treasurer’s Office, Internal Audit, Distribution Services, Accounts Payable, Employee Development, Legal Counsel, and Sponsored Programs. The wide representation of the campus community ensured that policy and procedural issues would be evaluated and decided upon by those whose day-to-day operations would be most affected and by those who would be responsible for enforcing the policies and procedures.

The project mission was defined as: “Implement a department-driven and controlled procurement card and supplemental small-dollar purchase system.” This long-term mission statement encompasses the design, development, and implementation of the acquisition card program as well as the design or redesign of various small-dollar purchase methods for those items that cannot be purchased with the card.

The project team used the following seven design principles to reach the program goals:

1. Provide value to customers.
2. Provide flexible, low-cost processing.
3. Take appropriate levels of risk.
4. Trust, train, and empower employees by delegating responsibility and authority to the lowest level.
5. Hold people accountable for fiscal efficiency, effectiveness, and responsibility.
6. Provide the right information to the right people at the right time.
7. Simplify systems and processes while creating user friendliness.

A core team of eight people representing the pilot departments, purchasing, systems, and the controller, was selected from within the project team to handle program design and development details. The core team structure was small enough to accomplish much of the work, yet provided a clear avenue to any of the project team members for input on specific issues.
System decision

After reviewing the functionality, costs, and hardware requirements of First Chicago NBD’s data delivery options, the project team chose to have UCB’s Information Technology Services’ Administrative Systems Group (ITS/ASG) develop an in-house system to work with the bank’s ASCII data. Due to the already-designated target date for the acquisition card pilot, the system had to be designed and implemented within six weeks of the decision date.

Design considerations included the following: The system had to work with any desktop device (PCs, Macs, dumb terminals); it had to communicate with the bank using 3780 protocol and interface with the university’s Financial Reporting System (FRS). Users needed to have online access to transactions for review and account editing, and the system had to provide management reports and adequate controls. All data needed to be secure. The design also had to consider future portability to a relational database for an eventual client/server implementation.

ITS/ASG chose to develop the acquisition card system (ACARD) in a UNIX, Pick-based (Unidata) environment, a platform that would accommodate the variety of desktop devices found on campus and a development environment in which ITS/ASG had enough experience to tackle the project’s time frame and functional requirements with confidence.

Project development

Development of the program’s policies and procedures went hand in hand with the process and system design efforts. The project team designed a high-level process flow and defined policies; the core team worked out details of fitting the processes and policies together while defining the ACARD system requirements. Program and process development each uncovered issues that affected the design of the other. System design had to support policies and processes. Department representatives spoke up whenever they thought additional work was being passed on to them as a result of policy, procedure, or process. Each time this concern was raised, the process was reevaluated until agreement was reached.

The team tackled many issues during program design, always mindful of the campuses’ varied purchasing needs, as well as the many different ways individual departments conduct business. The team’s work resulted in program decisions (described below) based upon meeting the goals, attaining the mission, and following the design criteria defined for the acquisition card program.

A $1,000 maximum per-transaction limit was set at the state level consistent with then-current purchasing delegation. The UCB Director of Buying and Contracting has the authority to allow higher limits on a per cardholder basis. Departments are allowed to define the maximum dollar amount per cycle and the number of transactions allowed per day and per cycle per cardholder. Appropriate and acceptable card-use policies complement the basic First Chicago NBD card controls.

To facilitate ease of use, the project team tried to minimize restrictions on the card. The program specifies five types of card-use violations that carry specific consequences: personal purchases, cash, split purchases, inappropriate purchases, and lack of original documentation. Test pilot team members recommended cardholder-oriented consequences, which differ depending on the nature of the violation, and range from retraining to loss of card to termination and criminal prosecution.

The controller’s influence helped establish the program requirement to reallocate each transaction from the default account:object code to help track purchases and ensure that each transaction is reviewed by the department. As part of the accounting discussion, rules conforming to university and federal accounting guidelines were also established.

Hierarchy, participants, and roles were defined to organize information and structure the program within the campus. Program participants assume one or more of four basic roles within the hierarchy: (1) cardholder, (2) approving official (monitors card usage), (3) reallocator (enters accounting information for each transaction), and (4) department liaison (manages the program within the department). The program allows
a single person to assume multiple roles if desired, as long as a cardholder is not his/her own approving official.

Program documentation includes “set-up” agreements (Program Entry Form and Cardholder Agreement), which are required for all participating departments and cardholders. Every transaction must have an appropriate receipt for the purchase, and the cardholder and approving official must sign the monthly Statement of Account acknowledging that the cardholder’s transactions were for university business.

Each department undergoes an initial audit shortly after entering the program, involving a visit by representatives from Buying and Contracting and the Controller’s Office. Ongoing audits of random samples of statements with transaction documentation attached for Buying and Contracting review will also be conducted. The audit results are used as a training tool and for program improvement and accountability.

