INTRODUCTION

Users or potential users of computing services at research and educational institutions are currently trying to meet their computing needs in cost-effective ways that will also provide them with high-quality services. As these individuals attempt to match their needs against the expanding menu of available alternatives (mini- and microcomputers; central campus facilities; and local, regional and national networks), they may face restrictions on their choices. Some institutions treat all users alike and, subject to budget constraints, they are allowed the same access to all services or face the same restrictions. At other institutions, some users and not others face restrictions on the amount of available computer funds and on the types of resources that can be purchased.

Often the treatment of users depends on how the institution bills for computing services. For example, access to local computing services is "free" at many institutions, and only very superficial efforts are made to allocate or account for computer usage. At others, users are given "funny money" accounts (accounts that represent funds pre-allocated to the computer center) so that local usage can be monitored and controlled. In both cases, there is little provision for the use of services other than the central facility. When "real" money (operational funds) is used to pay for computer services, users often have more flexibility in selecting services. Thus, institutional financial policies may be a major factor in determining how well the computing requirements of the user community are satisfied.

One often-proposed method of meeting some user needs for computing services is through a national resource sharing computer network. Such a network could provide access to specialized computing resources, minimize duplication of software development and promote a widespread exchange of resources among educators, researchers, administrators, and students.1 Sixteen institutional participants worked closely with EDUCOM in a recently-completed project2 to investigate these issues in more detail. The participants included large universities and small colleges, public and private schools and teaching and research-oriented institutions. Interviews with key people at each institution concentrated on obtaining a deeper understanding of the institution's policies and practices with respect to computer usage and possible computer networking.

Although this paper is mainly concerned with the implications of the various types and levels of user control of funds on network participation, the discussion is relevant to most currently available computing options.

INSTITUTIONAL PRICING STRATEGIES

The pricing structure established by an institution's computer center can be used to implement various objectives.3 A common goal, for example, is to recover a fixed percent of the overall costs of the center (usually 100 percent). Since the net price to users often represents the sum of many component resource prices, the relative charges for these component services presents another degree of choice within the primary goal of cost recovery. Some institutions attempt to relate these prices to actual costs—i.e., the charges for memory, CPU, peripherals, etc. are directly proportional to their costs. Alternatively, the component charges may be directed towards encouraging efficient system utilization, allocating scarce resources, maximizing system usage and/or revenue or achieving a variety of other management goals.

Instead of setting prices by the separate components of a service, circumstances may indicate other strategies for selected services. These include charging a flat rate (usually hourly), pricing by service and unit input or output pricing (i.e., by item retrieved from a data base or by transaction processed). All of these approaches can be scaled to a given cost recovery rate if desired, and can be tuned to meet the objectives described earlier.

The usual approach in pricing is first to establish a base or standard price. Variations of this price can then be used by management to attain operational goals. For example, shift differentials are common procedures to encourage load

---

1 This work was supported by the National Science Foundation under Grant Number MCS75-20295, "A Simulation and Gaming Project for Inter-Institutional Computer Networking."
2 EDUCOM is a consortium of more than 270 colleges, universities and non-profit organizations that serve higher education. It was founded to help its members make the most efficient use of computer communications technology.
leveling, and priority differentials are a traditional way to use the price mechanism to determine scheduling. Often there are variations in price to reflect institutional policy towards various user groups or categories. For example, surcharges are frequently placed on all outside users, with even higher surcharges if the user is not from an educational institution. It is common to bill users with outside funds at a rate equal to full cost recovery, while other internally-funded users may be charged a lower rate (i.e., they are partially subsidized by the institution). In this context, a billing percentage of zero for some users implies that they receive free computing. This approach is preferable to no billing since it permits monitoring and accountability. More important, it has been shown that when users know the actual cost of their computing, even if they don’t have to pay it, they function in much the same manner as those paying the full charges.

**SOURCES OF USER FUNDS**

In the past, many institutions offered computing free to their internal user communities. Although this practice still exists, at least partially, at many institutions, the current trend is towards charging in some fashion for computing services. Even if the charges do not amount to full cost recovery, they are useful for the purposes of allocating a scarce resource. At institutions that charge for computing services, a prospective user must look to either internal (institutional) or external sources of funding to pay for these services. At any institution, if a user does not feel that the internal services are appropriate, and wants to purchase services from an outside source, he must find a means of paying for these services.

