

**MIS STRATEGIES APPROACH
TO UNIVERSITY EDUCATION**

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ABSTRACT

IT strategies play a major role in the success of an institution. The objectives of these strategies are to create an environment, which facilitates the effective and efficient use of information technology in support of the institution's activities. The technological advancements determine the core of these IT strategies. The principles that are targeted must be attainable and able to be realized in a suitable time frame.

This study has selected a university as a particular application field. The major target of this IT strategy is to enable the university to provide high-quality education and maintain international standards and credibility.

The range and quality of IT services and facilities available has to do with the university's mission, vision, principles programs and the targets that have been set to be achieved.

ÖZET

Bilgi yönetimi stratejileri bir kurumun başarısında çok önemli bir rol oynamaktadır. Stratejinin hazırlanmasındaki amaç o kurumdaki etkinliği ve verimliliği arttırmaktır. Bu stratejinin oluşturulmasını teknolojik gelişmeler belirler. Konulan hedeflerin gerçekçi olması ve zamanında tamamlanması sistemin dinamikliğini sağlamaktadır.

Bu tezde uygulama alanı olarak bir üniversite seçilmiştir. Stratejinin temel hedefleri üniversitenin nitelikli bir eğitim verebilmesi ve uluslararası standartlara sahip olmasıdır.

Bilgi yönetimi stratejileri çalışması hazırlanırken, üniversitenin misyonu, vizyonu, amaç ve hedefleri temel alınıp bu hedef ve amaçlar çerçevesinde uygulama alanları belirlenip, bu alanlarda yapılması gereken çalışmalar anlatılmıştır.

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CHAPTER 1

INTRODUCTION

Recent changes in the organisation and funding of higher education within Turkey suggest a future which will be increasingly complex, competitive and subject to rapid change. The ability to manage change effectively will likely to be a key characteristic of a successful university in the next decade. A university will therefore be committed to the development and implementation of new approaches to research, teaching and administration.

The need for on-line information system is expected to be occurred with University's focus towards higher mobility of students both among schools of a university, and outside. Reliable and widely accessible information source will be asked for, which would give both students and teachers the information they need for studies and work. The information which will be gathered in digital form can also be easily used for management's decisions, internal evaluation and streamlining of the data flow across the organization, creating more transparent environment both for University members and for the public.

Information systems are becoming more important to the effective operation of the universities. In most areas, they will be essential to the local operation, and many systems will be critical to the missions of the universities. Thus, inadequate

provision or lack of coherence could be very expensive and at worst, disastrous for the institutions.

The avoidance of such unnecessary expenses and achievement of value for money, both for existing and new systems, would be important for a university. Funds will be limited and there may be many justified calls upon their use. This strategy attempts to assist with the achievement of that aim by setting down some overall principles and giving guidance on targets to be achieved.

In particular, the imaginative use of information technology (IT), combined with more flexible use of library and other resources, will be regarded as essential if a university is to cope successfully with an expanding research programme, more students, particularly part-time students, a more modular course structure.

The objective of the IT strategy is to create an environment that facilitates the effective and efficient use of information technology in support of a university's activities. The range and quality of IT services and facilities available will play an important role in the recruitment and retention of staff, the recruitment of students and in maintaining research and teaching programmes of international quality and repute.

This study is expected to propose an IT strategy for the next five years, and also highlight key policy issues and their implications for a university. The detailed technical options available for the implementation of the strategy will evolve in line with developments in technology and specific details are therefore generally excluded at this stage.

CHAPTER 2

MANAGEMENT INFORMATION SYSTEM

The main significance of MIS systems is that it enables managers to gather, analyse and summarize the levels of information they need to be able to maximize their performance. Management information systems support top-level managers formulating strategy and policies. An MIS help middle-level managers implement these long-range plans by providing information that helps increase employee performance, product quality, and customer service. An MIS gives first-line supervisors ready access to information that ensures the effective conduct of the organization's daily activities.

In today's global environment, managers find themselves performing in an unpredictable, and ambiguous environment; therefore, they need to sharpen their skills. They must first diagnose and then process the information required to deal with these situations. Management information system ensures that these global managers can access, analyse, and report current and comprehensive information. Management reporting systems, decision support systems, groupware, and executive information systems support these needs. [7]

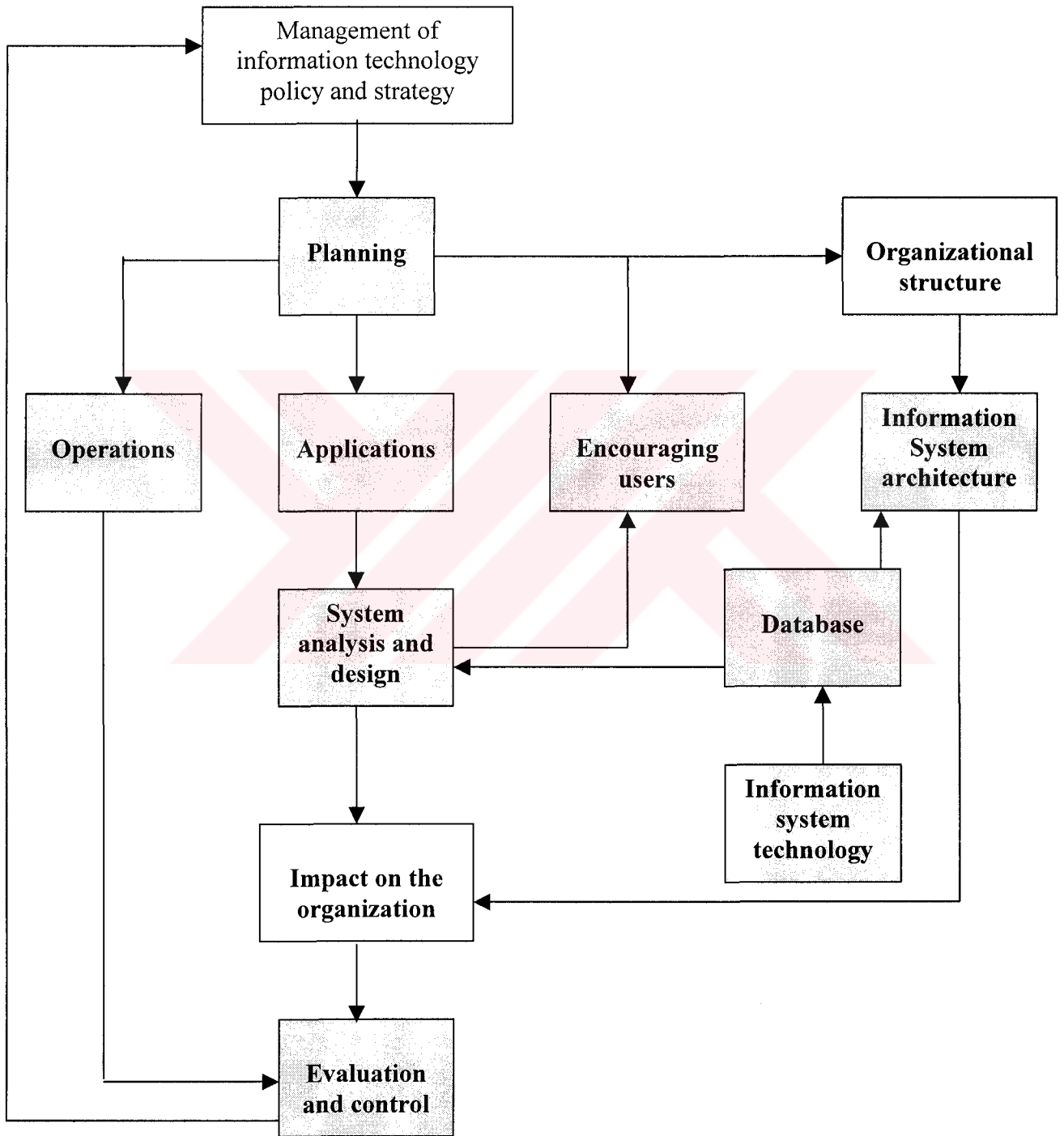


Figure 2.1 The Process of Managing Information Technology.

