Acquisition and Replacement of Technology Hardware in Higher Education

Coping with the acquisition and replacement of technology poses both challenges and opportunities for higher education

By **David Wierschem** and **Dean Ginther**

Today's academic institutions face a new challenge prompted by their increasing reliance on technology. Unlike the traditional academic issues of fluctuating enrollments, shifting budgets, noncompeting salaries, and changing curricula, the requirements of maintaining, upgrading, and replacing rapidly outdated institutional and instructional technology hardware is a relatively recent and novel development.

Computer technology affects all elements of society, from individuals to businesses to government institutions, but nowhere has it had a greater effect than in higher education. It has affected all aspects of the educational process, from the exponential growth of knowledge to be stored and accessed, to the use of equipment and software required for modern multimedia classrooms and distance education, to the computationally intensive processing required for research and operations. Not only has the use of technology in education required a profound initial adaptation, the reliance on technology requires that educational institutions continue to address the rapid development and obsolescence of hardware and software.

Without comprehensive planning to address the academic community's technology requirements, academic institutions may use their limited resources inefficiently and ineffectively.

This article identifies the main issues confronting academic institutions in developing a structured plan for acquisition and replacement of information technology hardware assets and recommends steps for developing such a plan.

Use of Technology in an Academic Environment

Technology has always been a part of the academic environment, either as a topic of study, as part of its operational infrastructure, or as an aid to instruction. In these capacities, technology has traditionally followed a standard product life cycle. However, in many respects new computer technology fails to follow this predictable course. While many of the unique attributes associated with computing technology are viewed as benefits, they come with sometimes hidden significant costs.

The following attributes are not necessarily inclusive of all those associated with using computer technology within academic settings. However, they highlight some of the major issues.

Physical Life Exceeds Useful Life

While not unique to computing technology, premature obsolescence is much more pronounced in this arena. Academia, with its inadequate budgets, has a reputation for squeezing usefulness from equipment long after its standard useful life has expired. However, the definition of useful life for computing technology has little to do with its physical capabilities and much more to do with software compatibility, communications capability, and maintenance. The costs associated with using computing technology past its useful life are prohibitively high in terms of dollars and personnel. For example, over the course of several years an organization will acquire computers from various manufacturers with divergent system setups, different operating systems, and no standard application configurations. Providing support for this conglomeration of hardware and software requires significant additional training and support for integration among the systems.

Decreasing Cost, Increasing Capabilities

While this may seem like an obvious benefit, it results in unique problems for academic institutions. The problems arise because limited budgets typically require purchasing technology in limited quantities. This often results in different technology being acquired each time a purchase is made, often introducing additional complexity and incompatibility.

For example, at our university one department with nine faculty members has five different types of computers. This inconsistency arose because each time a purchase was made, the technology available for the same cost had changed and improved.

Such a situation introduces not just the technical issues of complexity and potential incompatibility but also personnel issues. These include, for exam-ple, deciding who receives the newest technology. Should such a choice be based on seniority, or should the faculty and staff with the oldest technology have priority? Should the faculty and staff who use technology the most receive the new systems? Should the faculty and staff who "contribute the most" to the department receive the new computers? What about new faculty — should they automatically receive the latest technology when they begin their employment? How should these priorities be identified, and by whom?

Rapid and Continuous Evolution

The continuous improvement of computing technology, while obviously positive technologically, presents difficulties for the academic institution striving to best prepare its graduates. With initial design to final manufacture of a computer taking only about 18 months, providing students and faculty with the most recent technology quickly becomes prohibitively expensive. It is not uncommon to specify a computer and find that particular model no longer current by the time the internal/state purchasing process is completed and the purchase order forwarded to the manufacturer.

Each improvement in speed, quality, capacity, size, and so on needs to be integrated into the curriculum so that students can learn and use the technology effectively upon graduation. Failure to provide students with reasonably current equipment and training places them at a disadvantage with others who have access to better technology. The institution must develop a strategy to balance the requirement of providing training and education using current technology with the financial constraints in higher education.

Continuous Expansion of Applications into New Areas

While the depth of technology continues to evolve, even more challenging for academic planning is the continued expansion of its breadth. Development of specialized software and hardware has made technology central to academic programs in business, marketing, and human resources, as well as pro-grams in education, social science, the liberal arts, and virtually all other academic disciplines. Computing technology is no longer limited to computer science and engineering.

