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The use of computerized information systems to increase efficiency in university management

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by Bikas C. Sanyal

1. Introduction

The size and complexity of universities today call for rapid and efficient methods of planning, communication and analysis of their management functions. Evidently it is beyond the capacity of heads of universities, to observe personally, the many activities that are going on in their universities, but nevertheless, they must gain an overview of the various components – staff, students, financial resources, facilities and the environment. Moreover, they should be capable of effectively integrating all the components into a total efficient operational system. To manage efficiently, individual creativity has to be maximized at all levels of the administrative hierarchy without impairing the overall aims of its organization. There is increasing pressure on universities to rationalize the decision-making process, ensure better allocation of resources, increased accountability, transparent operation and evaluation of objectives. All these call for internal monitoring and modification of the process of management through effective control of the component parts of the system, i.e. evaluation of the achievements of the university and revision of procedures and/or choice of programmes and priorities and sometimes even of objectives. This aspect of internal monitoring and modification, which would otherwise be called feedback, makes 'information science' an increasingly indispensable aid to university operation. Computers help to analyse the interdependence of the different components of the university system and to rationalize decision making and resource management by way of better communication, feedback and control. Technological developments, especially in hardware development due to miniaturization, and new architectures coupled with accelerating development of ever improving software packages have facilitated the use of computers and, thereby, of an enormous amount of varied but useful information for university management.

From the management point of view, a university is an 'open system' with all the consequent characteristics. The need for scanning the environment around the university to identify the external opportunities and threats and scanning the institution to identify the internal strengths and weakness, so as to determine the missions, goals and objectives, clientele, programme mix (including their comparative advantages), leading to the planning of the different subsystems (e.g. financial, facilities, academic human resources and the organizational subsystem) and their implications for funding – in brief the need for adoption of strategic management – call for mastery of all information in a university from a systems point of view.

Such an information system would have to provide integration of files on the basis of one-time entry of data into centralized common files set up to make information available on a university-wide basis. It would furnish appropriate quantities of organized, detailed information on which the university manager can base plans and make decisions. It would provide for automatic relating of information among subsystems and automatic cross-referencing among files, as well as give the historical information needed to build and support necessary models and demonstrate the trends and tendencies of the university, including indicators of performance of the different sections of the university. It would support the traditional reporting requirements of the university.

The above concept has led many universities in both developed and developing countries to attempt to set up information systems and computerization of different managerial tasks. However, progress towards integration has been very varied.

Information systems of higher education institutions may be said to have passed through three phases in the last two decades, though some institutions have remained in the first phase, while others have gone even further than the third. The characteristics of the first phase are (i) the use of central mainframes for administrative purpose; (ii) non-integrated systems except for the use of some key or reference file; (iii) 'partial support' for clerical work to facilitate handling huge amounts of data; and (iv) focus of management support on the mandated delivery of statistical data to outside agencies rather than on the institution itself. This system could be called the 'big system' phase. The characteristics of the second phase are: (i) shift of the emphasis of computer support from mass data processing to user-friendliness providing middle management staff with necessary information direct;

(ii) installation of departmental computers; (iii) increasing number of 'marginal' administrative areas supported by computer, and (iv) extension of administrative computing support to decentralized organizational units. This phase could be called the 'decentralization phase'.

The third phase called the 're-integration phase' is characterized by four integrative tendencies:

(i) focus on providing support for integrated administration tasks, i.e. transfer of data/documents from one system to another, from one department to another etc.;

(ii) provision of integration between central administration and decentralized units which were supported separately in the previous phase;

(iii) establishment of links between office automation (e.g. word processing) and administrative computing systems; and

(iv) integration of the administrative computing systems of the various administrative departments for use by institutional managers.

Some institutions are moving forward to linking the central administrative departments to each other to cover the entire institution in a network. The development of an information system is not only a technical task but also a political process, depending upon the degree of autonomy of the different units and the relationship between the university and the government. The extent of merger of different information requirements influences the nature of the information system.

2. Prevailing state of information systems/computerization in universities

Introduction of information systems, like any other managerial change in a university, depends to a large extent on the government steering policies for higher education within a country. Two major types of such steering policies have been delineated: (i) self-regulation within a broad framework of accountability which is to be found in the USA (greater use of free market incentives), and in the United Kingdom, the Netherlands, Canada, Australia, (under state guidelines) and (ii) direct centralized planning and control as

seen in many developing countries including China and some continental European countries, e.g. France, Italy, Austria, Portugal). A number of countries are in transition from centralized to decentralized, e.g. the Nordic countries.

As a whole, whether under self-regulation or centralized planning, computerization of university management is receiving increasing attention in the universities of developed countries for the following reasons:

- Increased need for accountability.
- Complexity of university management.
- Increased need for decentralization of decision making.
- Emphasis on client-centred and service-oriented planning.
- Increased need for strategic planning and management in certain universities calling for continuous updating of information and modification of decisions.
- Availability of high power computers and user-friendly but sophisticated software packages at cheap cost allowing the tackling of highly complex computing problems at a higher speed than is possible for any human being.