2.1 Contemporary Approaches to Information Systems

Multiple perspectives on information systems show that the study of information systems is a multidisciplinary field; no single theory or perspective dominates. Figure 2.1 illustrates the major disciplines that contribute problems, issues, and solutions in the study of information systems. In general, the field can be divided into technical and behavioural approaches. Information systems are sociotechnical systems. Though they are composed of machines, devices, and “hard” physical technology, they require substantial social, organizational, and intellectual investments to make them work properly.

2.1.1 Technical Approach

The technical approach to information systems emphasize mathematically based, normative models to study information systems, as well as the physical technology and formal capabilities of these systems. The disciplines that contribute to the technical approach are computer science, management science, and operations research. Computer science is concerned with establishing theories of computability, methods of computation, and methods of efficient data storage and access. Management science emphasizes the development of models for decision-making and management practices. Operations research focuses on mathematical techniques for optimising selected parameters of organizations.

2.1.2 Behavioural Approach

A growing part of the information systems field is concerned with behavioural problems and issues. Many behavioural problems, such as system utilization,

implementation, and creative design, cannot be expressed with the normative models used in the technical approach. Other behavioural disciplines also play a role. Sociologists focus on the impact of information systems on groups, organizations, and society. Political scientists investigate the political impacts and uses of information systems. Psychologists are concerned with individual responses to information systems and cognitive models of human reasoning.

The behavioural approach does not ignore technology. Indeed, information systems technology is often the stimulus for a behavioural problem or issue. But the focus of this approach is generally not on technical solutions; it concentrates rather on changes in attitudes, management and organizational policy, and behaviour.

2.1.3 Approach of This Study: Socio Technical Systems

The study of management information systems (MIS) arose in the 1970s to focus on computer-based information systems aimed at managers. An MIS combines the theoretical work of computer science, management science, and operations research with a practical orientation toward building systems and applications. It also pays attention to behavioural issues by sociology, economics, and psychology.

A socio technical systems perspective helps to avoid a purely technological approach to information systems. For instance the fact that information technology is rapidly declining in cost and growing in power does not necessarily or easily translate into productivity enhancement or bottom-line profits. [6]

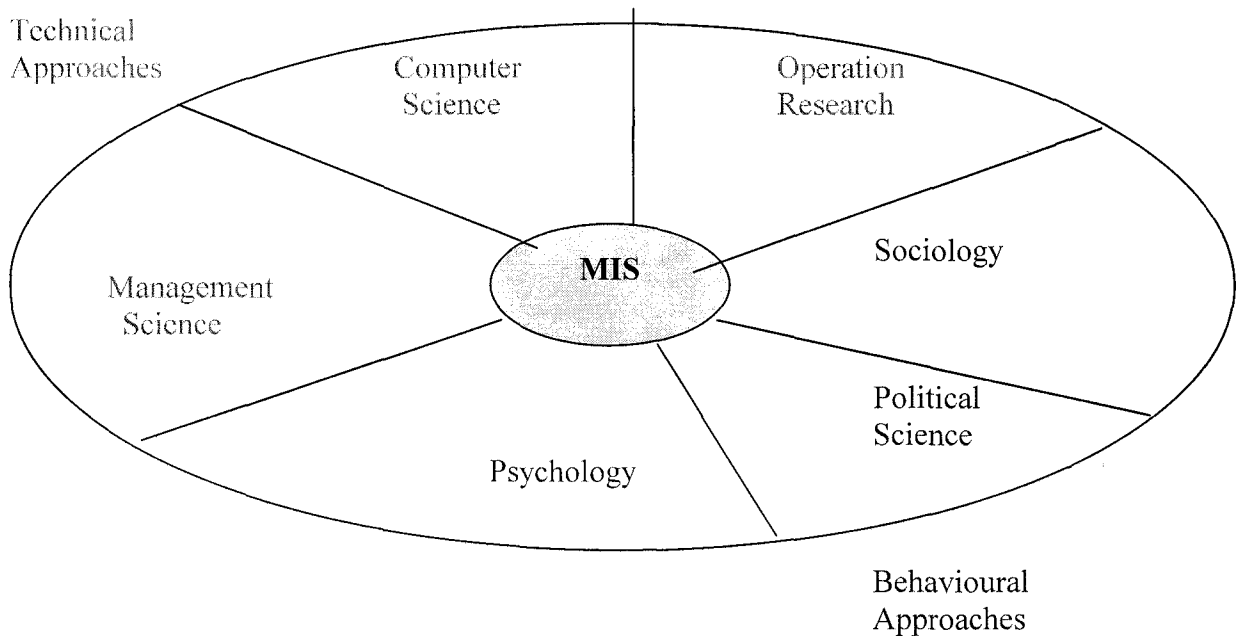


Figure 2.2 The major disciplines that contribute problems, issues, and solutions in the study of information systems.

2.2 Information Strategy - Guiding Principles

A successful Information Strategy ensures that an institution avoids making technological investments without the necessary accompanying changes in working practices, attitudes and behaviour. An Information Strategy supports the processes through which a university achieves its mission.

The best way to think of an Information Strategy is as a set of attitudes rather than as a report. It is a set of attitudes in which:

1. Any information that should be available for sharing (and most will be) is well defined and appropriately accessible (allowing for necessary safeguards);

2. The quality of information is fit for its purpose (e.g. accuracy, currency, consistency, completeness - but only as far as necessary);
3. All staff know, and exercise, their responsibilities towards information;
4. There is a mechanism by which priorities are clearly identified and then acted upon.

The role of the Information Strategy Co-ordinator is to assist the Information Strategy Steering Group in analysing and facilitating the flow of information within the organisation, and to help bring about the cultural change that is necessary.

The following Guiding Principles **seems appropriate:**

1. The primary source of university information will become the networked electronic form.
2. Information will be freely available within a university unless there are good reasons why it should not be.
3. Printed information will be derived from the networked electronic form.
4. The provision and maintenance of much core information will become widely devolved.
5. The training of information providers will be crucial in achieving this goal.

2.3 Strategic information systems in Contemporary Organizations

Goal setting, strategy formulation, and strategy implementation involve personnel at all levels within the organization. Communication among personnel at different levels is necessary to ensure that corporate-, business-, and functional level

strategies are attainable and consistent with each other and with corporate goals and objectives.

For example, strategic managers at the business level cannot hope to formulate realistic business-level strategies unless they receive input from functional-level managers concerning the strengths and weaknesses of each functional area. Without such input, business-level managers might decide on a strategy that the organization does not have the functional resource to pursue. Similarly, corporate-level strategic managers cannot hope to formulate realistic corporate-level strategies unless they receive input from business-level managers about the strengths and weaknesses of each business unit, as well as the market opportunities and threats that each unit faces. Strategic managers also have to make certain that the strategies being pursued by different levels of the organization are consistent with overall corporate goals. The need for such information necessitates further communication among managers at different levels.

To ensure that the strategies being pursued at each level are consistent and attainable, most organizations go to some length to establish institution wide strategic information systems.

Strategic information systems help organizations implement their long-term direction and activities used to achieve their goals. Strategic systems can support both externally and internally focused strategic initiatives.

- Externally focused initiative focuses on systems used by customer, clients, or suppliers to create special relationships with organization.
- Internally focused initiative focuses on systems used by the organization to reduce costs, increase profits, or improve quality. [4]

2.4 The Rational Planning Perspective

Rational Planning , also referred to as formal planning , is a process or a system for logically approaching the task of identifying the ends an organization pursues and determining the means by which those ends can be reached. Typically, the ends an organization pursues can be “stacked” in a hierarchy ranging from the most broadly defined intentions to the most specifically defined. We call the collection of ends being pursued by an organization its strategic intent. According to the rational planning perspective, the means by which these ends are best pursued is strategic programming, a process designed to translate strategic intentions into manageable agendas for action.