High Maintenance Costs

A major hidden cost associated with technology is maintenance. While computing technology may require infrequent physical maintenance, a high level of user support accompanies the implementation and use of technology in academic settings. Users often need assistance with installation of software, recovery of corrupted data and programs, maintenance of security measures, and training, which should be consistently available. These costs are significant in the high-use and sometimes technology-abusing environment of academia, especially with novice users. Often, funds for appropriation of hardware and software are available, but no subsequent funding is provided for installation and maintenance. These costs must be integrated into existing maintenance budgets, placing significant additional demands on funds and personnel.

Another unique aspect of computing technology is that it operates constantly — 24 hours a day, 7 days a week. Computer labs, network servers, and Web servers all require that personnel — often highly trained and well-paid technology specialists — be available for on-site supervision and maintenance. In an academic environment, seldom is the cost for these positions identified as part of the total cost of a technology purchase.

Centralized, Distributed, and Local Responsibilities

Computing resources on campus appear largely local to the end user (the faculty member, student, or staff person). However, such computers typically connect to the campus network, which is usually supported by centralized servers and other central computing resources that provide high-speed Internet access. This combination requires a system of careful planning for optimal allocation of support and resources among the various campus entities. The

different areas and levels of responsibility often lead to confusion and delay end-user support.

Technology's Influence

Academic institutions are large, multifaceted organizations that strive to meet the needs of many and various stakeholders. Their use of technology is likewise multifaceted and serves many stakeholders. This makes developing a coherent and structured plan for acquisition and replacement of technology assets extremely difficult.

The first step in creating a campus technology plan is to identify the major areas of asset differentiation. There are several ways of performing this differentiation — by type of use, technology category, location, organizational structure, political structure, and others. A differentiation process primarily facilitates the identification and prioritization of assets for replacement. The differentiation strategy used should separate the technology assets into easily identifiable groups, each of which supports a structured plan for replacement. In the academic environment the physical and organizational structure of the organization lends itself to such differentiation by combining the primary use with the technology category.

Six primary areas distinguish technology use for the academic community: stand-alone personal computing, classrooms, labs, library, distance education, and infrastructure. We will discuss each area according to the use and technology category that separates it from the others. Figure 1 illustrates the relationships among the different uses.

Stand-Alone Personal Computing

By far the most pervasive and visible component of technology is the personal computer. Every faculty member, every secretary, every administrator has at least one computer. This represents a significant investment in and of itself. However, in addition to the computer are the required software, printing capabilities, and, in some instances, other peripherals such as scanners, backup media, and so forth.

Each individual uses technology to meet particular needs and thus has unique requirements. However, the technology employed to meet those needs can be quite uniform. For example, in the academic environment the requirement for a unique or specialized word processor or spreadsheet is the exception rather than the norm. Therefore, the ability to standardize on a single application minimizes support and maintenance costs, promotes quantity discounts, and simplifies and expedites purchases.

Classrooms

Classrooms are one reflection of the university to the student. They can be viewed as the packaging in which the product of knowledge is presented. Similar to personal computing, classroom technology needs typically can be uniformly addressed. However, unlike personal computing, not every classroom instructor needs or will use electronic technology in the classroom. Additionally, classrooms are a shared resource, since multiple instructors have access to individual classroom technology. Therefore, an institution must match instructors and classroom technology resources in an optimal way. Such technology classroom resources may include projectors with support of digital devices, networked computers with a connection to the campus LAN and the Internet, and so on.

Labs

In many academic programs, computing labs have become a focal point for instruction. Both instructors and students place increasing demands on such labs in terms of the quantity and sophistication of the resources and the availability of the labs. Labs can be further classified into teaching labs and general-purpose labs.

Teaching labs are more controlled and organized. Their primary purpose is to support the instructor's efforts in disseminating knowledge to students. These labs support in-class assignments, tutorials, and instructor demonstrations. Like classrooms, these resources are shared, and they must be allocated among instructors and classes. Access is typically restricted to instructional purposes only.

Unlike teaching labs, general-purpose labs are available to all authorized individuals. The primary activities they support may include the completion of homework assignments and class projects, e-mail, instant messaging, Internet surfing, game playing, and other technology-dependent activities. These computer labs generally have high usage rates and are subject to the most abuse.