Information systems have evolved in developed countries from a disintegrated database at the initial stage through automation of administrative computing in an integrated system to management information systems useful for policy-makers. The latter has also been called an "Executive information system"(1). The experience of a few universities will be described below, but since the basic characteristics remain more or less the same, only deviations from the usual practice will be emphasized. It should also be noted that in many cases the systems and the subsystems have undergone several revisions but only the latest stage will be discussed.

(a) Self-regulation and accountability

In the Netherlands, at the national level, universities are independently responsible for their information policy and its implementation and they all

began with administration computerization. In 1981 they formed the Foundation for University Administration Automation to co-ordinate analyses and design of systems for staff, finance and students. There was an abundance of data but lack of information for policy or management and thus increasing attention had to be paid to information systems in order to provide required information to the Ministry of Education (MOE). In 1983 the universities and the MOE agreed on an Information Statute for the supply of basic data on students, staff, space, finance, research and examination results. However, in 1988 the Association of Universities formed their own committee on information policy to agree on local and national databases. In 1990 interest shifted towards information for planning and accountability. The universities and the MOE agreed that: information should be linked to university needs and decision making; the supply of information should be carried out as much as possible through existing periodic reports which should be limited and co-ordinated as regards content and information flows should be simplified(2).

In the Netherlands, in the University of Twente, (6,700 students, 2,300 staff, which developed a strategic plan in 1987 and has a decentralized system of finance where departments are given a lump sum budget), 73 information processes are operated which collect 165 types of information in 10 clusters (education, research, social services, management control, finance, staff, materials, project services, general services and campus), each of which is covered by an information plan (who needs what information for what purposes). It was felt that there was a need for: (i) a central unit for information planning and support, (ii) standardization and integrated information, and (iii) a system to edit data, make surveys and plan. The existing Computer Centre was then integrated into a new Centre for Information Supply to deal with these needs and develop a training programme. The situation now is still one of over abundance of data and proposals have been made to appoint an information controller/co-ordinator in each department. An automation policy is being worked out to establish: expenditure per annum; timing of purchases of hard and software, standards of system development, data analysis etc. Priority is to be given to student and financial information (Schutte F., ibid.)

In Finland, in the University of Joensuu, the system has been redesigned to support the new budgeting and outcome-oriented management, especially at the departmental level. With the aim of providing a strong basis for financial management, the information system of the department consists of

five integrated subsystems, which use a common database with all relevant information about personnel, posts and students i.e. the 'Personnel and Post Register'. This includes all personal information of personnel and students (because students often get paid for part-time tasks and become members of the personnel system). The 'Student Subsystem' provides departments and central administration with information about student selection, registration, credits, degrees awarded and so on. The system is also used to produce documents for students, departments and general administration for different purposes. The 'Teaching Subsystem' is a decentralized tool where data are fed in if the offices of the basic units around the campus and central administration uses this, for instance, for payroll, making letters of appointment, reports to departments etc. The 'Premises Management Subsystem' is used for the reservation and monitoring of teaching rooms and other common campus space showing the possibilities to change for certain purposes and also to differentiate between different sites, and their time of use. The Salary Planning and Monitoring Subsystem supports the function of lump sum budgeting. From the autumn semester of 1992 the university has been experimenting with a flexible Work Load Subsystem so that the departments can allocate teaching, research and other duties among the faculty members and buy services from outside if necessary, according to their preference without any centralized control. The departments feed the annual work plan of each faculty member negotiated with the Head into a new information subsystem built upon and linked with the basic subsystems. The work load subsystem uses the Teaching Subsystem in the identification of the position and personal characteristics of the faculty member.

However, the accounting system does not yet work in real time. Departments receive the accounts once a month which does not support the new budgeting system, because all governmental organizations use a centralized accounting system which has not yet been adapted to the new system. The library subsystem is also part of the national network of scientific libraries and is therefore not able to provide departments with information on scientific activities in a form suitable for management purposes(3).

In Sweden there has been a close link between use of computers for university administration and for academic development. Up to the middle of the 1980s computers were destined mainly for research and teaching. Responsibility for Informatics Centres was given by the National Council to regional universities. The University of Uppsala specialized in management

and produced the first systems for salaries and student registration which were adopted by most universities. Mini computers in the 1980s allowed decentralization within the university to departments when the central regional computers became uneconomic and some centres then only offered advice. A National Centre of Super Computers was created and universities were connected to it in a network. At present most universities have a local system which allows management to decide which data to produce for their needs. At the University of Stockholm, monthly reports are produced for the Rector on the financial situation of each department, and a new student registration system was introduced in 1991. Libraries are linked to a national system. It was felt that standardization of procedures and better training of users can reduce wastage but this may also reduce attempts at innovation as well(4).