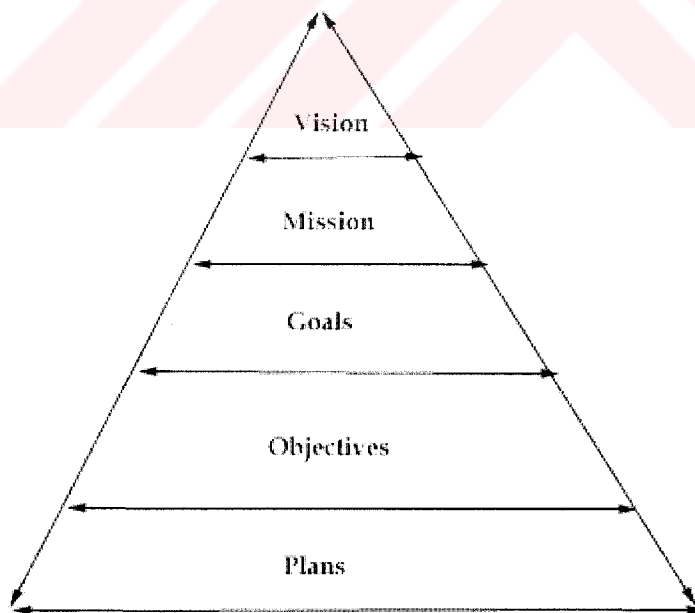


Figure 2.4.1 The Hierarchy of Strategic Intent

2.4.1 The Hierarchy of Strategic Intent

As illustrated in Figure 2.4.1 , the hierarchy of strategic intent includes five types of elements ranging from

1. a broad **vision** of what the organization should be ;to
2. the organization's **mission**, to
3. specific **goals** that are operational zed as
4. various strategic **objectives** to be reached by acting according to specific
5. **Plans**

The elements of this hierarchy set forth the ideals and ideas that serve to unify the energy and forces scattered throughout an organization. They are beginning points for any formal planning process, but they also provide the sense of direction necessary to assure that incremental behaviour culminates in overall progress.

2.4.2 Vision

In strategic management, vision refers to the category of intentions that are broad, all inclusive, and forward thinking. A vision describes aspirations for the future, without specifying the means that will be used to achieve those desired ends. When managers refer to a vision, they usually refer to a mental image of some desired future state. One author team calls this foresight; a view of how managers hope things will develop. Sometimes, managers also talks about a shared vision, meaning that individuals from across the organization have a common mental image and a mutually supported set of aspirations that serve unite their efforts.

The most effective visions are those that inspire, usually asking employees for the best, the most, or the greatest. It may be the best service, the most rugged product, or the greatest sense of achievement, but it must be inspirational.

2.4.3 Mission

An organization's mission is the purpose or reason for the organization's existence. A well-conceived mission statement defines the fundamental, unique purpose that sets an organization apart from other organizations of its type and identifies the scope of the organization's operations in terms of products offered and markets served.

Most visions are not written statements—perhaps the points they raise are too ephemeral to look convincing on paper. Of course, this makes them more difficult for organizations, especially larger organizations, to understand and to adopt en masse. Consequently, managers find it useful to move beyond a broad mental vision to develop more specific, and usually written, statements of their organization's mission.

A vision becomes more tangible in the form of a mission statement. Such a statement can verbalize the beliefs and the directions in which a visionary manager wants to lead an organization.

2.4.4 Goals

The most mission statements are more specific than anyone's visionary thinking, but they are still hardly concrete directions for action. Therefore, just as mission statements try to make vision more specific, goals are attempts to improve

an organization's performance by making mission statements more concrete. The strategic goals identified by most organizations share several features:

- They address both financial and no financial issues.
- They facilitate reasoned trade-offs.
- They can be reached, with a stretch
- They cut across functional areas.

2.4.5 Objectives

Objectives represent the operational definition of goals, or explanations of abstract concepts that are concrete enough to suggest specific actions. Goals describe in fairly general terms what the organization hopes to accomplish, but objectives detail, in more precise terms, what needs to be accomplished in order to reach the goals. As the operational definitions of goals, the most helpful objectives have the following characteristics.

- They can be measured
- They incorporate
- They reduce conflict.

2.4.6 Plans

The lowest level in our hierarchy of strategic intent deals with the plans that manager develops to help accomplish higher-level intentions. These plans typically describe specific tactics, assign responsibilities, identify how resources will be allocated, schedule activities and efforts, and specify various targets. To use an analogy of computer software, plans are the instructional code by which we program

our organizations, and planning is the equivalent to strategic programming for organizations. Plans play such an important role in strategic management that you need to study them in considerable detail.

2.5 Strategic Thinking for Private Higher Education

Strategic thinking is akin to critical thinking, a familiar concept in higher education. Traditionally, critical thinking has been identified with the field of logic and the mental ability to reason in the abstract. Today, critical thinking is an essential element of most disciplines including management, leadership, and strategic planning. Strategic thinking might be explained as focusing on higher level learning and more complex thinking abilities. Thus, categories in the cognitive domain such as analysis, synthesis, and evaluation are rich fields for critical thinking. However, our focus is that of strategic planning in a practical and applied context. Therefore, we must direct critical thinking beyond knowledge within a discipline to application:

- Between disciplines
- To real-world predictable problems
- To real-world unpredictable problems

Strategic thinking also emphasizes:

- Asking and seeking answers to penetrating questions which affect survival of the organization
- Scanning the environment, both external and internal, for unique ways of “doing more with less at higher quality”

A leader who thinks strategically will focus on the following:

- Conceptualised direction-setting actions for the organization

- Identify areas of changes that will impact the vision, mission, and overall goals of the institution
- Look at the big picture-across traditional boundaries and beyond the next two to three years
- Emphasize the why and how of strategy design and implementation
- Search for the best competitive advantage, or best competitive position relative to other key institutions which may target similar student markets and donors

Strategic thinking emphasizes development and implementation of organization-wide or overall strategies with accountability toward effectiveness, efficiency, and quality in mind.

2.6 Private Higher Education

Most institutions of private higher education are not-for-profit. However, there are some for-profit universities. The typical profit-seeking university relies almost solely on the sale of its services to the public for its revenue. The not-for-profit university also relies upon gifts and contributions for much of its revenue, and institutions such as research universities rely upon government and private research grants. In some cases there are special programs that are government funded. Let's explore the differences between these three types of institutions within higher education.

Almost all institutions can be classified into three types:

1. Private for-profit or proprietary educational firms. These firms provide educational services in the marketplace with the primary mission of earning a profit from operations. Such institutions are often of a very high quality

level. They are primarily tuition driven; as a minimum they have a higher percentage of total revenue derived from tuition and fees than not-for-profit institutions.

2. Private not-for-profit educational institutions. This type of organization is by far the most common in universities. In serving the public, these institutions typically rely heavily on endowments, gifts, and contributions, in addition to the tuition and fee revenue they might generate and from the sale of auxiliary and scope from single purpose institutions to comprehensive universities.
3. Public (government-supported) universities. Funded by taxes, these are created by law. Government creates most of these institutions although the government will sometimes operate the institution through a local board created by law. Increasingly, this type of institution is directly competing for gifts and grants, a factor private higher education must include in its strategic planning. [3]

CHAPTER 3

MIS Strategy

A strategy will require to provide one set of data which can be accessed, viewed, or applied in many different ways to provide information, in order to support the mission and business of a university and to enable a university to be efficiently and effectively managed.

Most of this information has to do with a university itself -

- staff - who they are and what jobs they do;
- students - who they are, what they study and their academic progression;
- a university estates - buildings, land, usage and maintenance of the estate;
- research activities - projects, funding, expenditure, research outputs;
- financial matters - underpinning all of the above, income and expenditure for all activities, budgeting and financial management.

