Administrative and Financial Aspects of Computers in Education

This paper discusses in a general way the acquisition of computing facilities. Guidelines are given for how to start in computing, what factors to consider in the acquisition of one's own equipment, where to get advice, who should use the facilities, and how to provide security and privacy for the user and for the facility.

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By 1970, it is predicted that there will be 75,000 computers in use in the United States, with a value of $18 billion. About half these computers will be in use in educational institutions. Administrators are making mistakes at a growing rate, because they must be planning about 100 new facilties a year. I want to dispell the notion that acquiring a computer facility is as simple as moving the computer in and pressing "start."

I will disuss some of the factors involved in the organization and operation of a computer facility within an educational institution. Some of the factors include: purpose of the facility, access to computing power, centralized versus decentralized facilities, administration of facility, cost of facility, and security and privacy.

Today, any educational institution (whether public or parochial, or whether primary, secondary, or higher) should be involved in a real way with computers. Unhappily, most are not involved yet in any way. No real excuse can be offered for this lack of involvement. Computing power is, or can be, readily available at relatively little cost. Now, let us consider the purposes for which a computer facility is desirable.

There are two broad areas of interest in which computers play an important role: (1) education and (2) administration.

Within the educational area, two categories of activity may be distinguished:

1. Use of computer-assisted instruction (CAI) in the traditional sense of providing a surrogate for human teachers in giving instruction on some subject (which might include computer programming, e.g., Tutor Basic on G.E. Time-Sharing Service).
2. Use of the computer in a "noninstructional" mode (perhaps a better term would be "self instruction"). This includes the use of the computer as a tool in sorting application, the solution of a numerical problem, research activity, and so on.

The overlap between these two areas is obviously considerable. Hence, I will not distinguish further between them, but will refer to the whole educational use of computers by the term "computer-assisted instruction" (*1*).

On the administrative side, one can distinguish between basic accounting procedures and report generation as an aid to the administrative decision-making process. The latter includes, of course, generation of grade cards, absentee lists, and student performance reports for use both by the classroom teacher and by the administrator.

One can consider the areas of education and administration separately in the planning of a computer facility, but it is unwise to do so. The computer facility must be able to cope with both the educational and the administrative problems.

• Acquisition of Computing Power

What sort of computing power (hence, to a large extent, what sort of cost) is required to handle the functions outlined above? The answer to this question depends on a number of factors.

1. How large is the institution that is to be served by the facility (i.e., what is the student population)?
2. At what stage of development are the staff and students with respect to utilization of the facility? How sophisticated are the potential users?
3. What are the financial resources of the institution? What outside resources can be tapped?
4. What is the expected growth of the institution and of the utilization of the facility?

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The interaction of these factors will determine whether to acquire computing equipment or not, and, if acquisition is the choice, what to acquire and how to acquire it. Let us consider these points in more detail.

There are a growing number of computer utilities from which computer time can be obtained at reasonable cost. These companies have computer facilities devoted to the sale of computing power, either on a time-shared basis or a batch-processing basis. These utilities may also provide assistance in the development and maintenance of programs necessary to the institution. Thus, there exists the possibility of buying computer time from a utility and, consequently, avoiding many of the problems attendant upon the acquisition of one's own computing equipment. To be sure, such computer time is often more costly on a per hour basis than time on one's own equipment, but this cost differential is offset by the reduction of administrative costs that are associated with "in-house" equipment, about which I will say more later.

If an analysis of the various factors mentioned earlier indicates that the acquisition of computer facilities "in house" is the correct course of action, then one must consider whether to lease or to buy the equipment. Leasing has many advantages and generally is preferred to purchase. Among the factors influencing this decision are:

1. Life expectancy of equipment
2. Need to expand equipment
3. Servicing of equipment and of software
4. Ability to dispose of equipment when replacement is required
5. Software investment
6. Mode of use (dedicated machine versus general use)

It is not entirely clear whether it is more advantageous to lease or to purchase, as a general rule, but, lease seems to be the preferred route at present.

Whatever the source of computing power may be, one must be cognizant of the many problems associated with the acquisition of computer facilities. It is a mistake to take the word of the manufacturer too seriously, because he has a vested interest in the placement of his equipment. It is often desirable to retain the services of a consultant, but care should be exercised here also. The consultant should have had experience with a variety of computers and peripheral equipment and should be made aware of the needs and capabilities of the institution. Finally, his advice should not be taken as gospel, but as a guide in deciding what equipment to acquire.

• Hardware and Software Considerations

Let me say a few words about equipment. There are available computers ranging from desk size to barn size. One should not assume that their capabilities are directly proportional to their size. Costs range from a few thousand dollars to several million dollars. Speeds range from very fast to unbelievably fast—several hundred thousand instructions per second to several million per second. Another factor is the way in which the machine handles data. Some machines handle data in large chunks, some in small chunks. The latter type provide greater flexibility, particularly in handling alphabetic data.