In Switzerland, a new campus-wide computing and communications infrastructure has been introduced at the University of Geneva (12,000 students, 1,700 teachers, 1,100 administrative staff and 80 buildings). It was developed by the university data processing service based on a Model 204 database management system running on a mainframe computer shared with the academic community. Access is through a network of terminals or work stations and it is integrated into the SWITCH country-wide network for research and higher education which is also part of an international system. It serves academic and administrative requirements, particularly access to libraries. The administration information system provides databases on: students: files, history and taxes; examinations: session management and results; personnel: files, contracts, salaries, allocation; finances: budget, accounting; 'structures' support facility: organization hierarchy, buildings and global aspects; and lecture catalogues; contents and publishing. Forty man years had to be invested in the development of these programmes. All 80 buildings are connected in the Local Area Network. The system is the result of several years of effort to persuade the academic community to comply to centrally determined rules of network discipline. Another essential element was planning strategy. Today the important issues are considered to be network management, cost effective maintenance and the balance between routine tasks and innovation(5).

The experience of the United Kingdom is different from the others. According to one author(6), technologically formalized information systems have not been as beneficial as originally thought. Initially, senior management distanced itself from the information system and usually left it to the

administration, i.e. a data processing unit which was later converted into a Computer Centre to provide services for all departments. Those universities which started late have been able to make rapid progress based on the experience of others. The impact of changing technology has been to alter the view of what can be handled by computers. The five main areas computerized initially were: student and staff records, finance, space and services, to which have been added catering and estates management. The university development plan must now include information policy objectives based on a network concept where the administration is linked to the academic departments and to other universities.

Two major grants were given in the 1980s by the *University Grants Committee* (UGC) for computerization, one to Bradford and the other to Aston. Now 19 universities and colleges (London, Exeter, Dundee among them) have agreed to use the most advanced computer systems to improve top level management under the *Management and Administrative Computing* Initiative (MAC). Software comes from CHA and is based on Powerhouse computing language. It covers finances, student records, estate management, research contracts and payroll and personnel records in a single system, and uses a common data format in a *Management Information System* (MIS) to generate reports across the system for the *University Funding Council* (UFC) and grant applications. Universities are spending 2.1 million pounds sterling on software and 2.2 million pounds sterling on a five-year contract to maintain it(7).

Most administrative computing systems are adequate at the operational level but less good for management information. Rebuilding a system to rectify this is costly and many universities could not afford it. But costs can be reduced if universities work together. This is the idea behind MAC which began in 1988. All institutions are put in groups which use the same software and develop and maintain it jointly. The managing team of MAC first drew up the core information requirements on the basis of common administrative activities (broken down into six areas: general management, finance, staff, students, physical resources, research and consultancy). Universities compared their own systems with the blueprint of common requirements/activities and designed strategies to move towards the blueprint. The strategies were then analysed to form viable groups of universities. Each group prepared its plans to develop its system and the University Funding Council (UFC) released funds to help cover the costs. Cost reduction is obtained through joint development of software and purchasing and joint

efforts resulted in higher quality, greater consistency of data and facilities and reduced risks and costs of maintenance. Eventually MAC may generate income from software developed. The main benefits to the university will be improved management decisions and administration(8).

In addition to MAC, the *Department of Education and Science* (DES) developed a new system called 'Prospect', at a cost of £2 million sterling. The system, which should be launched by now, provides the opportunity for self-assessment by students, teaches students how to approach the process of career choice and also gives occupational information. It will eventually provide an employer database and job vacancy database for university graduates(9).

At the institutional level the most advanced example of an information system is to be found in the Aston Technological University (see above)(10). Aston has attempted to use information technology in all its activities, and has as its aims to improve the quality of management in the universities of the United Kingdom. In addition to management tasks, the system allows for independent learning based on project and problem solving approaches using more real life data. A Pro Vice-Chancellor of Information Technology monitors the programmes' effectiveness (the programme has invested heavily, some £9 million sterling to date), adjusts the organizational system to provide wider access and new forms of communication and arranges staff development programmes in the use of the system.

In another less spectacular example, the Polytechnic of Central London in its information system has amalgamated academic support services in one unit called Information Resource Services (merging library, computing and audio visual services) providing access to a network of information despite scattered sites with six libraries. It is composed of a library catalogue Libertas and CDROMs database. The central base manages 129 librarians, programmers and technicians on other sites. Department heads sit either on a committee for this group or on another for the management information system which deals with finance, student registration, etc. The two groups interact on a regular basis(11).

This section would not be complete without some mention of the experience of the United States of America. A brief overview of a national system will be given followed by a few case descriptions.

In the USA EDUCOM was founded in 1964 as a non-profit consortium of higher education institutions to facilitate the introduction, use and management of information technology in higher education, and to promote co-operative efforts among the institutions in the USA. Initially, most universities installed cheap microcomputers for students, then by 1985 the emphasis was on campus networking by co-operative agreements with hardware vendors and in the late 1980s the accent is on information management. The initial projects incurred considerable high development costs, false starts and uncertainty. Some universities made a conscious decision to delay, others involved only individual departments. It was as late as 1985 that some consensus emerged about the scope and opportunities for investing in a campus computing and communications infrastructure. It was realised that information technology could revolutionize a whole range of administrative, management and service functions. The problems are not just technical but relate to devising new administrative and organizational structures and to social and managerial issues. The impact of computers in administration had in the past been less impressive than in learning support in the USA. They were used for accounts, personnel, registration, inventories and libraries but less so for decision making. The reason is that environment variables change rapidly, are not easily subject to quantification (e.g. attitudes) and relations are complex(12). But the situation has changed since a *Decision Support System* (DSS) has been developed as a flexible, interactive computerized system to support university administrators in decision making. DSS is used mainly for solving non-routine, complex problems, can provide on-line immediate response and prepare reports even during meetings. The system contains a database, model base and user system interface (mouse devices, menus). This is capable of producing reports, data analysis, model construction (forecasts, regression analysis), monitoring, financial planning, graphics, optimization and simulation. The softwares used are:

- EFPM financial planning model (available on time-sharing basis and used by a consortium of 500 colleges.
- IFPS interactive financial planning system (EDUNET time sharing used by 150 universities).
- Lotus 1-2-3.