An MIS strategy will become necessary to define:

- What Management Information services will be provided
- Who is responsible for providing management information services
- How this will be done

- Priorities for provision of new facilities and improvement of existing facilities
- Who has access to what information
- How to access to Management Information Services will be distributed and supported
- What common standards should be applied
- What resources would be required and how resources available should be utilised
- Mechanisms for understanding and mapping Business processes.
- A mechanism for maintaining and renewing the strategy.

The over-riding objective of an MIS Strategy is that it must be practical and aligned with the business of a university.

3.1 The Structure of the Strategy

The strategy statement is expected to present in two parts. The first part, DEMAND DRIVERS, will summaries policies and development in teaching and learning, research, and institutional infrastructure which are relevant to information systems, and present a university's information policy. In effect, the first part is going to establish what it is that information systems are to be provided for.

The second part, APPLICATION AREAS, will lay down strategies for the different kinds of information systems and associated services in a university – infrastructure, central support, academic computing and so on.

3.2 A university Mission Statement

To provide the highest standard of excellence in higher education while pursuing continuous quality improvement, to foster the intellectual and personal development of students, to stimulate the greatest degree of meaningful research and to support faculty and staff in satisfying those whom we serve

A university's educational role will be to assist students to realize their potential in becoming scholars, professionals, citizens, and scientists. A university's research role will be to provide an environment for the expansion of knowledge and to contribute to local, regional, and national priorities through basic and applied research programs, center, and institutes. A university's public service role will be to meet the educational needs of the region and the nation.

A university is going to be committed to excellence in teaching and the discovery and application of knowledge through research and creative activities.

A university:

- * Conduct high-quality instruction, scholarship, and service by:
- * Foster excellence and innovation in teaching and learning;
- * Support research and creative activities that advance knowledge, strengthen undergraduate and graduate programs, and promote the application of knowledge for the benefit of society; and
- * Maintain a community founded on free and open inquiry, academic integrity, and the examination of values;
- * Nurture development of students by providing continuing opportunities for intellectual, physical, emotional, social, and career growth;

* Stresses understanding and appreciation of the historical, intellectual, technological, scientific, and cultural nature of the search for knowledge;

* Promote the advancement of the arts; and

Information technology has already transformed many areas of university life (general inter-personal communications, reference searching, student skill requirements, business systems, remote learners) and is capable of fuelling many more radical changes. In extreme cases, there is the possibility of some universities being or becoming almost entirely virtual with all staff and students geographically distributed but connected and communicating through the use of IT. From a spectrum of possible university models each with different degrees of virtuality and with varying levels of commitment to the use of information technology and information systems, a university will need to choose its own position. In making that choice, the values and mission of a university will be the essential considerations and they will guide the creation of all of the strategies and sub-strategies.

The values of a university include commitment to:

- the provision of high quality education and research.
- the provision of a secure supportive learning environment
- a process of continuous development through investment in our strengths and in new opportunities.
- widening the region's participation in higher education.
- facilitating lifelong learning through flexibility, outreach and partnership.

3.3 Information Policy

Information generated by a university shall be regarded as public information unless it falls under the provisions of relevant legislation or is specifically excluded by the Information Policy.

The Information Policy will aim to ensure that a university's information environment promotes effective teaching, learning, research, administration and service, and that a university can provide information to develop a mutually beneficial relationship with the community, industry and government.

The policy provides for a campus information environment that will support access to and distribution of administrative information and scholarly information. The policy will encourage the development of a sense of community by providing multiple channels of access to information and a variety of ways for members of a university to provide feedback to service providers.

Information is a resource, which is needed by a university as a corporate entity and by each member of a university community. Information will be needed by academic staff to stay knowledgeable in their areas of expertise and to perform administrative functions, by students learning to be professionals and by professionals returning to a university to update their knowledge. It is also needed by administrators to make resource allocation decisions, by administrative staff and support services staff to perform their jobs and by students, student representatives and student organisations to be active participants of a university community. Information will also be needed by a university to remain responsive to its environment and to provide information about a university to the community and to government.

Information quality would be a priority. Users of management or corporate information will need to be able to rely upon it. But new technologies could make it

far easier to generate and distribute information, tempting people to pay correspondingly less attention to quality.

The use of electronic mail, World Wide Web and related mechanisms for internal communication will be encouraged, and efforts made to ensure that staff and students have the tools and skills they need. Standards for communication tools will be promulgated.

A university should be aware of the risk of information overload as it becomes easier to produce and distribute information. This is not an easy problem to tackle: most people feel that they get too much unwanted information and too little of what they want. Staff will be encouraged to target information appropriately, and to avoid sending it in several different ways to the same recipients.

3.4 Teaching and Learning

3.4.1 Teaching and Learning - University Aims

As stated in a university Plan, a university should aim to:

- 1. Offer students the best possible learning experience in a research environment.** This will be achieved not only through participation in lectures, seminars, tutorials and other formal teaching arrangements, but also by using library and computing facilities to maximum advantage by implementing active learning and group work where appropriate, through the provision of a range of extra-curricular activities, and, where relevant, through periods of study in other institutions;
- 2. Ensure that the quality of learning and teaching is a corporate concern;**
- 3. Identify, encourage and reward good teaching practice across a university;**

4. Monitor quality and demonstrate that appropriate quality assurance mechanisms are in place;

5. Ensure realistic workloads for students on all courses;

6. Produce graduates who are well fitted for their chosen careers, who will have acquired a range of transferable skills which enhance their employability, and who are able to continue self-education throughout their lives.

A university's strategy, as outlined in the remaining sections of this research is intended to give practical guidance on how these aims can be achieved, at Departmental, Faculty and University level.

3.4.2. Teaching and Learning Strategy

The key elements of the strategy are expected to be as follows.

1. Ensure that all Departments have clearly stated **aims and objectives** which complement those of a university, to which all staff will be committed and which will apply to all programmes offered;

2. Encourage regular review of the design and delivery of programmes and units; develop new programmes within the spirit of a university's Modularization system and establish a mechanism for ceasing to offer units or programmes;

3. Establish methods of teaching and learning which are appropriate to the subject matter and to students admitted to the programmes, will be integrated with the methods of assessment used, and encourage the acquisition of lifelong learning abilities;

4.Ensure that **assessment procedures are appropriate**, reflect teaching and learning methods and are clearly stated for the benefit of students, staff and external examiners;

5.Ensure that there must be **commitment to the development of personal or transferable skills** and that content of units and teaching, learning and assessment methods reflect this;

6.Ensure all students must receive **training in information technology (IT)** skills;

7.Provide **adequate resources** for the library, IT and other academic support services;

8.Continue staff review and a **development programme** which is expected to enhance and broaden existing skills for all those with teaching responsibilities;

9.Encourage **dissemination of good practice**;

10.Offer **opportunities for promotion** in line with a university's stated promotions criteria.

11.Ensure that **appropriate teaching and learning quality assurance** procedures are in place.

In support of its teaching and learning strategy a university should developed Teaching and Learning Guidelines which outline policy, procedures and good practice. There will be six sections to the Guidelines. It is also intended that in

addition to supporting internal aims, this structure will enable Departments to prepare for external monitoring of their teaching and learning. [1], [10]

The six sections of the Guidelines are as follows:

- Curriculum Design, Content and Organisation
- Teaching, Learning and Assessment
- Student Progression and Achievement
- Student Support and Guidance
- Learning Resources
- Quality Assurance and Enhancement

3.5 The Institution

A university's resources will inevitably be stretched — staff, finance, buildings. This is expected to have clear consequences for the development of information systems. On the one hand, it will be a constraint: information systems are expensive, and it can be difficult to find sufficient funds to reach the critical mass for success while providing support and ensuring reliability; and identifying the cost-benefits can be more a matter of faith than science. On the other hand, the effective use of information systems can recoup investment, and can give gains in efficiency that help counter the squeeze on resources. To be successful, this generally involves considering complete processes and how information systems can enable them to be organised more effectively. In particular information systems can help counteract pressure on staff, by enabling flexibility in time and place, by speeding up processes, and by displacing some tasks and allowing staff to use their time more fruitfully. The introduction of an information system application can however, involve

significant initial effort, and if one gets it wrong it can increase rather than decrease burdens. As dependence on information systems grows, reliability becomes a paramount consideration. With the spread of information systems some staff roles are changing. Many staff use their desktop computers to do what were formerly secretarial tasks; secretaries in their turn are becoming to a greater extent managers of information. These changes can improve effectiveness, but only with adequate support and training.