The type of machine to acquire depends upon the type and quantity of data to be processed, the need for future expansion, and the quantity and variety of peripheral gear (tape drives, card readers, printers, plotters, remote terminals, disks, drums, data cells, video display devices, process control equipment, etc.). Not all machines are capable of handling these items, nor of handling the variety and number that may be required.

Another factor to consider is the vintage of equipment to acquire. Is it necessary to keep up with the Joneses? Not so, in most cases. There are now available many second generation, i.e., pre-1955, computers that are quite adequate for small- to medium-scale operations, and these can be acquired (usually purchased) for a song. It does not necessarily follow that one must have the most modern equipment to have a good computer facility. (Keep in mind, however, that maintenance may be more of a problem than with newer computers.) No matter what type of equipment is acquired, it should never be as a status symbol.

So far we have talked about hardware. What about software? Software is as important a consideration as is hardware. There are three basic kinds of software to consider:

1. The programs that operate and control the functions of the hardware. These are called operating systems, monitors, etc. The operating system should, in general, take up as little memory as possible and use as little time as possible. The work of the operating system is essentially nonproductive work and so should be kept to a minimum.
2. The programs that make possible communication with the computer in a reasonably simple fashion. These are the programs that convert the users' programs, written in a relatively easily used and understood language, to the language of the computer. Such programs are called compilers and include such representatives as FORTRAN, COBOL, PL/1, BASIC, and ALGOL (*2*). The equipment that is acquired should have software available for several of these languages.
3. The programs that perform service functions such as sorting, printing, copying tapes, etc. These programs are called utility programs. A variety of utility programs should be available with the equipment that is acquired.

The administrator responsible for the acquisition of computing equipment must therefore be aware of the capabilities of both the hardware and of the software of various manufacturers.

• Housing the Computer

Assuming one can decide what equipment to acquire, where will it be placed? The location, relative to the user population, will be deferred for a few minutes. Let us

concentrate now on the space requirements of our computing facility. Even the smallest of computers occupies finite space, and this space costs money. Furthermore, space must be provided for work areas for users, for storage of supplies, for housing personnel who will operate the facility, and so on. In addition, most computers require a temperature- and humidity-controlled environment.

Is air-conditioned space available? If not, how much will it cost to provide such space? If air-conditioned space is available, is the air-conditioning system adequate to handle the heat output of both the equipment and the personnel? In addition to these considerations, one must provide furniture, storage cabinets, and the like for the operating personnel and supplies, all of which adds up to more money.

Here are some examples of costs of computer facilities (*3*):

1. 500 students, $2,000,000 budget:	
Amortization of capital equipment	$10,000
Maintenance	3,400
Supplies	750
Personnel	7,000
Total (1%)	21,150
2. 7,000 students, $21,000,000 budget:	
Amortization of capital equipment	$6,000
Maintenance	1,200
Leased equipment	26,000
Supplies	3,000
Personnel	20,000
Total (1¼%)	56,200
3. 8,000 students, $28,000,000 budget:	
Amortization of capital equipment	$144,000
Maintenance of owned equipment	15,000
Leased equipment and supplies	100,000
Miscellaneous	7,000
Personnel	80,000
Total (1¼%)	346,000
4. 25,000 students, $90,000,000 budget:	
Amortization of capital equipment	$65,000
Rental	924,000
Supplies	106,000
Miscellaneous (including some facilities)	100,000
Personnel	576,000
Total (2%)	1,771,000
+$750,000 administrative data processing	

• Centralized versus Decentralized Facility

Wherever the computer facility is housed, it will not be near enough to the user. The situation is quite analogous to the location of the library. A central library is too far away for most users; hence, departmental libraries. The departmental library may be next door or on the next floor and is still too far away; hence, personal libraries. The closer the facility is to the user, the closer he wants it. This augurs against central-computer facilities. Nevertheless, in planning a computer facility, the relative simplicity of a centralized facility together with attendant savings in costs—for equipment, space, personnel, and the like—will be very influential in the decision-making process. What is actually required is a network facility.

A network may take various forms depending upon the size and complexity of the facility contemplated. Generally speaking, the network consists of a central computer of medium to large size to which is connected a number of terminals remote from the site of the main computer. The simplest form of terminal is the pickup-and-delivery service. A number of locations around the institution are designated as computer service points where the user may submit his programs, pick up his result, and perhaps obtain advice and consultation. No sophisticated equipment is required, just a few keypunch or other similar machines, perhaps a printer, and a telephone or two. Programs are carried by hand to the main computer for processing.

A more sophisticated system involves automatic transmission of programs and results to and from the remote terminal. The simplest of these requires a card or paper-tape reader/punch and a printer. You can carry this reasoning on, through many combinations of equipment, to the notion of the time-shared facility where many users have direct access to the central computer at essentially the same time. The ultimate remote terminal would itself be a computer facility linked to the giant central computer, linking many users by smaller remote terminals such as typewriters or video consoles. The kind of network just described can be depicted as in Fig. 1 (*4*). An alternative, minimum in-house facility is shown in Fig. 2.

However the facility is organized, the byword is *service*. A computer facility run to provide employment for computer operators is worthless.