There are few documented applications of a comprehensive DSS – the Wesleyan University reports that the budget application resulted in quicker and more objective decisions with less internal conflict. The monetary

aspects are difficult to measure. Development of DSS usually begins with specific functional applications and once a university acquires a DSS tool, more administrators use it. At Florida International University, students work on actual administrative problems as part of their course requirements(13).

Stanford is among those universities which make the most intensive use of computers. The unit devoted to administration is designated *Information Technology Services* (ITS) with sub-units in the Director's Office, Administration information and services, financial services, communications, computer operations, data sources, graphics and mailing. The unit for academic services (ACIS) also has a variety of sub-units on instruction and research, time sharing facility, networking and video education. ITS and ACIS are the two university wide computer systems. The most important administrative lesson learned was that the use of computers should not be organized centrally, each unit must have computers for its own specific use. A problem was how terminals could be connected in a network. Stanford introduced gateway technology, each system enters the main network through a gateway (31 at present)(14).

The *Massachusetts Institute of Technology* (MIT) also has one of the most developed information systems group to establish a campus-wide network. By 1988 this included 1,200 computers in 27 buildings.

The above brief review has shown that governments have had to lead the way in establishing not only national and international networks but in providing the resources and initiative to set up university management systems, due to the need for these to be compatible and able to produce comparable data. Universities did not themselves have the funds for such investment. Self-regulation policies have therefore been a driving force behind these developments.

(b) Centralized planning and control

In France information systems are meant to serve three basic goals, to: (1) provide an accurate picture of the teaching and research systems, (2) assist deployment and adjustment of resources, and (3) control information flow and support. By 1988 two management information systems had been introduced in French universities, one for finances and accounts and the other for education, with access to a common database associated with a guarantee of autonomy for each individual department in its own sphere

of responsibility. The same system has been installed in different institutions with varying kinds of organization. The procedural rules are imposed by the management of each. The new technologies have not yet made their full impact due to lack of training which delayed implementation, and the use of common software standards was found to be essential(15).

The Ministry and universities continued to experiment. By 1992, 85 institutions were grouped under GIGUE (Group for Computerized Management) to study and develop computerized systems of finance, staff, students etc. A project SISE (system of student records) will at last give reliable information on students and their progress. The old norms will be replaced by a more flexible and precise analytical system (SANREMO) for the allocation of resources. Funds for basic running costs will be calculated on standard criteria(16).

In Germany, the transition of emphasis from quantitative to qualitative aspects of higher education, from efficiency to effectiveness, concern for structural changes, emphasis on self-regulation, competition for resources among universities, government interest in the implementation of the use of performance indicators for allocation of funds, need for public relations to establish a corporate identity including the marketing of programmes and establishment of priorities for research programmes, have characterized the evolution of information systems in the universities. The Hochshul – Information System – the national software house for administrative computing for higher education institutions (HIS) has developed two software systems. First, a mainframe based system for central administration is available in standardized version, and adaptable to meet individual institutional requirements. Second, a personal computer based system may be used mainly by decentralized administrations such as departments, institutes, faculties or even individual research projects. HIS provides advisory help. Unfortunately, demand for the HIS software packages has been more in public sector administrative offices rather than in the universities (Frackmann, E., idem).

From the above, it is noted that in the developed countries as a whole, the governments have offered assistance on information system development but the take-up has been more enthusiastic in some universities than in others. It is obvious that wide disparities exist in the use of computerized information systems and given this experience, rather strenuous efforts would have to be made to transfer what is most useful in this domain to improve

management efficiency to universities in such areas as Africa and parts of Asia.

Africa

In Africa so far very little use of information systems is made for university management. Among the countries on which information has been collected, universities in Nigeria and Ethiopia (University of Addis Ababa) have introduced computerization in the management of information. The University of Zimbabwe has developed a relatively efficient computerized system for student affairs (student applications, admissions, records and examinations) but has not yet been able to computerize financial management which is one of the priority needs of the University. The University of Swaziland, in co-operation with Vrije Universiteit Amsterdam, has developed a student information system incorporating modules for registration, admission, student finances and library use and envisaged as of January, 1994, to expand to include a continuous assessment module to monitor student progress. The University of Lesotho has also started a project to computerise its student records in 1993(17). Ghana and Madagascar are now attempting to install an information system for improving university management(18). Evidently much remains to be done in this domain.

