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COMPUTERS IN SYSTEMS OF HIGHER EDUCATION

John G. Caffrey

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by

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2500 COLORADO AVE.

SANTA MONICA

CALIFORNIA

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ABSTRACT

Computers emerged first in the academic world. In early administrative applications, they served to automate manual procedures, with little thought given to system design exploiting all the new potentials, and uses emerged first as imitations of earlier procedures. Little thought was given to integration of systems for different users: registrars, financial officers, deans of admission, faculty, etc.

Examining the management of higher education as a system requires careful planning to exploit all the potentials of both the machine tools and the common data base and requires thought about the purposes of management and administration. More careful thought must be given to information management system design because of rising costs of computer utilization and the increased complexity of management problems and procedures. The traditional separation of research, faculty, student, and administrative uses of computer centers was in part dictated by concern over queuing and scheduling problems, partly by fear of loss of control and access. Newer techniques, such as time-sharing, and the increased capacity of modern computers for multiple purpose usage make it possible to consider integrated total systems for higher education, whether or not all parts of a facility are physically centralized.

The computer facilities of an institution of higher education are becoming as essential a part of its resources as are the libraries and laboratories have been. It is conceivable that computer resources will become important in the ability of a college or university to attract and hold students and faculty as well as to receive support for research and development. The movement toward increased use of computers requires that the manager of higher education know more about computers and their supporting systems, including the instructional uses of computers (as tools, subjects, and objects of instruction).

Designing an information system requires that the administrator think carefully and make very explicit his objectives and criteria, and some observers feel that such an imperative is a useful discipline in its own right. As the need for regional and inter-institutional use of computers and information systems increases, new arrangements will be needed for cooperation, both vertically and horizontally, among and between institutions and their governing or regulatory boards.

Steps will have to be taken to provide training and orientation for all levels of management in higher education, especially in the training of novice administrators who will manage tomorrow's systems of higher education. Using the existing technology (not all of it as yet widely disseminated or well understood), it is possible to draw a picture of the university of tomorrow in which the computer, with its attendant peripheral equipment and software systems, will be a basic and indispensable part of the fabric of management as well as of the total operating and instructional program of the institution. The main problem at the moment is not the technology, which has outpaced its users in higher education, but dissemination, development, and the training of appropriate personnel.

COMPUTERS IN SYSTEMS OF HIGHER EDUCATION

The computer evolved in the academic world, both in concept and engineering, with major assistance from the electronics industry, and in many colleges and universities it remains essentially an academic possession. As the need for computer scientists and users has expanded in recent years, the computer has also become an object of instruction, and the demand even on freshmen in many colleges to know computing very early, and the expanding interest of second schools in teaching computer lore, has made the computer as common a tool for problem solving as were the slide rule and desk calculator two decades ago.

The use of punched card equipment for administrative purposes antedates the use of the computer for similar purposes by many years. Until fairly recently, few managers in higher education knew much about computers, and in many institutions the academic community posted a clear KEEP OUT sign on the computer room door. As computers became better understood, and as smaller ones became available, some institutions converted their punched card procedures for card-based computer systems, essentially doing faster and cheaper what they had done with cards, and a small minority even introduced more advanced tape systems.

However, it has not been until recently, and in a minority of cases, that attention has switched from the How To Do It stage to the nature of the management system itself. "It," in this context, has proved in most cases to be such pedestrian but massive tasks as student registration, grade reporting, test scoring and analysis, accounting, personnel records, etc. One could make a long list of such possible applications, which I call transactional, and I dare say no one here could think of any reasonable transaction or application which has not been tried somewhere, in some cases with outstanding ingenuity and acceptance.

Most such applications have grown in the face of demand. That is, those applications were tried first which were well-known to those running the data center, or which were of most pressing urgency, or which could be borrowed from a neighbouring institution, or which the machine manufacturer could provide as an added inducement to using his wares, or which most closely resembled a manual process which was well-enough understood to be easily imitated with automated equipment. In very few cases have management information applications emerged as a result of prior systematic study of the total problem of management in higher education. Indeed, it is easy to find situations in which systems developed quite separately, and with little if any interface, in the same institution: The registrar having a 407/EAM unit, the comptroller a 1401, and the counseling and testing center a scoring machine and some minimal EAM gear. Needless to say, not far away may be a monster computer center with large capacity not fully utilized. We even

know of one case where on the same campus two separate and mutually unknown efforts were being devoted to mechanized class scheduling.