**Internal sources of funds**

Internal funds may be allocated in different ways within the institution. Frequently, some or all computing is provided as a “free” resource. This was true for the main institutional facility for two of the small colleges in the project. At most institutions, this occurs primarily with special purpose micro- or minicomputer facilities. Usually, the “free” facility is a dedicated operation serving a small, homogeneous community within the institution such as a department or research project. Depending on their location in the organization and function, such facilities may be capitalized by state funds, government or foundation grants, tuition revenues, or departmental operating funds. In lieu of charges, there is usually an implicit allocation of resources depending on one’s status or role in the organization, size or type of job, or the total system workload compared with the computing capacity (i.e., service may deteriorate as usage increases).

A second method used at many universities is to give money directly to the computer center for operating expenses. Users (generally for academic or internal administrative purposes) then receive accounts against which they may draw. These funds, since they actually have been allocated to the computing center, may not be spent for any purpose other than computing at the local facility. At half of the institutions studied, computer charges for most local users were handled through a combination of free computing and “funny money.” Although there may be an upper limit to the total amount of funds available to a user, it is usually a straightforward process to obtain additional funds.

There is a growing trend towards a third approach: Considering money for computing as part of the operating expenses of the department or college. Over a third of the institutions studied treat their computer budgets in this way. The decision on how much money is to be spent on computing is made (often at budget time) at the departmental level. Operating funds are usually considered as “real money” and the department, if not the user, has reasonable freedom to spend them as it sees fit—e.g., for an internal system, at a service bureau, for networking, etc.

These approaches have different implications for both the computer center and the user. In the “free resource” and “funny money” cases, the computer center has a fixed income with which it can budget its activities. Although this income may or may not meet what the computer center management perceives as its needs, it is a known amount that is negotiated periodically between the computer center management and the administration. The job of the computer center is then to provide the best possible service for the available money. In the third case (“real money”), however, the income is not so certain, since the computer center must compete with other resources that are vying for the users’ dollars. This puts the center in a very different light. It must now stand or fall based on the quality and price of the service it provides relative to available alternatives, i.e., the computer center is running a “business.”

For the user, the first two cases represent degrees in his perception of a free good. The former may appear to him more unlimited than the latter (that is, if he could just get his turn to use the facility!), but there is no sense in either environment of being able to exchange the use of this service for any other that he might need. That must be done by special appeal or process, and at an incremental cost. With operating funds, the tradeoffs are much more obvious and concrete. The user measures local services against alternative sources of computer services, if not also against the cost of new books or journals, graduate students, or secretarial help. He must then make a conscious evaluation of how much the local computer services are worth to him when compared to other options.

There are obviously various combinations of these methods. Many institutions, for example, use a combination of “real” and “funny” money so that users are billed at a specified percentage of the actual cost of their computer usage and university funds make up the difference.

**External sources of funds**

External sources of computing funds available to the user are usually research grants or contracts sponsored by gov-
government, industry, or other funding agencies. The process for obtaining these funds depends on the particular source involved. Typically, the user must take the initiative obtaining those funds, and often, in the process of obtaining them, they are earmarked for computing. In general, users' control of their externally-supplied money more nearly approximates the "real money" method of handling institutional funds. Again, the tradeoffs must be weighed by the user himself and a choice made.

For the computer center, users supported by external funds may represent a relatively unpredictable source of income. When a new grant is requested, the potential recipient decides what portion is to be spent for computing services. There is no guarantee that all of the funds indicated for computer services will be spent as planned, or that the grant will be awarded in the anticipated time frame. A majority of these funds come from granting agencies that can fluctuate in the level of their awards from year to year and there is no sure continuity. This uncertainty is one price that the individual researcher must pay for the added control that comes with outside funding. In aggregate, however, the income from such outside sources is normally fairly predictable, and the computer center management becomes very adept at estimating what this will be.

USER OPTIONS FOR OBTAINING COMPUTING RESOURCES

Depending upon the policies established by the institution for the expenditure of computing funds, a potential user with computing needs and funds is often faced with a choice of options. The money may be spent at the local computing facility (which may be a service purchased externally by the institution); to purchase services from an external source such as another university, a research institution, or a service bureau; or to purchase his own hardware, such as a minicomputer.

At institutions participating in the project, users with external sources of funds had the most freedom to exercise options that they selected. Those who use institutional operating funds to purchase computing services face more restrictions but usually have some degree of choice. Users with internal funds for computing, however, find it very difficult to purchase from any source except the local computing center.