Asia

Most of the countries in east and south-east Asia have computerized their university management tasks to some degree. In the Chulalongkorn University of Thailand, for example, the information system as of 1989 had the following components:

- Courses (scheduling and costing).
- Students (personal details and academic performances).
- Staff (qualifications, past work, grade, salary, course teaching, leave).

- Finance (source, allocation, utilization by faculty).
- Physical facilities (room size, type, space by type per student).
- Library services.

Services are provided for each faculty with its own terminal, for students (to carry on dissertation work), for internal administration and to government

agencies according to their requirements. The system used now was acquired through a trial and error process. After an unsatisfactory performance of a Canadian system, the 'US National Centre for Higher Education Management System' was found to be more efficient and has been adopted for the University's computerization process.

In India, the Birla Institute of Technology and Science has computerized student admissions, student timetable and examinations, staff payments, inventory and library services. Other universities in countries like the Republic of Korea, Singapore, Malaysia and Indonesia, have also set up management information systems with different degrees of extent and sophistication.

The situation in China will be discussed in some more details below.[1]

In China, the *State Education Commission* (SEDC) is co-ordinating the plans and programmes of various associations of information systems analysts and is covering all regular *Institutions of Higher Education* (HEI) of the country.

As of 1994, about 97 per cent of HEI's used computer management in administrative work. However, where PC's were used, 70 per cent used them in an isolated fashion to carry out complex data-processing for financial management, instructional personnel, capital construction and R&D management; 20 per cent of HEI's were preparing for networking and the remaining 10 per cent had set up an intra-institutional network.

SEDC is now using the management information system (MIS) of universities for diagnosing problems in HEI's and identifying corrective measures with the use of statistical indicators. They are also using statistical indicators for ranking HEI's in an attempt to reform the national college entrance examination.

1. This section is updated based on the presentations in the seminar.

However, at the national level, the problems are:

(i) uneven development of MIS among provinces and universities;
(ii) lack of timeliness, accuracy and pertinence of data used in the MIS.

Some specific examples are given below:

Yunnan province has a plan for a harmonized development of MIS in all the HEI's of the province involving the following steps:

(i) Setting up organizational bodies and equipping them with the professional and technical personnel needed.

(ii) Drawing up a master plan and budgetary estimates, organizing a team of experts to make a critical examination of the plan for feasibility.

(iii) Selecting hardware and concluding agreements with vendors and other contractors.

(iv) Procuring hardware, installing and budgeting it.

(v) Developing software.

(vi) Designing and executing the plan for a network.

(vii) Training of technical personnel handling hardware and software and training of managerial personnel.

(viii) Collecting and processing information and developing the databases.

The Yunnan University is designated as the leading institution in south-west China in MIS.

The plan envisages the choice of the state of the art hard and software, expendability of the system and standardization in two principal areas: library management and educational management.

The plan also envisages inter-institutional and intra-institutional networking with the long distance transmission of data facilitated by the optical fibre cable network and/or X.25 Wan especially to connect with SEDC. 'Internet' is proposed for international communication.

The *Higher Education Management Information System* (HEMIS) of Sichuan province is being used for statistical reporting and assessment studies in educational development. It has also been used in ranking HEI's based on nine indicators.

The province has trained about 1,000 personnel by 1994 in various MIS related training courses.

The above development has taken place at the levels of the province (32 HEI's) and Municipality (23 HEI's). Statistical reporting has become timely and the possibility of checking has made the statistics more accurate.

All the HEI's have set up their databases on student affairs and inventory of equipment and supplies. They are now in the process of developing software for managing finance, staff and student performance.

Selected HEI's are also building up their local area network (LAN).

However, the following problems still exist:

(i) uneven nature of the development among HEI's;

(ii) lack of co-ordination among information services and functional services of government;

(iii) standard of analytical and evaluation studies is yet low;

(iv) in spite of extensive training, qualifications of staff working in information services leave much to be desired.

Qinghua University had set up the first computerized information system in the country in 1985 and by 1986 it had set up the personnel information system, graduates information system, residential facilities system and financial management system. The University began setting up campus network in 1987. By 1993 it was complete with a large scale database

management system with a high power ELXI/6400 mainframe computer. Around the same time the whole information system was consolidated with training of personnel, purchase of hardware and software facilities and organizing a team to develop, operate and protect the system.

During the third stage with the campus network as the base, extension will be made to Ministries, and other relevant agencies with the 'NOVELLE' network.

The experience of this University indicates the pitfalls, such as: (i) the design of the information system to be based on the institutional needs; (ii) the design should be comprehensive, relying mainly on the deductive method but also the inductive method; (iii) design should be data-oriented and not process oriented; (iv) the design of the information system should be 'evolutionary' rather than based on 'life period model' and finally; (v) the role of the decision-makers must be recognized and they must be engaged in the design.

Shantou University where MIS was set up in 1990 gave the stages of development of MIS where the basis changed from mono-computer environment to network environment; the operational pattern changed from mono-user to multi-user and the relation between each sub-system changed from the state of being independent to the state of being interdependent(19).