It is also easy to cite examples of mutually exclusive systems, with a payroll office using one set of codes and files for staff, a registrar's pupil record office a completely different set of codes in class lists and grade reports, and an alumni office using yet another set of codes and records with no relation to the registrar's. To say nothing of the fact that the computer center on the same campus uses yet another system of codes to keep track of faculty and student work and assigns different sets of codes to work done on contracts than is used by the university contract officer and yet again by the business manager. There is nothing inherently wrong with chaos if one never notices it or if one plans for it. Those who used to worry about system compatibilities have begun to realize that it is probably more sensible to design software for inter-system translation.

However, the instances I have suggested of Topsy-like growth of parallel, disconnected, uncoordinated, incompatible "systems" are intended to suggest the lack of consideration giving to approaching management as a system. However, as Brown and Mayhew point out in their recent American Higher Education, our higher education system works reasonably well without systematic form or structure. Local autonomy, between and within institutions, is a matter of fierce pride. Anyone who offers to tinker with the information system component of management offers to open up a hornet's nest of vested interests, tradition-based practice, actual as distinct from formal organizational lines, procedures whose original objectives have been forgotten, fear of automation, and plain cussedness.

What is driving the higher educator to think more systematically about his system, and especially to think about automating portions of it, is a combination of: rising costs; increasing demands for more and better data from boards of regents, state and federal agencies, foundations, and from planning and fiscal control agencies; and the generally increased complexity of management problems which come with rapid growth.

The development of automated management practices in education--and this may be true, if it is true at all, in other agencies--seems to follow a classic pattern: automation at first simply takes over and imitates what used to be done by hand. Then new and more elegant applications are developed as the relationship between very various files are perceived and as pioneer technicians experiment with massive, brute-force solutions to problems like scheduling or other optimization and resource allocation problems. At first, the academic manager may be inundated by waves of paper bearing more figures and tables than he has ever used before. If he is able to stem this tide or demand better data reduction, he may begin to perceive the increased utility of information based on more complete, accurate, and timely sources, and he may begin to think of new kinds of management information he could use.

If he is fortunate, his information service officer invents new reports, controls, and processes and teaches the administrator how to use them effectively.

However, one is hard put to find very many examples of a broadly integrated and comprehensive management information system which is designed to serve the purposes of administration. In pursuit of a study of my general topic, and with the cooperation and support of the American Council of Education's Commission on Administrative Affairs, I have been visiting a few colleges and universities this year and expect to visit many more in the near future. I have talked with presidents, other administrative staff, and heads of computer centers and information processing systems. My remarks now are based on a small number of observations, but I am struck by the consistency with which the same problems, attitudes, and directions of thought emerge.

1. Administrators are just beginning to be aware of the potential utility and power of truly integrated information systems. Those that have any such systems at all, a minority, and the minority of those who have thought much about it, usually cite convenience and economy as the chief advantages and objectives of their systems. Many have been grateful for the solidity which clean data can contribute to an argument, a budget message, or an alumni fund-raising appeal. But there is also a growing interest in what they have heard about the possibility of using simulation to test the effects of decisions, to arrive at better problem solutions by converging iterations, to project the shape of proposed programs, to forecast needs, and so on.
2. At one time, in the early days of university data centers, it was a widespread conviction that research and administrative units should be separate and that even within the administration separate facilities should be used for--say--grade reporting and payroll, to avoid peaking and queueing. However, as computers become faster, as time-sharing systems become practical, and as inter-computer system integration makes it possible to have a separate satellite which is all one's own part of the time and a feeder to a very large monster another part of the time, and as executive programs provide reliable scheduling and multi-program processing so that both payroll and grade reports can be handled at the same time, the movement is toward the design of centrally planned and managed systems which meet the needs of research, instruction, and administration. A central system, it is perceived, does not imply a single large hardware center but may involve units placed for convenience of access and control at various points and yet with the potential of being combined into very large hardware complexes when large capacity or more sophisticated and complex processing is required.