**Process design**

Given the variety of departments and purchasing needs, the team wanted to establish a flexible process allowing each department to adapt the program to their unique needs. The Rummler-Brache Group’s process-mapping methodology was used to design the process flow, which included six modules: set up and training, purchasing with the card, accounting, approval, filing, and payment to First Chicago NBD.1

The process map was five feet high by twenty feet long, and hung in the Buying and Contracting conference room for three months. This map illustrated the process steps and corresponding input and output, and highlighted required steps, the steps’ added value, and controls. It also provided a visual aid for detecting repetitive tasks, missing tasks, or inappropriate sequencing. Open issues were noted directly on the map. The map also unexpectedly provided two side benefits: its omnipresence kept all participants thinking about the project, and it acted as a billboard advertisement for the acquisition card program for anyone meeting in the conference room.

The final design eliminated paperwork traveling across campus, eliminated duplicate transcription and keying of information, established new documentation filing rules for individual departments, and moved payment processing from accounts payable (for individual invoices) to the treasurer’s office for one monthly payment. The revised process also pointed out the need to make more purchasing information available through easily accessible sources such as the Web.

**Application system design**

The primary objectives of the system design were to reflect First Chicago NBD’s data with 100 percent accuracy, to provide quick and easy review and allocation of transactions to appropriate university accounts, to provide management reporting, and to ensure security.

To meet these objectives, the ACARD system was designed with the following functions:

*Bank transmission.* An automatic process dials daily into First Chicago NBD and retrieves the day’s transaction data, which is read by the ACARD system. Cardholder, transaction, merchant, and hierarchy activity records are built and balanced against each other.

*Daily e-mail.* After transactions are posted, e-mail with volume totals is sent automatically to program administrators, while e-mail to each cardholder and the corresponding approving official lists transactions that arrived that day for the cardholder.

*Online accounting entries.* Three screens of varying functionality and complexity are available for reallocating transactions to appropriate accounts. Transaction information as sent from the bank (merchant, amount, transaction date, etc.) cannot be modified; only accounting information, transaction status, and notes can be entered by the user. The system edits accounts and object codes for validity and adherence to accounting rules established by the project team. Transaction entry screens are accessible only by users with reallocation rights, and only by those users who are related to the transaction through the program’s established hierarchy.

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E-mail reminders. The system sends weekly reminders to users and reallocators for older transactions that have not been reallocated.

Financial system interface. A nightly feed to the Financial Reporting System (FRS) is automatically run for new edits and unedited ten-day-old transactions. E-mail with batch totals is sent to project administrators and data control. The system coordinates the bank payment cycle with the FRS close, so that only current cycle transactions are posted to current month FRS.

Disputed transactions. Transactions can be flagged for dispute on the ACARD system, which will generate bank-ready dispute forms.

Cycle closing. Cycle-end processes are handled automatically by the ACARD system upon recognizing transactions for the last day of the cycle. The system sends the controller and program administrator an e-mail with cycle totals and the amount due the bank. Cardholder statements are printed. Monthly totals are calculated and posted per organization hierarchy, cardholder, and merchant. In addition, all current-cycle transactions are fed in time for the FRS close.

Reporting. The system includes a variety of reports as well as ad hoc reporting capabilities. Reports fall into six broad categories of transaction-based, merchant, cardholder, statistics, audit, and administration.

Card controls

Specific program controls are essential to promote correct use of the card, encourage timely reallocation of transactions, help detect fraudulent transactions, and protect transaction data and card account numbers. Many of the controls are built directly into the program and system, while other controls are handled through policy.

Card-oriented program controls include card activation and university-specific information printed on the card. In addition, card limits and purchase types are verified at the point of sale. The ACARD system adds control points with transaction-initiated e-mail sent to cardholders and approving officials, age-based reallocation reminder e-mails, system feeds of transactions to the Financial Reporting System based upon program parameters, automatic generation and distribution of monthly cardholder statements, and ACARD system security based upon user profiles.

Policy-driven controls include the cardholder agreement, which must be signed and kept on file. The MasterCard liability protection program addresses cardholders who have terminated employment, and each department has the right to cancel any card within their hierarchy at any time. Policy controls also cover departmental responsibility for educating cardholders, appropriate approving official relationships, and review and filing of monthly cardholder statements.

Project implementation

The test pilots were the first to experiment with all aspects of the program: training, record keeping, ACARD system use, and reporting. Record-keeping systems received a lot of attention, with one or more flavors tried out in each of the departments. Pilot departments are now using their experiences to help advise other departments as they come on board. Test pilot use of the ACARD system revealed a number of areas that could be improved, such as the need for a simplified “quickie” reallocation screen to handle those cases (the majority) when a transaction needs to be reallocated to only one account.