A university estate is a major asset, and one, which is costly to maintain and develop. The need to increase efficiency in energy consumption, to improve security and safety, and to manage changing use is a driver for information systems.

A university is home to national centres, resources and services, notably The Data Archive. It should be a university's policy to ensure that the service provided by national facilities is of high quality. This will have wide implications for information systems support, both in those facilities and centrally in a university.

3.6 Research

A number of aspects of support for research will be determinants in the development of information systems. For a university, it is access to information and its management, which will be particularly important, applying to all sectors of research in a university but particularly taking into account the importance and prominence of research in the social sciences.

There will be specialist IT needs for some research. Special infrastructures may be needed, for example for high performance networking. Departments will need to ensure that their researchers have adequate access to basic information systems. In

addition, a university must have internal resources, such as The Data Archive, which would be used by researchers.

Computing needs will vary widely among researchers across a university; they may be roughly divided into three different groups (with the recognition that an individual researcher may fit into more than one group).

General Users: Virtually all researchers will need a well-provisioned electronic workplace environment, consisting of a modern workstation or terminal on the desktop, connected to and backed up by a network or local server, and supported by a high-bandwidth networking infrastructure, with associated software licensing and support. This environment alone will satisfy the computing needs of a substantial percentage of researchers.

Specialized Users: A substantial number of researchers may also require dedicated computers embedded in experimental apparatus, often running highly specialized, locally written or proprietary software. However, these needs will largely be dictated by the nature of the experiment and apparatus, and, other than providing assistance with networking and hardware support, the researchers must be essentially self-supporting.

Heavy Users: A third group will also require high-performance computers for a variety of needs, including large-scale numerical or symbolic computation, database development or manipulation, high-quality visualization, and software development. Key hardware capabilities not available in the general-purpose research computing environment include: very large memory, very large disk capacity, very large CPU

performance capacity, specialized graphics engines, and specialized hardware such as multiple CPUs for parallel processing, software development, and applications.

While the distinct needs of the specialized users must, by nature, be addressed through their own expertise and resources, the work of the general and heavy users can be greatly facilitated through the provision of centralized resources and/or support. For such support to be provided effectively and economically, it is a must important to encourage the adoption of standard hardware and software configurations wherever possible. However, it will be more difficult to apply such restrictions to high-performance computers, as the most cost-effective sources of the required capabilities are often associated with new minority architectures or new vendors.

With rare exceptions, acquisition of the specialized equipment and software required for high-performance computing will be left to individual researchers and groups, who may seek the necessary resources from the granting councils, Centers of Excellence, or contract funding. However, such equipment will be becoming increasingly difficult to obtain without the existence of at least some local "seed" or "matching" money to stimulate the external donor.

A university is to provide researchers with an excellent networking environment and a considerable degree of centralized Unix support, and through Unix-support personnel who were available to help and guide individual researchers or groups in setting up managing their facilities.

3.6.1 Research and Research Training Goals

1. Enhance research and research training, acknowledging areas of existing strength at national and international levels and areas with potential to develop as strengths
2. Promote research collaborations and linkages that promote world class research and research training

3.6.2 Performance Indicators

1. Maintain status among the research universities via the Research Quantum earnings.
2. Effectiveness of University-funded schemes in promoting research and research training.
3. Participant evaluation of workshops and seminar programs aimed at enhancing performance in research and research training in all faculties and units.
4. Establishment of new research centres with demonstrable outcomes in research and research training.
5. Percentage of academic staff engaged in research activity.

3.6.3 Objectives and accompanying strategies

1. Maximise the opportunity for all academic staff to engage in significant research, creative activity, postgraduate research training and professional development. Through providing an atmosphere conducive to and supportive of the development of the research potential of individual staff members and of research groups, departments and faculties. Also by, encouraging the

collaboration and formation of inter-disciplinary groups to enhance research, creative activity and research training. Maintain and enhance suitable support schemes to recognise existing excellence and develop areas of potential and further by promoting exchanges with researchers and research groups of international standing while, optimising the use of the outside studies program as a vehicle for staff development.

2. Ensure a university contributes significantly through its research and research training to the development of the community regionally, nationally and internationally by developing areas of potential in research and research training of importance nationally and internationally. Also, through focusing research and research training towards industry clusters of importance to the region, establishing improved linkages with the business sector through applied research and research training.
3. Maintain and enhance a university's position as a leading research and research training provider nationally and internationally. This will be possible by encouraging undergraduate students to pursue honours and higher degree programs while enhancing access to doctoral study by recognising a wide range of formal qualifications and relevant professional experience. Another important solution will be assessing the performance of candidates regularly to establish satisfactory progress, with special emphasis in the first year of candidature and improving the supervision skills of the staff. Also, facilitating multiple supervision of research candidate to enhance mentoring between staff and providing adequate and appropriate resources and training to all research higher degree students. Lastly introducing a

generic skills component into research higher degree training to enhance graduates' prospects.

There has been a marked increase in the extent of research collaboration between institutions in recent years. This trend is likely to continue. To support such collaboration on tight budgets, researchers will be making wider use of videoconferencing and of remote cooperative working over networks. Videoconferencing will also offer the opportunity for remote attendance at research seminars or workshops. [9], [13]



CHAPTER 4

APPLICATION AREAS

This Part spells out specific policy and strategy for information systems in different areas of their application, and addresses issues covering all areas of application. It does not go into details, which are the preserve of the annual plan or of supplementary strategy documents.

4.1 General issues

4.1.1 Performance and reliability

Information systems permeate a university, in teaching and learning, research and administration. By that token the smooth running of a university is coming to depend upon the availability of its information systems. If they are not running or not accessible, or if they are inappropriate for the job, work is impeded and may stop.

Therefore a university will make reliability, availability, accessibility and predictability among the highest priorities for its key information systems. In doing this it will in each case be necessary to weigh the cost of support in staff time and money against the degree of damage done by periods of loss of service. It will also use procedures for the acquisition of systems that help ensure that they are right for the job. A service ethos will be cultivated among service providers.

4.1.2 Standardization within a University

A university needs to maintain the right balance in information systems provision between on the one hand freedom of choice and diversity and on the other hand manageability and ease of networking. The freedom to choose particular platforms or packages is valuable, whether it be because the choice is best suited to the particular applications, because of the persistence of legacy systems which would be too costly to replace, or simply because of personal familiarity or preference. However, it is costly to support a multiplicity of types of systems and software, not only because of the range of skills needed but also because of the problems of conversion and networking for both users and support staff. Therefore, the policy of a university should aim for standard solutions in central academic service provision and in administrative information systems both centrally and in departments. Standard solutions will be encouraged in other areas, but other solutions will be admitted on a self-help basis. Central support will, in general, be available only for standard solutions. Another important aspect is a university's commitment to the principle of fair and reasonable access to information in order to empower all members of a university community to fulfill their responsibilities. In addition, a university aims to provide fair and reasonable access to information by owning and making accessible on the campus the information essential to teaching, learning, research and administration and by encouraging use of the network to satisfy other information needs. It should also be noted that a university endeavours to provide staff with on-campus access to the network at no charge. They may, however, be charged for the costs of the information provided across the network to them by the suppliers of electronic information, documents and databases or dial-in access. This service is also valid to a degree for a university provides students with

on-campus access to the network up to a specified level at no charge. This 'free' allocation is normally adequate to satisfy the information needs of University courses. Students will have the option of paying for additional access and Divisions may fund additional access to meet the needs of specific courses. Charges may apply for some information provided across the network to cover the costs of electronic information, documents and dial-in-access. The connection fee charged for Student Residences should to cover the capital costs of connections and line rental. It does not cover access costs. Charges for information are sustainable provided that such charges are clearly not for compulsory activities or where other free options for access do exist. All in all, if information is compulsory to undertaking a course, in so far as failure to have access to the information would of itself result in automatic exclusion from the course or failure in the unit, then the information should be provided without charge to students. A particular point regarding the making of books of readings for sale to students is that it must not be done to make a profit. The purpose is to supply reading materials to students in a convenient form at minimum cost while recovering the direct and indirect costs of the process, and then it is permissible. As a guide, cost recovery relating to printing could include paper costs, operator costs and annual direct equipment costs; if the material is made available in a university bookshop, a mark-up to cover overheads such as staff salaries, telephone, packing, wrapping, lighting, heating etc. is permissible. Cost recovery of a proportion of the statutory license fee would be permissible.