Local services

Most institutions historically have had a single general purpose computer center that satisfies most of the needs of local users. As the cost of hardware drops, institutions are frequently offering several alternate centralized facilities. A common example is that of running student jobs and CAI (Computer Assisted Instruction) on a particular machine that is often a minicomputer. It is still the case, however, that most users are restricted to internal services and that, although there may be multiple campus facilities, the choice for any given user or application is usually quite limited.

External services

There are several factors that must be faced in deciding whether or not to purchase a service externally. If the desired service is not available locally, the first question is usually, "Can it reasonably be added to the local service offerings?" Larger institutions offer most standard services. Services that they do not, and possibly cannot, offer locally include such things as large data bases, specialized application packages, and bibliographic retrieval systems. If there were a large demand for any of these, the institution might consider acquiring the service. However, for a growing number of specialized services, it is not cost-effective to do so when both installation and maintenance costs are considered. Such services are likely candidates for outside purchase.

Another consideration is the quality of service. This is not as important in measuring local service as it should be but usually enters into the decision in evaluating external suppliers. As more external options become feasible, the issue of their comparison with local services will arise more frequently. For example, are external services a user option if they are "better" or less expensive than the local service? How does the quality of service, support, documentation, etc. of the external supplier compare with that of the local facility? How reliable is the external supplier as compared to the internal facility? Not only must the user considering an external source be aware of such factors, he must be able to evaluate their importance to him.

Dedicated computing

The number of applications in which the purchase of a mini- or microcomputer system makes sense is increasing. Hardware costs are decreasing rapidly, while performance is improving. Minicomputers can now meet many user needs at a low cost, while offering a degree of control and flexibility that the user cannot exert over the local computer center. In addition, minicomputers often can provide an interface to the central and network computers in addition to providing dedicated, low-cost, stand-alone service.

In addition to their role in satisfying specialized campus-wide needs (CAI, administrative systems, etc.), the price performance ratio of small systems justifies serious consideration at the project or departmental level. Typical applications include word-processing, introductory programming courses, monitoring and control of research experiments, specialized scientific software packages, and small simulations used by multiple students.

It is beyond the scope of this paper to comment on the problems (often hidden) associated with small computers, such as estimating their full cost, maintenance difficulties, support problems, software shortcomings, etc. At the user level, constraints on the availability of such resources are
similar to those for acquiring external services. Those users with internal operating funds or specific outside sources of funding are usually the only ones that can consider such acquisitions. Often the review process is more stringent and specific than for outside services since there is a capital investment involved.

At many institutions such acquisitions are not dealt with in an organized fashion and this has led to a diversity of incompatible equipment and duplication of capabilities. Given the total cost and net impact on the organization of these mini- and microcomputers, the need for institutional-level policies and coordination is becoming critical.

AVAILABILITY OF COMPUTING RESOURCES TO USERS

Machine resources

If more than one computer is available at an institution, certain classes of users may be restricted to particular facilities. The most common examples of these are the use of specific computers for class instruction or administrative data processing. Even if there is only a single computer, the institution may impose restrictions on the resources available to certain user groups. Samples include limits on CPU time, maximum memory allocations, limits on disk storage space, or job priorities. Systems with restrictions such as these usually have ways in which the limits can be raised by special request.

At institutions that use "funny money," or no prices at all, controls are important and may be quite involved. Several institutions imposed restrictions, for example, on the types of jobs that could be run by the various user categories. Others imposed resource limitations also based on type of user. One institution had developed an involved cutback algorithm whereby overusage by one class of users impacted only that class and no others. Another operated by dividing the day into periods for administrative usage and periods for academic usage. Within the academic time slots at this institution, usage was on a first-come-first-served basis.

When computing is financed partially or totally by "real," or operating, money there is less need for these types of controls. At such places, the pricing mechanism usually serves as a simple, effective allocation mechanism. To the extent that a free market environment is considered desirable, the motivation for using real money for computing increases.

Support services

There are two major areas in which human resources are required—consulting and programming. A few institutions provide extensive support free of charge in both these areas, while most only offer casual consulting free and charge for programming or extensive consulting. Some institutions offer minimal consulting and no programming whatsoever.

Different users at a single institution may receive different levels of support. For example, students can usually get information about running jobs but cannot obtain programming help from the consultants. On the other hand, a user with outside funds can often pay for both programming and additional consulting services from the computer center staff.