The full pilot implementation further extended the system. Training programs and documentation were refined, and a user-oriented program handbook evolved during this phase. Controls were re-evaluated to accommodate department-specific needs yet maintain the integrity of the program. And as system use increased, so did the list of requested modifications and enhancements. For example, a batch e-mail function was developed to provide Acquisition Card Program administrators with a means for e-mailing notices to selected groups of program participants.

The number of users and volume of data have not significantly affected system performance. To accommodate the implementation of the UCHSC campus, a separate system environment was established on the UNIX processor used to run UCB’s system. Each
campus has its own data, but only one set of programs is being run. Campus-unique logic differences are handled through control file items.

**Measures of program success**

Statistics and measurements of process performance help indicate how well program goals are being met. The majority of the goals have numerical targets or standards associated with them. Baseline data were collected before the implementation of the program for comparison purposes, and process improvement and movement toward the established goals will be gauged from these baseline points.

As a first effort to measure the impact of the program, a five-question survey was sent via ACARD's batch e-mail process to the program's first eleven departments (118 cardholders). Out of a 52 percent response rate, 93 percent of the respondents expressed satisfaction with the program; 80 percent believe the program involves less than or the same amount of work. Some respondents commented that they believe that once they become more familiar with the process it will be less work.

**Project highlights**

Some of the benefits of the acquisition card project are that only one monthly payment is needed for all of the small-dollar purchases handled through the cards, and users have control of their own purchases and accounting. Also, each department can develop the internal paperwork system that works best for them. Departments interested in implementing the card are able to examine the experiences of departments already using the card and adapt those procedures most applicable to their situation.

Other benefits are that vendors are paid quickly, and the program provides automated systems of control, notifications, and reconciliation. These automated functions are among the program's most popular features: (1) Controllers appreciate e-mail reminders of tardy reallocations. (2) E-mail notifications of new transactions are great for auditing purchasing activity against the card. (3) The batch e-mail communication feature makes memo sending a breeze for program administrators. (4) The “quickie reallocation screen,” listing all unallocated transactions per cardholder, is a hit with departmental account reallocators.

The program is not without its drawbacks. The university is liable for all purchases against the card, causing some departments to be hesitant about participating in the program. This liability is currently being investigated by UCB. Some departments have the perception that the program will generate more work for them. To alleviate this concern, pilot departments are sharing their experiences and successes with interested departments. At a functional level, matching the transaction documentation to the transaction sent by First Chicago NBD can be problematic, particularly in cases where a single cardholder makes many purchases with a single vendor in one day: the bank's electronic transaction does not include an item description, transactions often have freight charges added, and orders may be only partially filled. From a planning perspective, if any interfacing system changes, the ACARD system must be able to accommodate the change. The most vulnerable area to date has been the bank interface.

As a whole, the Acquisition Card has been a positive addition to the University of Colorado purchasing tool set. The Boulder and Health Science Center campuses have wholeheartedly embraced the program, and the Colorado Springs campus is eagerly anticipating its implementation. Our survey respondents have told us that the ACARD system saves them a lot of time, is a huge improvement in their flexibility to obtain parts and supplies quickly, and has made their lives much better and purchasing much easier. They appreciate that they have more control over the process. When they have last-minute needs, they do not have to force a rushed timetable on others. Most significantly, they have reported that their cardholders love the program.
Viewpoint

Revising Acceptable Use Policy to Account for Cultural Developments on the Net

by Rob Reilly

Given the changes in user demographics, there is a rapidly growing need to better understand the culture that is developing on computer networks. Today’s acceptable use policies (AUPs) should be based upon a balancing of logistical and operational issues with the cultural needs of the user. Those who craft computer-use policy should move away from the model of a “network as a superhighway” and toward a model of a “network as a commonly shared resource.”

Background and foreground

Originally, the Internet was a smattering of military and university computer systems connected to create a nationwide network. Policies were well understood, but often vague and even unwritten. Users trusted each other. Passwords and privacy were rare. The network that existed then was largely populated by a like-minded group of computer specialists and scientists with strong computer backgrounds.

In the intervening years there have been significant changes in the Internet. Now practically every college is connected to the Internet. With this has come a dramatic growth in the number of people who use this global network. No longer is the Internet a community of like-minded computer specialists and scientists with strong computer backgrounds.

In the intervening years there have been significant changes in the Internet. Now practically every college is connected to the Internet. With this has come a dramatic growth in the number of people who use this global network. No longer is the Internet a community of like-minded computer specialists and scientists with strong computer backgrounds.

The society that inhabits the Internet and local area networks, like any emerging society, needs to establish and understand its own set of rules. Presently, however, cyberspace has, not one set of rules and customs, but thousands. These rules and customs vary from “near-anarchistic code[s] of complete freedom to authoritarian [codes which deny virtually] ... all rights.”