Latin America

In Latin America, universities have used computers for some decades mainly for students data (admission and records), staff and payroll, inventory management, accounting and space allocation. Very often there is lack of integration of different subsystems. Previously all information was processed in the mainframe computer, but recently departments have developed their own mini-systems of information working on personal computers to meet their own managerial requirements. This, sometimes, results in duplication of work. It was also observed that in spite of the considerable number of staff engaged in information management, the central administrative office often received out of date, incomplete and sometimes incorrect information. Other problems facing Latin American universities are obsolescence of equipment due to lack of replacement of the old equipment as a result of the financial crisis of the 80s(20), and the fact that the establishment of an information

system calls for restructuring the staffing pattern of the universities which is often met by strong resistance from the staff.

These problems have been tackled to different degrees in the various universities and countries depending upon their stage of technological development, financial situation and managerial competence. In Colombia the database on higher education institutions has been created based on statistical surveys but no information system has yet been set up. Basic information on institutions is collected by ICFES (the Colombian Institute for Development of Higher Education) but no analysis is done as yet on wastage, unit costs or staff utilization(21). The situation in Colombia is similar to that prevailing in the majority of the Latin American countries. But there are exceptions. Several universities in Mexico and Brazil have gone far in computerizing university management. Two examples are given – one a system for the whole university in Brazil and another for a faculty in a university in Mexico.

In Brazil, a management information system was first developed in the University of Sao Paulo (50,000 students) in the late 80s. An excellent report on the system has been written, and an outline only of this is given below(22).

The University is Brazil's largest research institution, has 33 institutes or faculties on five campuses plus hospitals, farms, museums, and a radio station. Some campuses are 400 kms. from central administration. The information system has the following subsystems:

- Flow of documentation, i.e. location of documents and summary of decisions taken.
- Finance, purchasing, budget planning, accounting, inventories, salaries, some reports on-line for sub-accounts.
- Suppliers for purchasing.
- Staff, records, payroll, on-line reports by sector, indicators like SSR, salary expenditure per student.
- Academic affairs: enrolment by discipline, attendance, performance records ... supplies PIs or wastage, graduates per academic staff, thesis completion time by faculty...
- Libraries.
- University Press and book shops.
- Academic Productivity: papers, patents, curriculum vitae.

- Electronic mail, BITNET etc.
- Network management, which maintains information on location of terminals and printers, printing of reports and maintenance.

The university had to arrange for training of staff in the use of the information system in groups of twelve for a period of eight hours divided into two sessions of four hours each. Institutional managers, faculty heads and managers of central administration received five/six days' training on the whole system and its use as a managerial tool.

The system produces on-line managerial reports to support evaluations using performance indicators, planning and decision making. It centralizes information, but at the same time allows a decentralization of the administration of institutes and faculties. The performance indicators generated are used and decisions are now more respected and accepted. Up to 20 per cent of faculty budgets are allocated in proportion to academic productivity. PIs are published in annual reports allowing comparison between faculties and this has had a positive effect in that staff are more concerned about performance. There has been a 20 per cent decrease in administrative staff allowing recovery of investments in 16 months, after which there was a monthly saving of US$200,000. The overall cost was US$756,000 (hardware $609,000, infrastructure cost to link three campuses $110,000 and consultant $37,000). The development of the software engaged four staff full-time for three years. The major conclusions from this experience were that it is possible for such a system to be developed by a small team using available tools of information technology and renting the main computer and that it is more efficient and cheaper to build a new integrated and up-to-date system than to try to integrate existing departmental systems which are out of date.

The impact of this experience motivated several other Brazilian institutions to adopt the same management information system. One such adoption took place in the Federal University of Ceara (with 18,000 students, 1,474 teachers, 3,676 technical and administrative staff, 38 per cent of them in a medical centre serving the population). Since the software had to be suitable for all federal universities, Ceara organized meetings with six other institutions who expressed an interest. The system began to function in 1990 and links three campuses. Again costs were high (a total of $756,000 of which the hardware comprised $609,000). This further experience concluded that the development of a multi-institutional system is advisable since it considerably reduced the costs and time for each and that it was better to use

a small group of experienced information technologists from outside rather than staff from the old internal system(23).

The next example deals with the development of an information system in a large, almost autonomous, faculty, which needed information in order to cope with its own particular problems.

In the early 80s, the Faculty of Engineering of the National Autonomous University of Mexico (UNAM) (with approximately 12,000 students and 1,230 teaching staff, only 11 per cent of them with academic tenure), had acquired a reputation of producing distinguished experts in engineering but experienced the following problems: (i) relatively high wastage rate among students; (ii) relatively longer completion rate of studies; (iii) complexity of monitoring staff utilization and staff management because of a large number of hourly paid and non-tenured staff; and (iv) any attempt to improve upon the performance of the faculty needed a relatively complex analysis of a large database.

These were partly the reasons behind the adoption of an information system in the faculty. This has seven subsystems (students, academic staff, budget, teaching space, timetable, library and administration and planning), each with a very detailed database oriented towards measuring performance of the different tasks with predetermined periodicity and end-user. It is run by a complex set of computers: mainframe (1), mini (3), micro (76), and personal (7,500). The system allows users, to: (i) identify the nature and extent of wastage in different areas, especially in student time; (ii) measure the performance of teachers using both subjective and objective measures; (iii) monitor the performance of students through a combination of measures including self-evaluation; and (iv) monitor the progress of different activities at different points of time(24).