While a university aims to provide fair and reasonable access to information and the appropriate infrastructure students are also encouraged to purchase text books and equipment including personal computers and calculators to facilitate their own access to information.

4.1.3 International Standards

A university will as far as is possible choose information systems solutions, which adhere to international *de jure*, or *de facto* standards. Non-proprietary standards are intrinsically more open than proprietary standards. Where there is a choice, the former will be favoured. However, it is recognised that, with the rapid pace of change and development of information systems, solutions are likely to be market-driven and that, frequently, proprietary solutions are unavoidably the real standards.

4.1.4 Information Systems Security

A university will aim to continually improve the security of networks and computer systems, and will ensure that sensitive areas are protected. At the same time, solutions adopted will be proportionate to the risk, and will be chosen so as not to impede the open nature of a university environment. Advice on security matters will be made available.

All PCs will be expected to run up-to-date virus-checking software. Support and advice will be provided as a central service.

Access to information technology resources carries with it the responsibility for ensuring that the use of these resources is primarily for university purposes and university-related activities, and for maintaining the integrity and security of a university's computing facilities. In the interest of making the use of information technology resources a natural part of the day-to-day work of all members of a university community, incidental personal use is tolerated. However, one should use non-university sources of email, internet access and other information technology

services for activities of an extensive or recurring nature that are not related to university purposes. For the security of the information technology system, individuals having access to information technology resources must take reasonable care to ensure that unauthorized persons are not able to use their access to the system.

Security and privacy are important issues for a university to address in achieving a position of information technology leadership. Computing and network technologies have the ability to make local information available worldwide, and to access locally information from almost anywhere in the world. It is essential in this environment to both promote access to information and freedom of discourse, while ensuring personal privacy and protecting the intellectual property rights of individuals and other rights-holders.

A university must continue to develop policies and implement procedures that protect the security of its information technology resources and institutional data, safeguard personal privacy, and respect intellectual property rights, while at the same time promoting two traditional university values associated with academic freedom: access to information and freedom of discourse.

4.1.5 Regulations

A university will maintain guidelines and regulations for use of computing facilities and networks which strike a balance between on the one hand safeguarding freedom of action and expression, and on the other hand protecting individuals and information and shielding a university against obloquy or legal action.

4.2 Administrative Information Systems

A number of large information systems support the administrative activities of a university, and this sector is in the midst of the most radical changes it has seen in decades. Many changes have been initiated recently, and it is important that the entire University community work together to ensure that they come to fruition, recognizing that successful implementation of such new systems in fact relies on corresponding fundamental changes in the way we administer a university. The visions of how one might wish to "do business" must be balanced with the twin realities of experiences and the concrete capabilities of the new systems. Achieving this balance would consume significant resources and much emotional energy of the staff for many years.

Important infrastructure and tool components are the campus network, the World Wide Web, database management system, reporting and *ad hoc* querying, and analysis and high-level decision support. Assuming these projects are largely successful, a university will have moved into an environment where the information systems are supporting the administrative processes in a fashion that evolves with changes in technology and business practices, provides appropriate information in a timely fashion, and allows a university to leverage human resources throughout the institution to provide better, more cost-effective support to core activities of teaching, learning, and research.

The scope of these projects implies very significant staff commitments from both IST and client administrative departments. IST, in particular, should have sufficient capacity to undertake any additional initiatives.

Guiding principles identified by most university today include:

- Ensure that administrative IS standards, approaches, and infrastructure are consistent with a university IT standards, approaches and infrastructure, and vice versa.
- Commit to principles of distributed access, IS integration, and the exploitation of generic solutions and protocols as opposed to customized approaches or development for specific areas.
- Ensure that IS both the user groups support projects with appropriate commitment and IT/IS service providers, that priorities are well established through consultation, and that project feasibility, structure, methodology, and evaluation are appropriate. [11], [12]

Administrative Information Systems (AIS) is responsible for central administrative computing and related information management activities for a university. AIS develops, maintains, and/or provides technical support for the campus financial, human resources, and student records systems as well as appropriate computing for other administrative functions in academic and administrative units.

Information maintained on University administrative computing resources is a very valuable asset and must therefore be managed and protected appropriately. It is important that the integrity of data is maintained at all times and that sensitive or confidential information not be divulged inadvertently to unauthorized individuals. Those responsible for managing and maintaining University administrative computing resources must ensure that capability to continue processing in an accurate manner is maintained. Errors and omissions must be prevented and corrected in a timely manner. Controls must promote rapid detection, identification,

containment and resolution of problems that may lead to security violations, integrity problems or denial of services to information system users.

The overall strategy of a university's security program should be to achieve adequate, cost-effective and balanced security of its information processing resources. The appropriate level of security is ultimately determined by the cost-effectiveness of the controls or mechanisms.

A university's security policy must be responsive to legal and regulatory requirements including a university's duty of confidentiality to its student population and staff, intellectual property rights and contract law. This policy applies to all University administrative information processing facilities and resources. All others are excluded except when they have an impact on the security of University administrative information processing facilities and resources. For the purpose of this policy, information processing facilities and resources include but are not limited to: data stored in electronic form; software; application systems; magnetic media; computer systems (including mainframes, minis, personal computers and associated peripherals); communication systems; facilities housing mainframe computers, communications equipment, remote printing facilities and network equipment; and off-site storage facilities.

4.2.1 Compliance

This policy and all standards, procedures and guidelines issued in support of this policy shall apply to all users of a university's administrative information processing facilities and resources. Compliance with information security policy and all

supporting standards, procedures and guidelines is a condition of employment at a university.

4.2.2 Policy Statement

All of a university's administrative information processing facilities and resources must meet established security standards and must not introduce any security vulnerabilities to the existing environment. Exceptions must be based on a risk analysis and must be approved by senior management.

4.2.3 Ownership

All information resources that are part of or maintained on a university's administrative computing environment, except for those resources designated as private, are the property of a university, unless otherwise designated. All software developed by University staff or by contract personnel employed by a university, or purchased by a university for use by a university, is considered University property for the purpose of information security policy.

Data/information cannot be attributed to any one group in the sense of ownership, but certain individuals/groups have definite rights and responsibilities relative to the use and protection of data/information. For the purpose of information security policy, standards and procedures, these individuals/groups are referred to as Information Resource Managers.

4.2.4 Responsibilities

Responsibility for the protection of information processing resources rests with those individuals who are designated as Information Resource Managers.

4.2.5 Controls

Application of controls must be consistent with the value of the resource being protected as well as the confidentiality and sensitivity of that resource.

4.2.6 Audit Trails

When appropriate, audit trails must show how records in systems got to their present state, what they looked like before any changes, when and by whom each change was made, and the pertinent circumstances. For the purpose of this policy, audit trails are used to make it possible to reconstruct records, to fix accountability and thus help maintain the accuracy and integrity of data.