AUPs generally lack content that would cause them to be social contracts—to deal with cultural issues. Beyond its mechanical orientation, the AUP should set philosophical guideposts for the community of users in the way the U.S. Constitution establishes a social contract with all citizens—in the way the student and faculty handbooks establish a social contract for the campus community. A culture is developing on the Net, and the AUP must become the campus social contract relating to computing.

One social contract by which we live in...
our real world community is the U.S. Constitution. While many members of the U.S. community may not be able to elucidate Constitutional principles, they are aware of them. U.S. citizens understand concepts of the Constitution, and tend to live by them. These Constitutional concepts are not meant primarily as rules for law enforcement officials, but as foundational principles upon which our entire U.S. community is based. So, too, should an AUP provide philosophical and ethical guideposts for the developing community of users on the Internet and on university computers.

To accomplish this, AUPs should not only address the mechanical/operational concerns of computer networks (e.g., change your password frequently; do not share your password with anyone; do not run wasteful, computation-intensive programs), but should also address communal and individual interests (e.g., respect the privacy of all users, promote ethical responsibility, protect freedom of speech and the right of access, specify principles for use of shared resources, establish procedures for implementing and protecting due process).

**Tragedy of the unmanaged common**

Since the barrier between the natural and computer sciences is often high and opaque, it is best to first discuss the “tragedy of the commons” as Hardin outlined the concept. This will be followed by a discussion of the possible implications of the tragedy for online computer systems, and the crafting of an AUP as a social contract.

In 1968, biologist Garrett Hardin brought to science's attention a little-known work by the nineteenth century amateur mathematician William Forster Lloyd on population growth and control. Lloyd examined the fate of a common pasture shared among rational, utility-maximizing herdsmen.

Shepherds grazed their sheep on the individual parcels of land they owned. But there was another pasture, a large public stretch of land held in reserve, owned in common by the villagers and known, logically enough, as the common. Then, some shepherds became greedy. They began guiding their sheep to the common each day, preferring to wear out the public pasture because they thought it cost them nothing and saved their own small patches. Soon, others did the same. It wasn’t long before the common was turned into a muddy wasteland—useless to anyone. And as the shepherds watched their individual pastures fall to overgrazing, they realized that their village had been sacked by its own people. They’d stolen their shared livelihood, economic security, cultural center, and much of their village’s beauty from themselves and their children.

Once a resource is being utilized at a rate near its carrying capacity, additional use will degrade its value. Users will then enter into a cycle of escalating demands on the resource to gain advantage or try to break even.

The inexorable working out of the resource’s ruin is Hardin’s tragedy of the village common. In human affairs, this problem has never been more evident than it is today. Its effects are pollution, global warming, ozone depletion, overfishing, extinction of species, abuse of aquifers, and destruction of the rain forests—and in the not too distant future, perhaps computer resources will be added to this list.

But what relevance does this have for acceptable use policy?

Relating this to the creation of an AUP is relatively easy because at the heart of these models/research projects is the problem of the free-rider or the overgrazer, and the issue of regulating use of a shared resource—in our case, that resource is the computing resources. Currently there is, among other things, a lack of wisdom (applied knowledge/intelligence) about the Internet, about cyberspace, about handling legal issues, about handling cultural issues.

As Ostrom notes, the challenge becomes how a group can “organize and govern themselves to obtain collective benefits in situations where the temptation to free-ride and/or to break commitments is substantial.”

Ostrom studied a “wide range of communities that had a long history of successfully producing and maintaining collective goods. She also studied a number of communities

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6 Garret Hardin.

7 Readers should not seize upon the fact that resources cited (e.g., Ogallala Aquifer) are far less replenishable compared to computing tools and networks, which apparently can be renewed. Readers should focus on the inherent application of this model in managing a community of users involved with the use of a shared resource.

that had failed partially or completely in meeting this challenge."³⁹ In comparing the communities, Ostrom found that groups that are able to organize and govern themselves are marked by the following design principles:

- Group boundaries are clearly defined.
- Rules governing the use of collective goods are well matched to local needs and conditions.
- Most individuals affected by these rules can participate in modifying the rules.
- The right of community members to devise their own rules is respected by external authorities.
- A system for monitoring members’ behavior exists (this monitoring is undertaken by the community members themselves).
- A graduated system of sanctions is used.
- Community members have access to low-cost conflict-resolution mechanisms.¹⁰

Applying Ostrom’s observations along with a foundational understanding of the legal principles of privacy, search and seizure, and due process seems to provide a powerful model upon which the crafting of a public higher education institution’s AUP can be based. The new paradigm for AUPs should include issues that are found in a social contract, in addition, of course, to those issues that are traditional policy components.