Typical technology found in a general-purpose lab includes networked and stand-alone computers and a variety of software applications in support of academic classes. In dual-purpose labs (labs sometimes reserved for teaching and other times used as general-purpose labs), workstation and projection equipment may also be available.

Library

The library is a separate entity. Technology intensive and with a broad-based academic support mission, its responsibilities include supporting knowledge

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Figure 1

Relationships Among Technology Uses
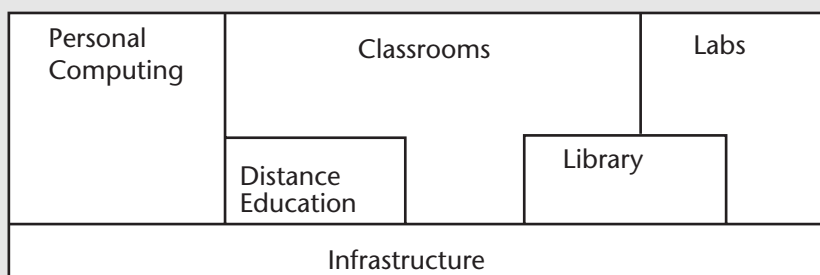
acquisition and dissemination for all academic stakeholders. In most instances, the specific technology applications within the library are unique and do not lend themselves for use in other areas of the academic environment. Dedicated terminals for catalogue lookup, storage technology for the massive data sets associated with electronic data, and restricted Inter- and intranet access for sharing of data files across organizational boundaries all require specialized hardware, software, and support.

Distance Education

The ability to concurrently conduct class sessions in multiple locations has become standard practice in most academic institutions. The technology required to convert a traditional classroom to support this activity often significantly exceeds that needed for a traditional (technology-supported) classroom. This area can be viewed as a subset of classrooms; however, we identify it separately due to the significantly increased and unique technology needed to support distance education, such as two-way, high-quality audio and video communications.

Infrastructure (Shared Resources)

Infrastructure resources are those technologies that support most, if not all, of the academic community. This identification spans a broad range of technologies but can be aggregated into three distinct areas: networking, large computing environments, and database technology.

Networks connect the academic community, providing the communication capabilities for data and voice. As a shared resource, a network supports the individual user's personal computing capabilities as well as lab and classroom connectivity. It also provides the foundation that enables distance education.

Large computing environments include such technologies as midrange and mainframe computing. These environments support the day-to-day administrative transactional operations and computationally intensive research efforts. In addition, they support fac-

ulty and staff advising, automated student transactions, network administration, and a host of other services and support operations necessary for every individual affiliated with the academic institution.

Database technology is becoming more important as administrations use institutional data to address retention, accreditation, and other concerns. The ability to quickly access and use information becomes vitally important.

Other areas of the academic institution have also begun to see the value of organized data storage. Placement services, alumni relations, student services, enrollment management, advising, and others want access to university data storage for relevant analyses.

Other

The final area is a catchall category identifying all those technologies that do not fall into one of the other areas. This could include technologies specific to an academic department or special purpose, such as digital photography equipment. These technologies are unique in their application or use and are considered on a case-by-case basis.

Obstacles to Policy Development

In addition to (1) identifying several major issues related to the acquisition and replacement of technology assets in higher education and (2) describing a framework for classifying technology assets, it is prudent to (3) identify some of the constraints and obstacles that may make developing a technology plan difficult.

Territoriality

Probably the single most difficult obstacle to overcome when developing an acquisition and replacement plan is academic territoriality. Nothing is more important to individual users, department heads, directors, vice presidents, and others than the control of resources, particularly technology resources. The increasing importance of technology in the academic organization is illustrated by the heated discussions that take place over acquiring and replacing such assets.

A new computer is often considered a reward or an indicator of prestige. Loss of control over selection of what an individual can request or assign, particularly in the case of faculty and department heads, is usually viewed as a loss of power. This holds true for every level of management. For a plan to succeed, the individuals affected by the plan must understand and support its purpose, and all concerned must view the plan as reasonably fair and objective.