3. There is increasing recognition that the computer capacity of a college or university is part of its total power to attract and hold students and faculty. It is safe to predict that within the next ten years a major college or university which does not have adequate computer facilities will be considered as unattractive as a college without a library. I know of instances in which outstanding scholars have turned down offers to join a faculty because of inadequate computer facilities. We also know of instances in which the award of research grants or contracts has been conditional upon the existence of such facilities. It is not just a question of keeping up with the Joneses.
4. In large institutions, the demand for computer services tends to become so great that the computer facility must keep up. As costs rise (not per unit of computing work, but absolutely) it becomes necessary to pool the resources of administrative budgets and research contracts in order to afford equipment of sufficient power. As the number of users, especially students, grows and grows, and not just in mathematics and the hard sciences, the need for easier access via remote terminals and more effective operating systems, with short turn-around, grows insistently. One even begins to hear it said that in the humanities and liberal arts programs there is growing realization that the citizen of tomorrow had better know as much as he can about computers, and hence the demands for instruction in computer sciences grow apace. It is possible to find in college catalogs across the country a great variety of courses designed for special purposes: The engineer and the business administrator apparently need different kinds of programming courses; there are courses covering the general lore of computers, the design of computers, computers in system analysis, and so on. The point is that it is hard to find a discipline in which the computer has not obtruded--even in art and music.
5. In the process of conversion to an automated system, the administrator is forced to think very hard about his objectives. Since the computer programmer must receive precise specifications for what he is to do, someone has to stop and figure out what is wanted and why. This process alone, according to my friend E. L. Katzenbach, is worth the price of the computer. The introduction of the computer into management may be the opening door not merely to facilitation of current practice but to the fundamental improvement of management itself. Thinking about the computer forces us to be painfully explicit about the purposes of administration.
6. The rapid advance of computer technology, and its implications for system design, has led to certain kinds of confusion and ambivalence on the part of administrators. Almost everyone has heard about

time-sharing, but this is often confused with the simple idea of providing remote input-output terminals. It is not necessarily the same thing. On the one hand, some assume (correctly) that the production of time-sharing programs can be quite expensive, and on the other hand (incorrectly) others assume that time-sharing systems are available as off-the-shelf items. Someday they may be, and a few, such as GE's, almost are. However, the largest and most elegant systems, such as Project MAC's and SDC's, are either tied to specific one-of-a-kind hardware or are not adequately documented. Most major computer systems will eventually be delivered by vendors with at least the framework for a time-shared system, but we should not be overly optimistic about the rapidity with which these can be delivered or put into operation. Another source of confusion is the problem of purchase versus rental. The computer censuses show an increasing proportion of purchase, apparently because analysis shows economies, but there is much worry about obsolescence. The administrator wonders whether a few years hence he will have a dud on his hands, and they know little about the market for used computers or about the proportion of cost which can be recovered in an exchange for a new model. There is also a tendency to forget that purchase does not eliminate periodic costs, such as maintenance contracts. Some administrators are waiting for computer development to "level off," probably somewhere this side of the speed of light, before they take the plunge.

7. I have found at least one enlightened college president who recognizes that his college is long overdue for a computer center but who will not move until his faculty evidences sufficiently strong interest--and especially in the instructional use of the computer, to say nothing of research use. The small college (1000 and under) has a special problem; in the liberal arts case, there is an uneasy feeling that a humanities curriculum should include something about computers, but the small college tends to feel that having a computer is expensive. It need not be as expensive as many presidents think, especially with the current wave of very fine small computers, some of which can be purchased outright for less than \$20,000, which could provide both modest computing power and sufficient experience for cultural broadening. Some small colleges are looking seriously at the possibility of remotely shared use of a commonly supported center, and many have profited by the use of such regional centers as the Western Data Processing Center at UCLA, the Dartmouth and Phoenix GE centers, the New England Education Data Systems, and the like. One value of the latter kind of experience is that the college ultimately gets accustomed to computer utilization and takes longer and faster steps toward developing its own facilities.