The AUP as a social contract—A transformational approach

The social contract reflects the agreement between the people and the government on how much power the people consent for the government to have and exert. The social contract between the people and the government exists so long as the government uses its powers within the due process of law and the people agree to the outcome of the due process. With the due process of law as a vehicle for maintaining the social contract, the government uses its power without compromising certain natural and inalienable rights of the individuals in a way unspecified by the Constitution, our social contract.

The AUP should be crafted to emulate other social contracts that regulate aspects of environmental sharing (e.g., the U.S. Constitution, a faculty handbook, and a student handbook). Those who craft the AUP should certainly consider the logistical needs inherent in maintaining a secure and continually functional computer network. In addition, they should also realize that a computer network is much more than a thing or a place where hackers and pornographers roam freely,¹¹ or where the primary focus is the survivability and functionality of the system. They should view the network as a community of people who congregate to seek or exchange information, knowledge, and wisdom.

For many people, the Internet has been like a worldwide, multimillion-member think-tank, available twenty-four hours a day to answer any question, from the trivial to the scholarly. This magical knowledge-multiplying quality comes from the ongoing cooperative effort of many thousands of people, who freely contribute their expertise in response to questions. That precious power of a large group of people to act as a collective think-tank for each other is vulnerable to human folly. A relatively small number of malefactors hold the power to mess up a good thing for a far larger number of cooperative citizens.¹²

The acceptable use policy should be a vehicle by which to develop and manage an “electronic common” that will preserve the power of cooperation and foster the growth of knowledge and wisdom without infringing on individual freedom.

Considerations in the “charge” to an AUP committee

The following points should serve as the basis for the charge to an AUP committee.

1) Lacking legal clarity on a number of network-related issues, a university needs to establish policy to clarify the “ground rules” for the entire community of users.

Sergent notes that because computer networks are so new, there has not been time for any conventions to evolve.¹³ Thus, it is important to define the ground rules for the users of computers and the computer network. Here is a suggested foundational phi-
losophy statement by which to craft an AUP:

Our network of computers and Internet access are finite resources that are intended to facilitate and support our mission as an institution of higher education. Overuse of these resources, or use not conforming to our mission or the missions of the various campus departments, is inappropriate.

As far as actual enforcement is concerned, this statement is vague and overly broad, and thus, would not be a campus policy that could be violated. However, it is a foundational statement for use of computing resources in the same way that “life, liberty, and the pursuit of happiness” is a foundational statement in our society.

(2) The university should first define what a computer user’s expectations of privacy should be. In determining the scope and limits of a person’s privacy, it is important to consider the rights and responsibilities of a person as a citizen of a free country. It is equally important to view an individual’s right to privacy as it relates to the community (computer network’s culture) of which that person is a member.

The privacy statement should be very clear and unambiguous. It should inform the users what they can expect in the way of privacy as members of the network community. Establishing the basic notions of what/where public spaces and private spaces are in regard to online computer systems is critical in order to build a foundation upon which resolution of other issues will be based (e.g., invasion of privacy, disputes concerning search-and-seizure issues, monitoring of accounts).

It is important for a university to establish its position that a computer account is not necessarily a private and secluded place. Establishing private places will create a situation where users have a reasonable expectation that those private places will not be invaded (or monitored, searched, etc.). If the situation is such that the computer users have an expectation of privacy in their accounts, then any rummaging about or intermeddling with that privacy is likely to be considered a search within the meaning of the Fourth Amendment.

A university should establish the belief (policy) that computer accounts and disk space are not immune from observation by appropriate university employees conducting tasks related to the rendition of service to the computer system and its users. In a hotel room, for example, the level of privacy is far lower than in a private home because of the need for daily maid service.

(3) The university administration has been established to ensure that everyone’s rights and responsibilities are properly addressed and protected. The stakeholders in the creation of policy should be constantly reasserting, in their minds, that crafting policy is a positive activity and should benefit and protect all the users, the administration, and the computer system itself.

(4) The notion should be established throughout the AUP that “personal property rights” as we know them in the outside world do not necessarily apply to a university computer system.

(5) If rules and regulations are set for computer lab/cluster usage, and even computer network use in general, they should ensure that

- due process is respected;
- rules are enforced fairly (e.g., there is no selective enforcement against material that offends the lab manager);
- the rules are clear and narrow;
- content prohibitions are not based upon viewpoint, tone, or offensiveness;
- the restrictions are motivated by a real need...
Current Issues…

(continued from page 7)

• customers to acquire the latest technology
• new expectations for student, faculty, and staff training programs
• the rapidly changing information technology field
• increased demands arising from campus standards and strategies, e.g., one department acquires new technology, everybody else wants the same
• embedding of information technology in the curriculum
• expectations that the central information technology organization will introduce and support change at an ever-increasing pace, leading institutional transformation.