Individuality

Individuals, departments, and academic programs are, to some extent, unique and specialized within most higher education settings. To suggest that a standardized plan will meet every individual's technology needs completely is naive. If the acquisition and replacement process does not carefully consider the individual user's needs, the process may be efficient but ineffective. Any structured plan must provide robustness in the selection process, either permitting users to adequately select their components or providing standardized packages that adequately meet the individual users' needs.

Control of Funds and Resources

Control of technology funds lets individuals provide incentives and/or rewards for jobs well done, milestones achieved, seniority, and so on. If such control is removed from faculty and department administrators for the sake of efficient allocation of resources, any structured plan must strive to obtain their support. Failing to control the use of the funds, however, can result in inefficient use and limit the overall benefit possible.

Fiscal Constraints

Decisions in academic organizations are subject to financial constraints, especially decisions affecting computing technology. Fiscal constraints typically are decided at the highest levels of the academic organization. The creation of a structured replacement plan should facilitate a cooperative environment between the allocation decision makers and those requiring technology

assets. The ability to put forward a coherent and comprehensive plan provides stronger justification than numerous individual requests for technology acquisition and replacement.

Additionally, a structured replacement plan should include prioritization methodologies. Fiscal limitations will always exist. With this in mind, long-term institutional strategic planning permits the development of a technology plan consistent with fiscal requirements. This should decrease the time required for obtaining funding, improve the overall effectiveness of technology acquisitions, and improve stakeholder support of technology allocations.

Operational Constraints

While fiscal constraints restrict technology acquisitions according to funding, operational constraints restrict acquisitions based on individually uncontrollable factors. These include federal and state regulations, system or institutional rules and regulations, and individual institutional or departmental procedures and processes.

A formal replacement plan should consider the operational constraints that can have a major impact on successful implementation. For example, the Americans with Disabilities Act affects not just access to buildings and classrooms, but also to computing facilities, Web sites, and other electronically provided resources. The acquisition and replacement plan must reflect a thorough understanding of all existing policies and procedures. By identifying these restrictions early, the plan can address them proactively. Exceptions for conflicts can be obtained, changes in policies or processes may be initiated, and the plan's acceptance and institutionalization can be streamlined.

Timing

The speed with which technology changes makes timing a major issue for technology procurement. The annual budgetary process requires identifying technology needs as much as 18 months ahead of time, depending on the size and complexity of the technology system. However, dramatic changes in the technology itself can occur during this extended period. Consequently, the devices and software eventually obtained are often obsolete upon arrival. This may even happen with short-term acquisitions.

The replacement plan should permit writing technology specifications to accommodate changes in technology that occur over the course of the purchasing cycle. The plan should also allow taking advantage of positive changes in pricing structures.

Presentation

As with most changes, the technology plan's acceptance depends strongly upon how it is presented to those affected. One of the keys to successful acceptance and implementation of a structured replacement plan is to include the users in the development process. How the plan is presented to the administration and the remainder of the academic community will either hinder or promote its adoption and institutionalization.

Decision Makers

The ultimate success of a structured technology acquisition and replacement plan rests with the administrative decision makers. One outcome of the plan may be to increase or diminish the power and control that current decision makers have, in order to obtain institutional efficiencies and address the institution's priorities. Inclusion of administrative decision makers in the development process is vital for the plan to have a likelihood of implementation.

Case Example

Given the uniqueness of every institution, it would be inappropriate to recommend a single solution or policy. Even within a single institution the complexity of balancing the needs of the many stakeholders can become overwhelming. Instead, we will present our experience in developing a policy for a regional university of approximately 8,000 students.

The existing IT structure of our university results in inefficient use of resources. A centralized organization provides the primary support for all hardware on campus. However, this support organization has little, if any, input into the individual departments' acquisition and selection of technology hardware and software. This distributed structure has resulted in each department creating its own de facto technology policies. One result has been that each department has created a variety of computer labs and divergent local computing resources.

The University Technology Committee monitors existing technology use and identifies, evaluates, develops, and recommends university policies on the acquisition and use of technology. Membership consists of the heads of the computer support group (the organization responsible for the intra-university technology infrastructure) and the instructional technology group (the organization responsible for the inter-university and academic instructional technology infrastructure), as well as faculty from each college who are directly involved in using technology in their class curriculums. It was assumed that committee recommendations would have greater credibility and an increased likelihood of implementation if the membership included both technology users and support and service providers.