4.2.7 Access Authorization

To access a University administrative information resource, a user must first be defined to an Access Control System and must either be designated as the Information Resource Manager for the resource, in which case he/she has full access, or must have been authorized by the Information Resource Manager for specific types of access. If the requested access is not authorized, the request must be denied. Any unauthorized access attempt constitutes a security violation.

4.2.8 Logging of System Activity and Security Violations

When appropriate, logging of activity and security violations must be done in all modes of operation. Violations also must generate notification to the responsible system administrator. Depending on the severity of the violation, the system administrator must notify the Information Resource Managers of the affected resource(s.)

Auditing of user activity should be transparent to the user, but when access is denied, a message should be sent to the user to indicate that access was denied and if necessary, why access was denied.

4.2.9 Information/Data Classification

Information/data classification will be used to designate the degree of confidentiality of the information/data. The designation will be used to determine applicable protection mechanisms as well as how the information/data is to be accessed, used, stored, distributed, copied and disposed of.

Information classification must be the responsibility of Information Resource Managers. Authorized individuals must comply with any applicable classification policy and associated procedures and guidelines for the handling, storage, distribution, copying and disposing of classified information. Classification policy and associated controls must be superseded by government acts such as the Freedom of Information and Protection of Privacy Act (unless specifically or implicitly exempted) enacted by the Government as well as any specific access to information policies approved by a university.

4.2.10 Usage and Accountability

A university's administrative information processing systems and resources shall be used only to conduct University business, unless otherwise specifically authorized by the appropriate level of management.

The use of software is subject to the terms and conditions of copyright or license agreements of the product. Users will be held accountable and individually responsible for their actions when using University information system resources.

4.2.11 User Identification

Each user of University administrative information processing systems must have a unique identification code, i.e., User ID.

4.2.12 User Authentication

Authentication of individuals as valid users of University administrative information systems, for example, via the input of a valid password or use of an authentication token will be required to access any shared automated information system. Each user of University systems will be accountable for the selection, confidentiality and changing of passwords required for authentication purposes, except where the password is automatically generated by the system.

4.2.13 Authorization (to access and use Information Systems)

Classified information/data stored on a university's administrative information processing systems shall only be made available through electronic access to those with a need or right to know. The Information Resource Manager or the appropriate level of management must explicitly authorize access to and use of any University administrative information system.

4.3 Library Information Services

4.3.1 Library Services Integrated with Computer-Based Working

Many of the Library's users, both on-site and off-site, will increasingly be using computers as tools for their work. Users will seek access to more and more of the Library's services across networks, using PC's and workstations in the workplace and the home. In the reading rooms, users will expect to use their own portable

computers in conjunction with the Library's automated services. Ultimately, some users will wish to access the Library's services from any location, perhaps with a hand-held computer linked to the Library by wireless-based network connections. The Library will integrate its computer-based services with these modes of working by providing services through telecommunications networks and by integrating its systems with widely used user-interface software. This is how remote document supply will see the greatest immediate benefit from improvements in telecommunications networks, widely available terminal equipment, and access to digital, or easily digitized, material. The aim must be to improve speed, quality and efficiency of document delivery services. However, in the longer term, network services will develop on a much broader front to provide as far as is practical the full range of library services. Although the development of network-based services is most prominent at present, digital publishing media such as CD-ROM have and will retain great potential for the distribution of information. The Library should supply information about its collection and services, and a range of other multimedia publications based on material in its collections, on CD-ROM. In the longer term, the Library will integrate this type of information with access to network services. An implication of these developments is the necessity for the close integration of the Library's services with the hardware, software and telecommunications products that are widely used in the personal computer and workstation environment. In order to achieve this the Library will follow established standards and work in partnership with the suppliers of these products. In terms of Strategic Objectives, the Library expects to reach out to a much wider group of users. For this purposes the Library will actively develop the provision of its services through intermediate organizations as well as direct to end users. Both forms of service provision will require support

by information about the services, the supply of any necessary software, the setting up of reliable interfaces, maintaining agreed service performance levels and rapid problem solving. The expected scale of operations for network services will be large and this support role will become a significant new activity for the Library.

4.3.2 A Collection of Digital Material

The basis of the Library's service will be the collection of books, journals, manuscripts and other materials to which its users seek access. As the volume of information recorded and disseminated in a digital form increases, the Library must be in a position to capture this information too. This will support the fundamental objective of building on the existing research and archival collection. However, in the digital environment the 'capture' of an item may take a number of forms and this may simplify the task. For example, digital information may be obtained on a physical object such as a CD-ROM or, as a digital file downloaded from another source; access may be enabled by a permission to obtain a copy across networks when required or perhaps just the knowledge of a source of digital information and the means by which to access items from it. In the longer term, these developments indicate the potential for a library to change its role from an organization that purchases, stores and provides access to material to one which acts as an intermediary between the providers of digital information and those seeking access to it across networks. Such a radical change will be approached carefully in order to retain a balance between the rights and needs of the providers and users of digital information and to ensure proper integration with access to the physical collection of books, journals, manuscripts and other materials.

In some cases the adoption of digital information as a part of the Library's services are expected to be relatively straight-forward, for example services based on patents supplied on CD-ROM. In other cases, the issues of copyright, the relationship of the publishing of digital information to the Library's role and the cost or technical difficulty of providing a service may prevent widespread exploitation. The Library should create a 'focus' to promote the development of digital collections and services based on them. Initially it will develop pilot services and demonstrator systems. Ultimately these will be transformed into new operational services fully integrated with existing services. Collection and acquisitions policies for digital materials will be integrated with those for existing materials. On the other hand, the Library must develop an infrastructure of efficient and effective storage, retrieval and transmission systems based on open systems principles. It must also develop the necessary expertise to find, preserve and use this information. For example, an understanding of the manner in which digital information is created and used will be particularly important in establishing the Library's role in the possible legal deposit of digital materials. However, preservation of digital materials, and preservation of the means of access to them, will pose new challenges. This applies whether the digital material was originally created in digital form or produced by digitizing conventional materials. Digitization also has potential for new preservation techniques as alternatives to existing media such as microfilm. The Library must develop and implement appropriate technical and other policies, seeking national and international coordination, and where appropriate using the expertise and resources of other organizations such as the existing academic data archives.

4.3.3 Efficient Library and Administrative Processing

The Library should minimize the cost of processing and administration activities by using computer systems that can make a proven contribution to cost-effectiveness. The use of personal computers and communications software must be well established in the Library. This is a rapidly developing area and further uses will develop, for example the use of 'groupware' (i.e. systems of software and telecommunications that enable group working) and 'desktop conferencing' to support team working. This use of computers and networks must be supported by the development of trained staff, the provision of an appropriate infrastructure, adequate support and an expectation that staff are empowered to exploit this technology to its fullest extent to improve efficiency. The result will be the widespread use of computers and telecommunications to support many of the Library's routine administration and processing activities. The Library's core infrastructure systems, for example cataloguing and catalogue access, will be integrated into this environment to facilitate widespread use.

4.4 Networked Information Services

It is the responsibility of Network and Information System Services to provide effective and efficient network administration for the entire university. Network and Information System Services should provide a wide range of services to the community. These services include but are not limited to the following:

- Maintain several servers. These computer servers collectively provide access to network applications, shared drives, network printers, electronic mail accounts, intranet web services and internet web services and are maintained on VMS, Digital Unix and Windows NT platforms.

- Maintain the different Internet/Intranet sites of a university.
- Provide centralized distribution of application software.
- Maintain a university electronic mail services.
- Provide additional collaboration tools through integrated messaging, web, and file/print services.

The primary vehicle for networked information services in a university is now the World Wide Web. The Web has revolutionised the process of producing and disseminating information, producing orders of magnitude improvements in ease and speed of these activities. By the same token it has introduced the dangers of haphazard quality, inconsistency, and dilution of institutional image and impact.