Strategies for dealing with these increasing expectations and declining budgets might include:

• partnering within the institution to ensure buy-in before generating solutions
• use of licensing and consortial agreements
• presenting new economic models that identify the true costs associated with networked computing
• garnering faculty and student agreement on realistic support levels
• strengthening communication strategies to ensure that customers understand what services will be provided and at what cost
• empowering customers through better training programs
• more effective planning and priority setting
• finding simpler, less elegant solutions
• re-deploying/recycling of information technology on campus.

Continuing Challenge of Information Technology Support

We have begun to recognize how the complexity of networked environments affects our distributed support models, making it more difficult and costly to isolate problems and

“The AUP should now move beyond the car owner’s manual model and become more a social contract.”

17 Dr. Carl Kadie (personal e-mail 28 January 1997).
fix them. This has exacerbated the ongoing challenge of IT staffs coping with increasing demands for customer support services, typically with limited resources. Although the scope of IT support may vary by size of institution, the basic challenges and issues are quite similar:

- What are the best current practices and under what circumstances are they optimal: central support, departmental support, no specialized support, or some combination of these models?
- Can IT staffs continue to support the “all you can eat” model or are there insufficient resources to meet the insatiable demand?
- What mechanisms do we put in place to encourage users to use scarce resources judiciously?
- What effects will responsibility-based budgeting have on the distributed model?
- How do we balance the need for “fire fighting” with the goal of long-term fixes?
- How do we get ahead of the problem? Can establishing teams across organizational boundaries or training departmental staff to provide first-line support resolve the challenges?

INFORMATION ACCESS CHALLENGES ON THE NETWORKED CAMPUS

The networked campus offers the opportunity for distributing information, applications, or access across organizational barriers as well as across institutional cultures. In this distributed environment, the IT organization is finding it necessary to re-examine its core values and address a number of issues related to information access.

- Computers intended for personal use are capable of serving as file servers, Web servers, mail servers, etc. Improperly configured servers present security and network performance challenges for IT departments. As two- and three-tiered applications are developed, traditional network designs will need to be updated to accommodate object request broker (ORB), proxy servers, and electronic commerce servers in secure and manageable configurations. Appliance-, switch, or server-based firewalls will be required to secure transactions and to provide front-line security for unwary users.
- Organizations will have to re-examine volume or site licenses for applications across departments and sites. New management considerations include the need to find more effective ways than IP address to validate users of library databases.
- The number of public-access computers located in libraries, computer labs, or student unions calls for strong distributed software management tools, managed printer solutions, and secured browser applications (e.g., conferencing, e-mail). Complicating the already difficult balance of administering dispersed networks and servers, academic software applications often require varying versions of operating systems, browser tools, and software development kits.
- Filtering of news, bulletin boards, and other public discussions remains a sensitive issue for higher education sites, particularly with the advent of anonymous or public e-mail accounts. We will need to develop institutional information access policies that take into account legal issues for minors, academic freedom, information ownership issues, freedom of speech, privacy, information archiving, copyright and fair use, enforcement procedures, and many other areas of potential policy.
Recommended Reading

As ‘knowledge workers’ we have the responsibility to pursue the Web’s use, and Khan’s well-organized, well-indexed compendium is certainly an asset to that end.

Web-Based Instruction
Edited by Badrul H. Khan
(Educational Technology Publications, Inc., 1997, $59.95, 480 pages)
ISBN 0-87778-297-0 Softcover

Reviewed by R. Lee Rayburn

The World Wide Web has proven itself an effective medium for delivering computer-based instruction in a variety of formats, and higher education is capitalizing on the technology. Both distance education and traditional classroom instruction are realizing benefits. Faculty, staff, and administrators are struggling to catch up and keep up with the diverse and rapidly evolving set of technologies commonly lumped together as “the Web.”

In compiling Web-Based Instruction, Badrul Khan has created a comprehensive overview of both the technologies used and the concerns involved with housing instructional resources in technology-rich environments. The book is organized into five sections, including a short introductory section. Two of the remaining four sections address development of learning environments and associated delivery of instruction. As an administrator supporting Web-based instruction, I found this portion of the text extremely informative at first reading, with content ranging from basic definitions to explanations of integrated functionality unique to this mode of delivery. Management issues, including institutional perspectives on implementation and support of Web infrastructure, constitute a significant portion of the discussion.

As a faculty member currently involved with developing my own Web course, I found the remaining two sections equally helpful. Theories of learning and instruction are covered in varying levels of detail and combined with principles of design to address many discipline-specific issues of instructional quality. Case studies from various disciplines and educational levels are provided to clarify and reinforce many of the concepts I found confusing as a novice in the area of instructional design.

After initially being somewhat intimidated by the length of this book, I found it very readable cover to cover, as well as providing an excellent reference. The volume of accessible information and potential for its efficient communication and processing truly give the World Wide Web the potential to transform significant portions of higher education. As “knowledge workers” we have the responsibility to pursue the Web’s use, and Khan’s well-organized, well-indexed compendium is certainly an asset to that end.