• Security and Privacy

Having planned a computer facility, especially one involving a network and many users, how are you going to make certain that the users' programs and data are safe from loss, theft, casual inspection, or malicious de-

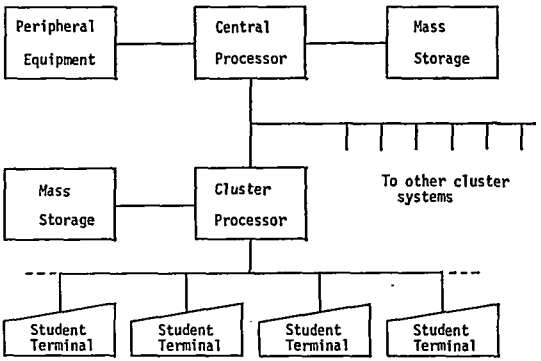

FIG. 1. A network computer facility

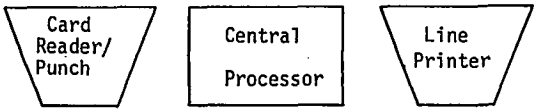

FIG. 2. A minimum in-house computer facility

struction? The user submits for processing at the facility a program representing many hours of work and thought. When he returns, expecting to retrieve his program and results, the program cannot be found. Who is at fault? The computer facility, clearly. To safeguard against this sort of occurrence, the facility must be well organized, and its personnel must have an acute sense of responsibility. When a tape is accidentally erased or a file in a time-sharing system is accidentally wiped out, the computer facility must be responsible. No time-sharing facility should be operated without backup for all programs and data files. These are problems resulting from accidental system failures.

How do you protect against the unauthorized use of, or access to, programs or data? How do you allow the user access to certain data files and not others? For example, it is acceptable for a student to retrieve information from a library file, but not from the institution's payroll files. How do you differentiate between users who are authorized to alter data files, and users who are authorized only to use the files? These are not simple questions, and there are no simple answers. An enterprising individual with sufficient knowledge and perseverance can get access to virtually any data or programs he desires. It is the responsibility of the computer facility to prevent unauthorized access; many manufacturers now provide considerable assistance in the matter of security and privacy (*5*).

There is one more aspect of security that needs to be mentioned. I mean security of the facility from willful, malicious destruction in the name of "peace" or some other similar cause (e.g., "war"). A number of instances have been recorded of mobs entering a computing facility and destroying both equipment and data and program files (the University of Montreal and the Dow Chemical Company are two examples). This is pointless, costly destruction and must be guarded against. Provision for illegal-entry alarm systems or for watchmen may be a partial solution, but complete backup of data files and software should always be maintained as well.

• Who Are the Users?

Suppose that a computer facility has been planned, funds have been allocated, space is ready, and the equipment has been delivered and installed. *Who gets to use the equipment?* The answer depends upon the cost of the equipment and cost of time for use of the equipment. In general, the user population will be that depicted in Fig. 3. Cost is reflected in the size of the lettering of the sign.

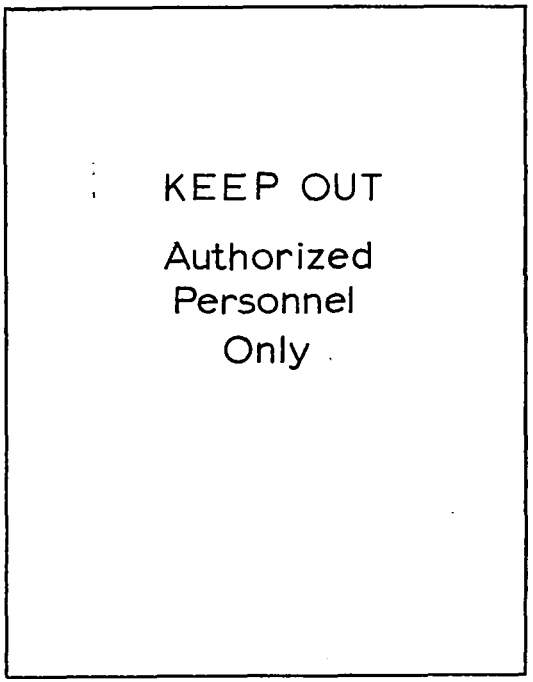

FIG. 3. The user population of a computer facility

References

1. GORDON, R. M., CAI: Some Operational Aspects, *Datamation*, 15 (No. 1):37–44 (1969).
2. SAMMET, J. E., *Programming Languages: History and Fundamentals*, Prentice-Hall, Inc., Englewood Cliffs, N.J., 1969.
3. CAFFEY, J., and C. J. MOSMAN, Computers on Campus, American Council on Education, Washington, D.C., 1961, p. 86ff.
4. CELLMAN, M., Centralized vs. Decentralized Computer Assisted Instruction Systems, *Proceedings of the Spring Joint Computers Conference* 30, 413–417 (1969).
5. COURTNEY, R. H., Data Security and Privacy, *Proceedings of the 6th Annual National Colloquium on Information Retrieval*, 9–14 (1969).