At most institutions in the project, limited consulting was available free of charge. Most of them allowed all users to buy programming services with computing funds although one institution did not allow student funds to be used to purchase such services and two institutions provided no programming at all.

INSTITUTIONAL REVIEW PROCESS

Most institutions consider it necessary to have a review group to provide an institutional view on the use of facilities other than the local centralized facility, whether they be external services or the acquisition of individual minicomputer systems. A variety of titles are in use, such as "Computer Review Board," "Computer Advisory Committee," or "Computer Center Oversight Committee." In addition to its role in reviewing outside purchases, it often also functions as a committee overseeing or advising the local computer center on purchases and budgets. Typically, members represent a variety of functional areas including faculty, department heads, heads of large research projects, computer center management and administrators. Usually the group is an institution-wide committee, although it may function on a college basis. At state institutions, there may be parallel legislative and institution-specific groups. At smaller institutions the review process may be performed by one person, such as the computer center director.

The areas of concern to this committee also vary. In some cases it reviews only proposed purchases of hardware, or only cases in which institutional funds are to be spent on external services. It may, however, have responsibility for all aspects of computing at the institution.

At some institutions, as long as the money involved is from outside sources, approval is almost automatic. Thus, a user with a research grant may have no difficulty in getting authorization to purchase a mini-computer or to buy time from a service bureau, whereas a faculty member wanting to use departmental computing funds to buy access to a specialized package offered elsewhere may find this extremely difficult.

About a third of the institutions had established a formal review committee as described above for the purchase of outside service. Another third had a review process that was performed either by the computer center director or through an administrative office such as the vice president for research or administration or the university's finance committee. The rest of the institutions had no such review process, either because all users had operating funds and were unrestricted, or there was such a low level of outside usage that any cases were handled on an ad hoc basis.

Computing at an institution is perceived differently by the
various constituencies that come in contact with it. The administration often has one perception, while the computer center director may have a second, and the users a third. The review process should be the place where these sometimes conflicting viewpoints can be resolved and translated into institutional priorities and policies.

There is a clear requirement for a review process at most institutions, and many are moving in this direction. However, emphasis to date has been on the approval or disapproval of specific requests, rather than on the establishment of mechanisms for providing more general policy guidance. As the number of options increases, institutions are recognizing the benefit of establishing overall policies for guiding and coordinating their computing decisions. For example, recommendations for standardization of time-sharing terminals have come from several committees, policies for network access permission have come from others, and a few have taken the initiative and promoted policies for acquisition and operation of campus minicomputers.

**USER CATEGORIES**

Users at any given institution can be grouped in a variety of ways to reflect source of funds, computing activity or homogeneity of grouping. Institutions in the project were asked to define categories that represented the major levels at which funding and usage are controlled. In general, the categories selected represented line items on the institutional budget. Although many of the variations were unique to individual institutions, the many common elements in the groupings reflect the similarities in how computer usage is perceived at educational and research institutions. These groupings exist because most institutions do not treat all users alike. Instead, the rules that apply to a user, and the control that he has over how and where his computing money is spent, depends largely on the category into which he falls.

The groupings used were surprisingly similar across the institutions. Almost all of the educational institutions, for example, had a category entitled "instruction." This included classroom use of the computer both in teaching a programming language and as a tool in discipline-related subjects. Another grouping used by the majority of the institutions was that of institution-funded research. This represented student and faculty work for which there was no outside source of funds. One institution separated such research work into that done for masters' theses and that done for Ph.D. dissertations. Typically, these two categories, instruction and internally-funded research, had great difficulty receiving permission to do computing on anything except the centrally provided facilities. Even in "real money" environments, central review committees were less than sympathetic to most requests for external expenditures or local capital investments by these users.

Three-quarters of the participants identified externally-funded research separately, and one even separated government-funded research from other externally-funded research. Those that did not use this category to distinguish users either had almost no externally-funded research (the very small teaching-oriented colleges) or felt that this was not a useful distinction since all users had "real money," i.e., this category was merged with institution-sponsored research. In general, funded researchers had the most control over their own computing destiny. By definition they have hard dollars to spend, their expenditures do not place a drain on institution revenues, and hardware acquisition or outside computing is often an explicit part of their grant or contract. Even so, there are often pressures to use the local facility if at all possible.