Reviewer Lee Rayburn is Director of Instructional Technology at Stephen F. Austin University.

Managers as Mentors
by Chip R. Bell
(Berrett-Koehler, 1996, $24.95, 208 pages)
ISBN 1-881052-92-3

Reviewed by Adel Barimani

Although information systems managers in higher education are often called upon to resolve crises, it’s not often that they get a chance to think about their roles as mentors. In his book Managers as Mentors, Chip Bell teaches that mentoring is not just a tool or process. For managers, mentoring is a critical factor in building and maintaining a productive workforce. For those on the receiving end, it is a basic human need in their daily lives. We often tend to forget that a simple pat on the back and a positive word given by a mentor or a supervisor will generate more productivity than any other method of reinforcement. This book describes how a supervisor can achieve superior results by acting as a mentor. I recommend it as a must read for managers.

Bell points out how mentoring benefits both employee and supervisor, and he clearly identifies the role of the mentor as both teacher and guide. He emphasizes the power of acceptance, through listening, as a key element in the role of mentoring, along with many other great suggestions.

The higher education community can benefit tremendously from this book. Today, the tasks of the manager are changing constantly, and budgets are strained to meet fi-
financial goals. With a shrinking workforce and staffs that are called upon to deliver more for less, the role of the manager as mentor is more important than ever.

This book can be an especially valuable resource for managers in training. No one teaches us how to be good managers. Often an employee is assigned a managerial role and then becomes a supervisor because he or she is simply the next person in line for the job. In such a scenario, when one has taken on a supervisory role without proper training, *Managers as Mentors* would be most helpful. If one is serious about having a productive staff, mentoring is a sure way to achieve that goal.

*Reviewer Adel Barimani* is Executive Director of Information Technology at West Chester University of Pennsylvania.

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**Building a Shared Vision: A Leader’s Guide to Aligning the Organization**

by C. Patrick Lewis

(Productivity Press, 1997, $45, 169 pages)


Reviewed by Margaret Drake

Building a Shared Vision is a thoughtful combination of philosophical models and practical blueprints for shared visioning. Beginning with an overview and definition of visioning, the author systematically lays out a step-by-step process for an organization, as well as a detailed visioning process for teams or units and for individuals.

Part I describes the what, why, where, and who of visioning. Author C. Patrick Lewis points out that “by the early 1970s, a growing cadre of leaders recognized that it is vision, personal and organizational, that provides the strategic element that is too often missing when their organizations discuss goals, objectives, and performance.” Moving from this historical context, the how of visioning is explained in six vision-building phases.

Once the historical and theoretical foundations are laid, Lewis moves briskly into Part II, which describes a methodology for vision development. Part III provides nine detailed questionnaires vital to the visioning process, allowing organizations to assess present thinking and organizational alignment. Part IV is a complete set of overhead presentation materials for use by the leader or facilitator of the visioning process. Finally, in Part V, the author presents the process in a format and approach suitable to departments and/or to individuals.

This visually attractive book is a fascinating combination of theory and practical how-to. The author’s low-key, yet no-nonsense style encourages the reader to enter into a visioning process, whether for an entire organization, a portion of that entity, or on a personal basis. I found *Building a Shared Vision* especially helpful in reassessing my role in our institution; as Mr. Lewis states, “A shared vision is much more than a powerful tool—it is a strategy and mental attitude for expanding your personal horizons about what can be.” In a time when universities and colleges are undergoing major shifts in expectations, deliverables, structure, constituencies, and funding, this carefully crafted book can provide us insight and direction for shaping our futures—organizationally and personally.

*Reviewer Margaret Drake* is Director of Institutional Management Support in the Office of the Executive Vice President for Administration and Business Affairs at the University of Texas Health Science Center at San Antonio.
Readers Respond

this article is online at http://www.cause.org/information-resources/ir-library/html/cem974b.html

Question:
How does your campus handle computer policy violations? Does your institution have a special procedure for technology-related incidents, or does it rely on its existing campuswide judicial process?

At Eastern Michigan University, we address employee violations through our progressive discipline procedure, and student violations through our Office of Student Judicial Services. Our administrative and/or academic computing offices collaborate with the Human Resources or Student Judicial Services offices on individual cases. We felt it was important not to isolate the disciplinary process. To date the process has worked very well for us.

Al McCord
Executive Director
University Computing
alan.mccord@emich.edu

When I was at Central Washington University, we worked through the usual judicial process. After all, computer abuse is more about abuse than about computers. Using that process guarantees due process, and it helps to have people involved who routinely deal with matters of discipline. They know all of the tricks students try and how to question students, and they know when and when not to pursue things. The technical people acted as expert witnesses only. The process worked really well for us.