8. There is no particular standard pattern for the genesis and expanded use of university computer centers or systems. In some cases, the lead has been taken by a college of engineering, in another by a school of business administration, and in still others by one of the "hard" science departments. Medical schools are also taking a lead; I have heard medical educators say with great conviction that no self-respecting medical school, even today, can do without a computer center. In some cases, as in medicine, physics, and other subjects requiring extensive on-line use in relation to experiments, separate facilities are a must. At Tulane University, for example, the computer complex, serving not only the medical school but several associated hospitals, is in use around the clock, monitoring laboratory work and surgery on a real-time basis, performing quick turn-around analysis of lab report, and involving specially engineered equipment for recording data on tape for direct computer input. Dr. James Sweeney at Tulane has developed methods for scanning and digitalizing X-rays to provide for faster and more sensitive diagnosis. In very few institutions, however, have I found any evidence of a faculty-wide comprehensive plan for the development of computer services. Other faculties than the one originally responsible for a center gradually climb aboard as they see what can be done, but in too many institutions this is left to chance. At Stanford University, special attention has been paid to acquainting a broad spectrum of faculty with potential uses of the computer in their own disciplines.
9. In some administrative areas, automated systems have provided some surprise economies and monetary returns. At the University of Colorado, for example, there is a very strict control of research contract budgets and expenditures, which provide periodic reports for short-term controls. In another university, alumni fund contributions and appeals are so effectively automated that the system can be credited with raising a quarter of a million dollars a year. Computers have been used for designing rooting section card stunts for football games, with huge savings in money, for handling football or concert series tickets, for mailing lists, and for the assignment of parking space. Some of these trivial and even frivolous applications, at which one may smile, still raise or save money.
10. One of the major problems hampering the advance of new and better integrated systems is the shortage of administrators who understand how computers can be used in management. Many computer center directors and technicians do not know much about administration, and a goodly number of them are not receptive to management appeals for help. Unfortunately, there are very few places to which an administrator interested in improving his understanding of these matters

can turn for training or assistance. There is a great need, which will increase in the future, for the establishment of centers to provide direct assistance, consulting services, training and orientation programs, and general information about existing practices and possibilities. The Association for Educational Data Systems now has an office in Washington, D. C., supported largely by a grant from the Fund for the Advancement of Education, but as yet its resources are very limited, and most of its users are in public school or state education agencies. The College and University Machine Records conferences provide a forum for the exchange of ideas and software. But these activities come nowhere near meeting the realized need, to say nothing of the greater needs perceived by those studying the problem. We hope that the ACE study to which I referred will result in stimulating the development of such centers throughout the nation. In the meantime, development of systems in individual centers involves much necessary re-inventing of the wheel and an inevitable duplication of work already done elsewhere at considerable expense. As rapidly as possible, we hope to eliminate some of this, and a year hence I would hope to be able to report encouraging progress.

Looking at present practices, trends, and interests, and peering into the future, let me conclude by describing some of the components and characteristics of computer centers and systems in the future--within the next decade, at least--in a typical institution of higher education. My example will be a state university with an enrollment of around 15,000, part of a statewide system, with the usual schools of medicine, law, librarianship, education, engineering, liberal arts, science, and so on.

The Computer Center, administered by a Director reporting to the university's president, is housed in a special facility which provides space for system analysis, programming, administrative, and operating staff as well as for the offices and classes of the Institute of Computer Sciences. The Institute provides instructional and consulting services for students and faculty and conducts advanced research in the design of computers and systems, in cooperation with the faculties of engineering, medicine, and mathematics. The Center is equipped with a large scale computer with extensive time-sharing capabilities. Access to the large computer is facilitated by the location of remote terminals and teletypes located throughout the campus--in the library, in administrative offices, study carrels, in the various professional schools, laboratories, and resident dormitories. In addition, the smaller satellite computers operated by the schools of medicine, engineering, and education, by the central library's Information Retrieval Center, and by the Instructional Materials Development and Resources Center for the monitoring of computer-assisted instruction, are all capable of being linked with the Center's computer on either a real-time or batch

processing basis. Linkage of either permanent or part-time input-output units is facilitated by use of the university's Centrex telephone network. In addition, through the Telepac A system, providing 12 channels connecting all seven of the state's institutions of higher education, it is possible to provide for inter-computer linkages among the institutions and with the offices of the state's board of regents. The latter has access via this system to the entire data base for all its institutions for purposes of administration, budget control, and forecasting and planning.