Administration was also a separate category at three-quarters of the institutions. At most locations administrative work was performed on the same facility used for academic applications. By virtue of their place in the decision-making hierarchy, this group of users should be expected to have great flexibility of choice in making computing decisions. Up until now the choice seems to have been made between separate administrative facilities and the campus computer center. Security and privacy concerns, the cost of running large processing jobs, and the perceived need for control and flexibility have all contributed to this limitation on options.

Two-thirds of the institutions identified computer center staff usage as an explicit item. The rest generally assumed that since these users were not billed, there was no need to explicitly identify or budget for their usage. The philosophy was that staff usage was a fixed and necessary part of the facility workload. Except for explorations of remote resources by user services personnel on behalf of their customers, there is rarely any justification for computer center staff to seek alternatives to the facility that they operate.

The final category identified by most sites was that of external users of the local facility. About a fifth of the organizations further separated outside educational use from other external use. Where this was done, non-educational users were billed at a higher rate than educational users. In general, even outside educational users paid a somewhat higher rate than internal users. Obviously, this group of users usually has no difficulty in "going elsewhere" for services whenever it chooses.

Although these were the most common categories of usage, there were a few variations and one notable exception in categorization. Instead of following these breakdowns, one institution reported usage by schools and administrative units. This reflected the philosophy of decentralized control, i.e., each school had to account for computing expenditures as part of its operating funds.

**CONCLUSIONS—NETWORKING IMPLICATIONS FOR USERS AND THEIR CONTROL OF RESOURCES**

Groups likely to benefit from networking

Outside users. It is evident that some classes of users are more likely to use a network, or other alternatives to the central computer center, than others. The most obvious
example is that of the outside (non-institutional) users of a computer center. These users are not directly affiliated with the institution and have no restrictions to prohibit their purchasing services elsewhere. Often they are purchasing raw computing power rather than the entire package of service and user support. In these cases, they are likely to go elsewhere for service anytime that they perceive it is in their best interest to do so. At most educational institutions these users represent a very small fraction of the total usage and are generally considered only as purchasers of excess capacity.

Externally-supported researchers. Users whose research is supported by external research funds are likely to both use and benefit from a network. The nature of their work often requires special packages or services that may not be offered at their institution. In most cases they are faculty members or graduate students who are familiar with those services that are useful in their work and that exist outside their own institution. This category of user, therefore, is likely to know about applicable remote resources (via professional or discipline contacts), and is also in a position to take advantage of them since the institution is likely to have less control over how their funds are spent than it does over other users.

Users of specialized resources. Any user who needs a specialized or unique resource is a likely candidate to benefit from a network. Examples of specialized resources include unique hardware, CAI systems, statistical packages, econometric models, planning models, and specialized data bases. These are the resources that may not be available at the local institution, and would be very expensive, if not impossible, to establish locally. Users of specialized resources may fall into any user category. Unfortunately, it is their category rather than their need that is likely to be the primary determinant of whether or not they may obtain these services via a network. There are indications, however, that this situation is slowly changing. For example, review committees are much more sympathetic to requests for outside service when the resource is not available locally (many state this as a formal policy). Institutions, even those that provide local service as a free good or on a “funny money” basis, are recognizing the need to support outside usage in these circumstances.

Groups unlikely to benefit from networking

Student users. Except for special packages like CAI materials, student instructional needs are less likely to be met through networking. Programming courses and the use of simple models and packages are the kinds of applications that can be accomodated very effectively at most local centers. In many cases a dedicated minicomputer may best serve such a group. Particularly in programming courses, access to outside services will not enhance the basic quality of instruction. An exception to this may occur at smaller schools that can not support the full range of programming languages. In such cases, the use of other facilities over a network may provide the only access to that service.

Computer center staff. The staff of the computer center is likely to be the most knowledgeable about networking possibilities and availability. They may be able to get free (or very cheap) trial accounts at other institutions and may try out new packages over the network for their user community. Their own need for these services, however, is limited since they are employees of the central facility and their job is to facilitate its use. Their budget in “real money” is likely to be extremely limited, and although they may be a major source of information, they are unlikely to become a major purchaser of network services.

Traditional administrative users. Administrative data processing, for a number of reasons, is less likely to be performed over a network. Primary reasons are the perceived need for control over the computing resources used, the concern for security, and the volume of input and output. Administrative applications are often very time-dependent and usually receive highest priority in the case of a crisis. On a network, such work has no assurance of special treatment and must be adapted to the schedule of the host computer. The second concern, security, is often mentioned but is actually less valid. Unauthorized access to such data may, in fact, be more difficult at an institution that is accustomed to protecting the data of a variety of outside customers. At present, networks are most effective for applications that require only a nominal amount of data input and output. Consequently, communications capacity limitations and the cost of data transmission currently impose severe barriers to administrative applications.