Jim Hasket
Boise State University
Director of Information Technology
jhasket@bsu.idbsu.edu

Baylor University determined a number of years ago that it was best to let the normal student and employee policy violation process take care of Information System Policies violations. First, we found that if we act in any way as judge or jury, then it gives IT a black eye. (It is essential that IT have a positive image on campus.) Second, there is already a process set up on campus, with an appeal process, etc., that works for other policy violations. (Why reinvent the wheel?) Third, IT staff do not have the spare time to take on this responsibility.

What the IT staff contribute to the established committees and processes is evidence and the role of expert witness about the technical issues involved. We do not make the charges. We may have to explain the policies being violated and the technical evidence, but let others make the official charges. This has worked well for us.

We have two levels of violations. In the case of a minor violation, a university official (who may be an IT staff member), brings in a student, advises them of a violation, and if the conversation goes okay the student is given a warning and sent on his or her way. If the student has another violation then it is submitted to the official policy violation process. Many students just need a warning to get on the right path. If the violation is not considered to be minor, it is submitted through the official policy violation process.

Finally, charges must be put into terms a judge and jury can understand, so there is no need for a technical judge and jury. This is also a good way to educate the administration, faculty, and others regarding the major technology issues that are becoming more important on our campuses. This education process is important for all of us.

Don Hardcastle
Director, Information Technology Center
don_hardcastle@baylor.edu

At the University of Minnesota-Twin Cities, we involve the police, the general counsel’s office, and/or the appropriate disciplinary process office. We then act in accordance with their policies and procedures. All disciplinary actions are driven by normal university procedures and policies for handling abnormal or unacceptable behaviors.

Don Riley
Associate Vice President and CIO
driley@mailbox.mail.umn.edu

At Princeton University, we handle violations through the campus judicial system. The computing organization is not the judge and jury. That responsibility falls on the appropriate dean or administrative office. We have guidelines for appropriate use which are uni-
versity guidelines, not Computing and Information Technology guidelines. We investigate the infractions, then report to the appropriate office for action.

Jacqueline Brown
Director of Information Services
jbrown@princeton.edu

Nipissing University (Ontario, Canada) has a small campus with few violations to date.

The ones that came up were in fact handled through normal processes with input from the computer department as needed. We thought that most of the violations were indeed just historical behavioral ones, disguised by the overlay of “computing.”

Ken Maharaj
Director, Technology Services
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Next Readers Respond Question

Has your institution built a new or re-purposed an existing building on campus to support the creative use of technology in teaching and learning? If so, what were the basic planning assumptions and design principles, and what forms of instructional technology are supported? Please provide URLs for any supporting material available on the network.

Please send your response, along with your name, title, e-mail address, and phone and fax numbers, by electronic mail to Elizabeth Harris, CAUSE/EFFECT Managing Editor, at eharris@cause.org.

Partnerships…
(continued from page 51)

Conclusion

Rider University is exceptionally well positioned to meet the technological challenges confronting institutions of higher education in the 21st century. The Rider-Bell Atlantic partnership resulted in a comprehensive, state-of-the-art information and communication infrastructure that enables the university to benefit from networked technologies now and in the years to come. Rider’s transformation is well under way; the infrastructure has already changed the institution’s academic programs, library services, campus life, and administrative operations extensively. The long-standing nature of the partnership means that future progress will proceed at the same rapid pace. Personnel from both organizations look forward to continuing to work together, investigating new areas, developing new plans, and capitalizing on new technologies. The Rider-Bell Atlantic experience shows that with proper planning, partnering can be an excellent tool for redefining and reenergizing the information technology organization and, at times, the university as a whole.

For further reading:


Feature Articles


Duderstadt, James J. “Transforming the University to Serve the Digital Age.” Winter, pp. 21-32.


Giunta, Celeste M. “New Approaches for Compensating the Information Technology Knowledge Worker.” Summer, pp. 8-16.


Metz, Bruce A. “True Partnerships: The Key to Technology Infrastructure Challenges.” Winter, pp. 46-51, 67.


Smith, Karen L. “Preparing Faculty for Instructional Technology: From Education to Development to Creative Independence.” Fall, pp. 36-44, 48.

Stones, David H. “Taming the Internet for Electronic Data Interchange via a Secure Server.” Summer, pp. 41-47.

Thomas, Charles R. “Information Architecture: The Data Warehouse Foundation.” Summer, pp. 31-33, 38-40, 60.


CNI Report


Smith, Karen L. “Preparing Faculty for Instructional Technology.” Spring, pp. 3, 7.

Ringle, Martin D. “Forecasting Financial Priorities for Technology.” Fall, pp. 4-8.

Giunta, Celeste M. “New Approaches for Compensating the Information Technology Knowledge Worker.” Summer, pp. 8-16.


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