Several subcommittees were created to address the committee's various concerns. The Subcommittee on Technology Replacement Policies consisted of three faculty members and one member from student services. Its objective was to create a policy that provided guidelines for the prioritized allocation of limited resources for the acquisition and replacement of IT hardware.

The subcommittee's first order of business was to identify the current inventory of technology, including ownership and use. Searching the university inventory records for all items that met certain technology-related identifiers yielded this information. The list was large and all encompassing. For example, in the area of personal computing, the inventory included IBM PCs bought in 1983, IBM 286s and 386s, and newer models. An analysis of the data also identified that the number of units purchased each year increased monotonically.

The subcommittee also searched the literature for any information on replacement policies. While considerable literature exists on mathematical replacement policies for inventory or manufacturing equipment, little addressed our objective. The subcommittee did identify some literature that addressed the replacement of personal computers within a business and industry environment, which was helpful in creating the policy.

Once the literature review was concluded, the subcommittee discussed the many issues that the policy was intended to address, as well as the possible repercussions. Two of the major points identified were (1) the politically sensitive nature of any policy that would infringe on the independence of departments in the acquisition of technology and (2) the likelihood that a centralized and coordinated purchasing and allocation body would greatly enhance the efficient acquisition and support of technology assets.

The subcommittee proceeded with these two conflicting considerations in mind. Each member talked to additional university users to identify and explore their concerns. The subcommittee formulated an initial policy recommendation to present to the whole committee for discussion and design of a final version.

Many of the ideas submitted were common and lent themselves to categorization. Other issues resulted in deeper debate and were never completely resolved.

Summary of the Policy

Replacement policies should facilitate the acquisition and replacement of equipment in a structured and objective manner. Such policies aim to facilitate the most efficient and financially beneficial outcomes for the university and its stakeholders.

Computing technology has several unique resource costs and operational characteristics relative to other university resources. The availability of up-to-date technology within the university has a large and measurable impact on the perception and success of the university community, as well as alumni, parents, students, and visitors. Any replacement policies must identify and address the dual requirements of efficient use by the university community and the ability to engender a positive, progressive perception among stakeholders supporting it.

With these objectives in mind, the technology replacement subcommittee proposed creating a more centralized organizational process for the allocation and management of all computing resources. The process would include

■ A three-year plan, updated annually, prepared and maintained to provide a guide for decision making. This plan should complement the university's strategic plan, its goals and priorities. Specifically, the three-year plan should address technology's role in promoting the university's vision and mission.
■ Creation and management of centralized teaching and open lab facilities with one 24-hour, general-use, "showplace" lab. The showplace lab should have the most current equipment to support the general student population. It should demonstrate to prospective students, parents, alumni, and other visitors that the university places a high priority on providing modern technology resources for its students and faculty. Equipment in this lab should be replaced every two years.
■ Teaching and other labs with the equipment necessary to support instruction and educational programs associated with the lab. Replacement of PCs should occur every three years, and peripheral equipment should be replaced as required to stay current with instruction requirements.
■ A system for coordinated purchase, inventory, and tracking of all campus PCs and other information technology assets. While departments should keep the right to recommend technology equipment needed to support their degree programs, a university-wide prioritized ranking of replacements should be compiled and group purchases made.
■ An annual inventory, review, and prioritization of infrastructure requirements, with particular attention to identifying resources that support or can be used by more than one department.
■ Infrastructure allocations prioritized based on
1. What best supports the instructional needs of the students.
2. What best supports the instructional needs of the faculty.
3. What supports the operational needs of the university.
4. All other technology requirements. For needs identified within each category, prioritization should be based on what will provide the most benefit for the most students, what economies of scale can be achieved by the sharing or reuse of technology between departments, and requirements for maintaining currency and quality of instruction.
■ All other technology requirements not covered by the above criteria should be the financial and operational responsibility of the individual departments.

Conclusion

Our purpose here was not to suggest a specific acquisition and replacement policy or even to provide a methodology for developing such a plan. Given the complexities and variability of academic organizations, that approach would be inappropriate. Instead, we aimed to provide a framework to identify the critical issues and components for the development of an effective institutional technology acquisition and replacement plan. Using this framework, institutions can better develop a technology replacement plan that will meet the many and often competing requirements necessary to use limited resources effectively. *e*

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