Special libraries, such as law and medicine, use their own computer facilities for document disposition and retrieval, and use the university's central computer in off-peak hours for the translation of foreign documents, on request. Scholars in all faculties may use the services of the Information Retrieval Center to obtain periodic or special request listings of new documents selected according to a list of keywords supplied by the scholars and revised periodically in the light of automatically produced periodic summaries of the utility of keyword lists; that is, the computer system counts "hits" and "misses"--and the number of times that each keyword produced a shelf-listing which turned out to be useful.

The university counseling center provides several services through its installation of six input-output terminals. Students can register for courses by using the teletype system, with automatic feedback if the student requests a course for which he has not met preliminary requirements. Students can also request information about their past records, using special code numbers designed to prevent unauthorized access to their records, and receive a certain amount of routine counseling assistance respecting requirements for certification in various fields, employment potentials, admission requirements of other schools or of graduate divisions, and the like. For specialized testing, computer-based standardized tests can also be administered which are scored as taken, the test terminating when the computer determines that the student has answered a sufficient number of questions to provide a specified minimum reliability coefficient. Counselors receive automatic reports concerning students whose course work is falling below specified minimum levels. The university center provides computer program service for the scheduling of all classes and prepares pre-addressed reports, for mailing, of class schedules, grade reports, tests, and other notices (e.g., periodic billing for tuition, loan fund repayment, etc.)

The university's administrative (and especially institutional research) staff has access to all of the data banks associated with the university's operations--student personnel, professional staff, budgets, research contracts, facilities, accounting, maintenance, and so on. The by-products from the transactional system provide current and immediately available information, in either CRT or hard copy displays, for current administration and planning. A general purpose CRT display system, which can receive inputs via light

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pen, teletype, or electronic tablet, is sufficiently flexible to permit the user to arrange data in a variety of tabular and graphic forms and then to obtain hard copies when he is satisfied with the results.

The president, who is responsible for presenting budgets and other plans to the board of regents and ultimately to the legislature, not only finds that his computer-assisted system permits more accurate and useful estimates of current and anticipated needs and resources but that the legislature has much more faith in the validity and accuracy of the information upon which he bases his plans. The board of regents, having direct access to necessary data through its linkage to all the state system's computer centers, finds that it is often able to conduct statewide planning and evaluation studies without having to take up the time of institutional officials in filling out forms and answering questionnaires. Indeed, many local institutional reports and statewide compilations are prepared and delivered automatically on a periodic schedule.

Is this so much blue sky and opium?

Finally, let me stress that almost without exception every technical development implied by the foregoing sketch of tomorrow's university is already a fact in either final or semi-final form and is available either in the public domain or through commonly accessible vendors. Our problem is not the technology of information processing. The creation of powerful management systems, with their associated instructional and research capabilities, requires only that we decide to move ahead, commit the required resources, create the human technology, establish the training and orientation programs, keep our eyes open to the still newer developments which burst upon the scene continually, and demand that our system designers and technicians put their best resources at our disposal to bring the management of higher education at least into our decade of the twentieth century--if not into tomorrow.

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<p>Designing an information system requires that the administrator think carefully and make very explicit his objectives and criteria, and some observers feel that such an imperative is a useful discipline in its own right. As the need for regional and inter-institutional use of computer and information systems increases, new arrangements will be needed for cooperation, both vertically and horizontally, among and between institutions and their governing or regulatory boards. Steps will have to be taken to provide training and orientation for all levels of management in higher education, especially in the training of novice administrators who will manage tomorrow's systems of higher education. Using the existing technology (not all of it as yet widely disseminated or well understood), it is possible to draw a picture of the university of tomorrow in which the computer, with its attendant peripheral equipment and software systems, will be a basic and indispensable part of the fabric of management as well as of the total operating and instructional program of the institution. The main problem at the moment is not the technology, which has outpaced its users in higher education, but dissemination, development, and the training of appropriate personnel.</p> <p>(author)</p>			