It does not appear that the overall situation is likely to change in the near future for traditional administrative applications. However, with the advent of decision-making tools such as planning and forecasting models, and specialized hardware dedicated to “office automation,” there are indications that new, non-traditional applications will be carried out in the most appropriate manner. Again, the place of this user community in the decision-making hierarchy of most institutions makes it likely that it will be able to acquire both funds and authorization as the need arises.

Groups that could benefit from a network but are unlikely to use one

Student users. Some student instructional work might benefit greatly from expanded network services, and yet be unlikely to have access to a network. In particular, the use of discipline-oriented computer programs as teaching devices falls into this category. Marketing models, political science data bases, chemical reactor simulations and econometric statistical packages represent computer resources of this nature that are not offered at every institution, and yet could represent a useful supplement to course work.

Internally-funded researchers. Internally-funded researchers, although they could also benefit from a network, are less likely than funded researchers to fully utilize one. The attractiveness of a network here lies in the specialized services that can thus be obtained; i.e., the need is similar to
that of externally-funded researchers, but the funds and flexibility are not available.

The primary problem that the above groups face when considering networking is that services purchased over a network must be paid for with real money, and this represents an apparent cash drain on the institution. To the extent that the user can demonstrate that the value justifies the total cost, and adequate funds are available, this is not a serious problem. In many cases, although there is a net cost saving to the institution by not doing the work internally, this is difficult to demonstrate, particularly in an environment where the user pays less than the full cost for local computing. The solution lies in reorienting institutional accounting and billing procedures so that these trade-offs can be made explicit. In other words, if it is cheaper overall to go outside than to do the work internally, one should be able to show this in a straightforward manner.

Needed organizational changes in a networking environment

Computer center focus on providing services. Computer centers must gradually change their images from that of providers of general computing capacity to that of providers of computing services. In this context, they must focus on how they might best help the user to satisfy his computing needs, rather than trying to adapt his needs to fit their offerings. This concept is much easier to state than to implement. Hardware budgets, number of employees and sophistication of equipment are traditional measures of responsibility that are easy to quantify and evaluate. Service or cost-effectiveness of service are generally accepted concepts, but very difficult to measure. Administrative officers must find a way to motivate their computer center to focus on the latter concepts in looking at its performance.

Expanded responsibility for user services. Particularly in a networking environment, the role of user services must be greatly expanded. It must be able to direct the user to available service options and alternatives, to assist in the selection process, and to assist the user in utilizing remote resources. All this is in addition to their more traditional services relative to the local facility. Although this new role is a difficult one, it is necessary before the computer center can effectively function as a provider of service as previously described.

More direct control for users. The current situation with respect to outside services at most educational institutions can be summarized as a financial consideration: Those with "real" or outside money usually may spend it where they like; those with "funny" or internal money are usually constrained to the local facility. This institutional posture may not show any relation either to need or to cost/benefit considerations. In order to effectively function in a service environment, control over choice, and the responsibility for those choices, must shift from the institution to the user (or at least to the department). The user must be given both the motivation to examine alternate modes of obtaining service, and the authority to act on his decision. His decisions need not be based on cost alone, but could also include considerations of reliability, user support, suitability of service to his needs and ease of use.

Make economic implications of choices more explicit. One of the major barriers to implementing the concepts just described is that the true economic implications of alternatives are rarely very explicit. Users are often faced with a choice, for example, between "free" internal computing and relatively expensive outside alternatives. In reality the incremental cost of providing the internal service may very well be higher than that of going outside. The evolution from free computing to real money will help this situation, as will an environment that motivates the computer center to focus on cost-effective service instead of merely the internal provision of service.

Implications for networking. Although networking offers a very attractive alternative for meeting certain computing needs, it will probably never be a very large percent of the computing usage at the average institution. However, for the user who cannot find what he needs locally, it represents a significant alternative for meeting his requirements through the purchase of external services. Such usage will grow slowly as institutions experiment with this mode of usage and accept it gradually where it proves successful. Financial concerns will continue to be a major factor, and users with their own source of funds will have more ready access to the network. This will gradually change as institutions begin to view computing as a service rather than a facility, and users acquire more control over their selection of such services.

REFERENCES