The enormous investments and high expense that are required are very striking and it is therefore not surprising that universities in Africa have not for the most part yet attempted to establish management information systems. This may turn out in the long run to have been rather fortunate for them, since the present time is a much more favourable one to start, given the much lower prices of hardware and the greater flexibility of personal computers, as well as the fact that such a lot of experience and software have been accumulated from which 'latecomers' may profit.

3. Current thinking on good practice in managing University Information Systems

An information system should be designed to provide for integration of procedures and files on the basis of one-time entry of data into centralized common files set up to make information available on a university-wide basis. It should furnish appropriate quantities of organized, detailed information on which the university administrator can base plans and make decisions, and provide for automatic relation of data among subsystems and automatic cross referencing among files. It should provide the historical information needed to build and support necessary models and demonstrate the overall trends and tendencies of the university. It should also support the traditional reporting requirements of the university.

(a) The database

An effective university management information system needs a database suited to its particular goals and requirements. The database may be sub-divided (according to general experience) into six categories: personnel, academic information, students, facilities, financial and auxiliary enterprises.

Personnel data relate to the up-to-date biographical record, current activities, publications, salary budget, payroll and benefits etc.

Academic information relates to the past, present and forecasted programmes in instruction, research and public service. This would include data relating to course offerings, degree programmes, research projects and advising activities. It would also include information on faculty time distributed among teaching, research, advising and committee work. Historical information of this type is useful in evaluating proposed programmes.

Student data would relate to admissions, academic records, extra-curricular and follow-up records, scholarship, financial aid, accounts due, medical records, housing and counselling data. A comprehensive database on students can provide information on student achievement before and after graduation and can serve as a key variable in the evaluation of the university's educational programme. Individual programmes can be evaluated from data on grades achieved by students changing to and from various curricula.

Facilities data would relate to inventories of land, buildings, classroom and laboratory space, equipment, special laboratories and maintenance. This would help to determine optimal utilization of facilities by activity, to assign rooms for classes, to maintain inventories and also to find joint uses for some resources.

Financial data should relate to individual university activities – accounting and payroll information on budget, income, expenditures, accounts receivable and student financial assistance.

Auxiliary enterprise data relate to housing, bookstores, food services and sporting activities.

The interrelationships among subsystems must be clearly recognized in order to use these data for monitoring, forecasting and planning purposes.

(b) Characteristics of an information system

Any information system should have the following five characteristics:

- Standardization.
- Accessibility.
- Flexibility.
- Maintainability.
- Protection.

- *Standardization*

Any element in the system should carry the same definition for all areas. Codes to identify activities must be standardized for all uses.

- *Accessibility*

The system should be so designed that a user can obtain data when he wants it.

- *Flexibility*

Computer programmes for storing information for retrieval and other purposes should be capable of modification when there are changes in the

database. The alternatives of variable length records should be evaluated. Flexibility does, however, incur extra cost.

- *Maintainability*

There should be only one source of updating any particular item of information and that source should act as the clearinghouse. Updating should be handled in batch runs at the computer. On-line updating should be a carefully controlled process.

- *Protection*

Adequate back-up procedures must exist to recapture information lost through error. Confidentiality of data must also be provided for. The flow chart on the next page demonstrates the steps involved in designing an information system.

(c) Implications of an information system

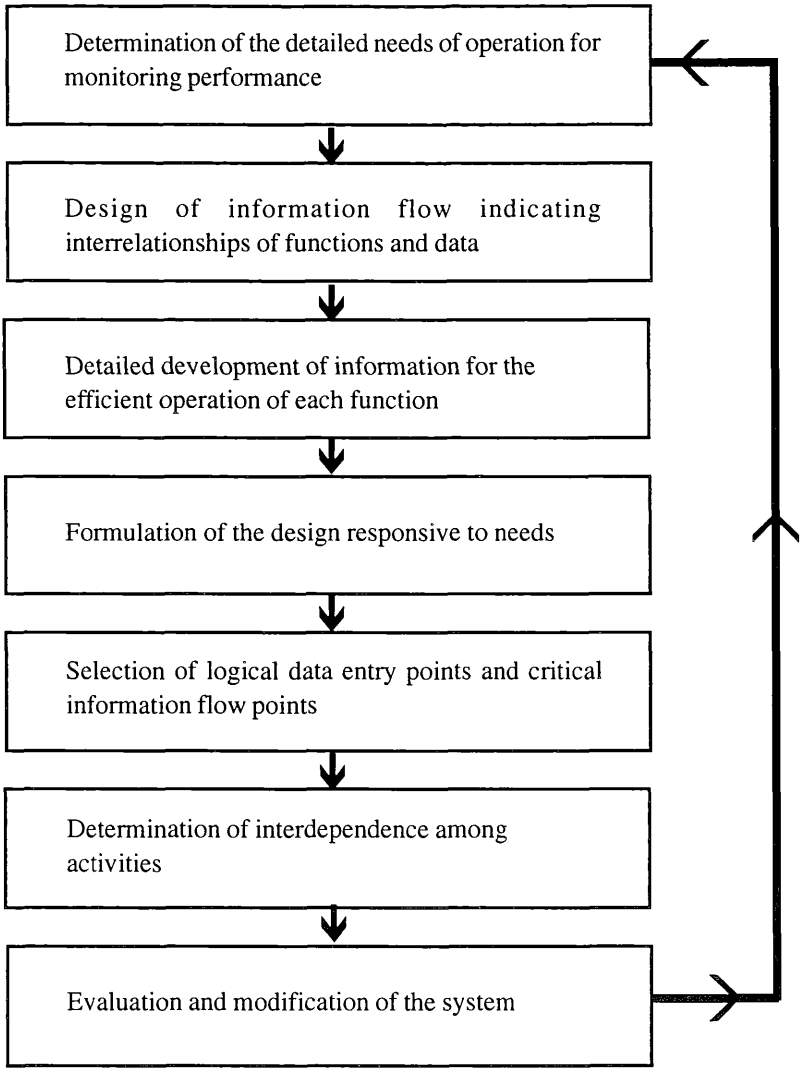
An information system should play the role of a nervous system in the operation of a university. It is different from the traditional modes of information processing and the implications of such a system should be clearly understood before it is implemented:

(i) The success of the information system in the communication, feedback and control of university activities depends on the co-operative effort of all administrative areas.

(ii) The freedom of the department in keeping some information private will be lost in a centralized, common file concept type of system. Once an item of information is entered into the system, it is available to all areas, though maintaining limits of confidentiality.

(iii) Some changes in the source of information are to be expected when logical sources of information are identified.

(iv) The administration has to define objectives quantitatively, identify types and form of information needed for sound decisions. The data systems staff may, of course, help them in doing so.


Determination of the detailed needs of operation for monitoring performance
Design of information flow indicating interrelationships of functions and data
Detailed development of information for the efficient operation of each function
Formulation of the design responsive to needs
Selection of logical data entry points and critical information flow points
Determination of interdependence among activities
Evaluation and modification of the system

(v) Identification of the critical information points, i.e. where certain management processes are carried out, calls for assessment of the management structure of the university.

(vi) Once the system is implemented, the university has the responsibility of operating it on a university-wide basis with the co-operation of all areas of administration. The head of the university should define the information that the top management needs, should approve the overall strategy for development of administrative computing and where relevant the management information system (see above for the difference), protect funding against competing claims and arbitrate on conflicts between priorities in the development programme(25).

(vii) The universities should have a long-term strategy to develop the information system for management, assign a senior competent person to implement the strategy, receive support and commitment from the head of the university and use commercially available or collectively developed software wherever possible.

(viii) If top managers are to be able to use the information system, it is necessary that (a) there is an effort to produce more comprehensive, frequently changing and rapidly available information and (b) the computer system be user-friendly keeping in mind the non-frequent nature of their use.

(ix) The database given in the earlier section mostly deals with administrative computing. University managers in the future will need more than administrative computing systems dealing only with internal data of the university, as already noted in the United States. Present modes of strategic management require that data related to the external environment affecting the university must also be integrated and analysed to help the manager in his decision-making process. Some additional non-quantifiable information on the internal functioning of the institution also become necessary for the purpose of an effective management information system. A list of such information and their sources is given in the *Appendix*.

(x) To meet the challenge of lack of skill and experience in this area as well as staff turnover (experienced especially in developing countries), software suppliers should be encouraged to develop support facilities and training workshops, institutions should establish training arrangements with more developed partners and work on a collaborative basis. The collaborative efforts implemented in the United Kingdom and Brazil have been discussed above and such training and co-operation among institutions are going to be two important areas for successful implementation of information systems in universities of the developing countries.

Appendix
Information requirements for strategic management

Information (Example)	Source
Output	
Graduates	AC
Employability of graduates	CS, US
Quality of graduates	CS, US
Salary of graduates	CS, US
Prices, awards, invitations, publications	CS, US
Citations concerning research	
Peer review results	CS, US
Research and services income	AC
Image	CS, US
Process	
Student/staff ratio	AC
Teaching workload	AC
Duration time of studies	AC, CS
Attrition/retention/completion rates	AC, CS
Ongoing research projects	CS
Cost structures	AC
Internal environment	
Organizational structure	IT
Internal service relations	CS
Organizational health	CS, US
Previous decisions	IT
External environment	
Information on peer institutions	PS, DE
Government decisions, rules, regulations, laws	ET
Information on donors/foundations/research funders	ET
Higher education related data	PS
Economic data	PS
Demographic data	PS
Constituencies' behaviour and motivation	CS, US
Input	
Financial, budget data	AC
Staff	AC
Students, enrolment	AC
Equipment	AC
Space available and utilized	AC

Key: AC: Administrative Computing, CS: Continuous Surveys, IT: Internal Text, ET: External Text, PS: Public Statistics, DE: Data Exchange, US: Single Surveys. (Adapted from: E. Frackmann, 1991, with permission).

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