A university should encourage the use of the Web within suitable guidelines. Pages on servers run by a university will fall into three categories: corporate pages, departmental pages, and private pages. Corporate pages are typically top level pages or pages designed to convey corporate information outside the institution. They are in a standard corporate format, and a university takes editorial responsibility for their content. Departmental pages do not need to adhere to the corporate format, but display a University mark. Departments will take responsibility for their content. Specific guidelines will be provided for private pages: they will not be able to display University marks, and a university will not take editorial responsibility for their content. Also, a university should establish a Website Steering Group to steer the development of a university's Web pages, and should appoint a Web Officer to provide central guidance, support and training for Web page production, but departments and sections will take prime responsibility for generating and maintaining their own pages. Each department, centre or section will designate a

staff member to take responsibility for maintaining the departmental Web pages. The Web Officer and External Relations Section will monitor Web pages for compatibility with a university's corporate image.

A university will maintain guidelines on content, covering issues of copyright, defamation, obscenity or content otherwise liable to bring a university into disrepute. It will act quickly where pages are believed to violate those guidelines. Innovative approaches to information provision will be explored, for example in applications commonly classed under the electronic library in the broadest sense, including lecture note and academic paper databases and their access mechanisms, and search and navigation facilities. A university will capitalise on the experience of The Data Archive in this area. Thought will be given to establishing integrated information access interfaces where this is appropriate.

4.5 Departmental Information System

There will be four categories of departmental information system provision may be identified: special-purpose systems specific to the discipline; more general-purpose systems for use by students; desktop systems for general-purpose use by staff; and systems for departmental administration. During this categorization departments must take complete responsibility for choice and running of equipment in the first category, with due regard to purchasing policy. General purpose systems for students will likewise reflect departments' specific needs, though departments will be encouraged to adopt University standard solutions. Since it will be recognized that all academic staff require their own office desktop computer, a university will provide supplementary financial support for desktop provision and replacement as part of the equipment grant to departments. As far as systems for

departmental administration, a university will develop and promote a standard approach, using PCs running Microsoft Windows and common applications software, with the aim of facilitating networking and support.

4.6 Campus Systems

A university should recognize the advantages of integrated campus card systems. The costs of installing card systems are high, and the nature of a university campus might mean that some of the potential advantages will not be realized. Accordingly a university should keep the options under review, without laying firm plans for the immediate future. As far as security systems are concerned, they will continue to be developed, and those involving innovative low-cost technologies will be explored, notably the supervision system. Building management and alarm monitoring systems will be enhanced. It is important to mention that there is anticipation that built-environment ("estates") systems will make increasing use of digital networks. The aim will be to use the existing campus network, though consideration will be given to providing dedicated network facilities if the need arises.

To create an information technology environment appropriate to a large, complex, Research university, a university, campus will adopt a new model for allocating resources for information technologies. The proposed model will support instruction, recognize that the research-computing environment is *highly decentralized and heterogeneous*, and facilitate outreach and services. The recommended model consists of a mix of *free* and recharged components.

Action Steps:

1. Provide a base level of service, at no visible cost to the individual user or department. Major sources of this service include support for student instruction, access to administrative systems and databases required to perform one's assigned duties, e.g., student, financial, payroll, personnel systems and network access for offices, labs & dormitories. Other available services are HELP desk services, access to training, general consultation, site license management, electronic mail, student and faculty accounts, campus wide databases, administrative information resources, centre for Advanced Information Technology.
2. Replace full cost recovery with cross subsidies, financial incentives and disincentives, and value added charges to reduce the net costs of information technology to the campus. Such activities will be possible through designing and equipping classrooms and other learning environments for the easy use of information technologies, including the wiring of classrooms for data and video transmission. Allow faculty members the option of using class or individual student accounts for course work. Identifying an appropriate source of funds to support a campus infrastructure for research purposes:
 1. support the network, network-related services, and databases.
 2. subsidize the cost of shared resources (including cycles and specialized equipment) in distributed facilities.
 3. leverage the acquisition of technology, including matching funds.
 4. provide support services for research.

Also there is a need to establish a fund to enable *have not* units to acquire appropriate technology and support services and assist academic and administrative units in developing plans to provide every faculty, and staff member with the technology required to access and use essential data and tie the allocation of funds directly to the advancement of these plans. In addition, there is a need for charging for value-added services, e.g., in-depth consultation and services, maintenance, special requests, network-based backup and disk storage services, use of specialized facilities, specialized consulting. Charge a one-time network access fee for each new voice, data or video connection and bundle monthly voice and data rates into one charge and one bill (posted electronically). Establish a mechanism for units to share the staff resources required to support information technologies. Target base level and value added training and support services at unit systems managers and coordinators (departmental experts).

3. Encourage the continual updating of information technology hardware and software, through developing a life cycle planning and capital expenditure model for centralized campus resources that incorporates the scale and capacity required by the local campus community, e.g., adequate disk storage, capacity appropriate to software and computational requirements, ubiquitous networking. Also, by targeting services at current and emerging technologies and setting up a loan and leveraging fund using Information Technology (IT) reserves, Instructional Use of Computing (IUC) funds, and other campus funds to provide loans and matching funds for units to procure and update information technologies. Setting up a used equipment resale

program that includes a mechanism for the off-campus sale of equipment that is outdated or incompatible with the campus-computing environment.

4. Develop a procedure to identify and purchase site licenses. This will be possibly establishing a site license fund to seed purchases, instituting a mechanism to replenish the fund and providing network server services.
5. Provide financial incentives, e.g., special discounts, for students to purchase their own computers.
6. Establish a budgetary mechanism for units to accumulate funds over more than one fiscal year for the purchase, upgrading and replacement of information technologies.
7. Ensure that the funding model encompasses support for interdepartmental/interdisciplinary projects and programs, and disciplinary core facilities, as well as traditional departmental funding.
8. Appoint a committee to develop new criteria for the allocation of IUC funds in conformance with these recommendations.
9. Review, assess and revise (as appropriate) this model annually.

4.7 Central Support Services

4.7.1 Purchasing

As part of its overall purchasing policy, a university should provide a central service for IT purchases. Such a services usually provides advice, places orders, handles external payment and takes initial delivery. Departments, centres and sections which do not wish to use the central purchasing service may, with the agreement of the Central Service Management Group, handle their own purchases for some or all IT equipment. In any case departments usually purchase special

equipment directly, on the understanding that the Computing Service agency should be kept informed. This will be kept under review for the longer term. A university will keep under review the implementation of central purchasing, in particular the avoidance of delays and bottlenecks, and the way in which the operation is funded. The procedures will be clarified and adequate documentation provided. The advisory function will continue to be emphasised.

4.7.2 Hardware and Software Support and Advice

Generally, Most of the universities have a mix of central and devolved/departmental support and help for information systems. To establish the right balance is complex. As is common in most universities, some scientific and technical academic departments have established their own support services, sometimes employing several staff. They are in a position to provide extensive advice to staff and students. Humanities and social science departments on the other hand commonly have little or no internal support, and few departmental information systems. They inevitably turn to central services for support. Furthermore the style of support sought by departments can vary significantly according to discipline. This is the reason behind the fact that there's no single approach to support, which would satisfy all academic departments. The nearest to the ideal might be the retention of self-support by those scientific departments that wish to do so, with the provision of centrally-managed targeted support for clusters of departments which prefer that approach. However, such a solution would probably require staff resources going significantly beyond those currently available.

For the administrative sections, the Management Information Systems group provides a first point of call, and can make some initial checks on problems.

Meanwhile A university will continue to review the arrangements for support and help services, and the balance in particular cases between central and devolved provision. Given the existing resources, any significant shift to greater central provision is unlikely in the short term. However, efforts should be made to improve information flow and sharing of expertise between departments and central services. In line with a university's policy on standardisation, central support will be targeted at a restricted set of hardware and software options. In particular Intel-compatible PCs and to a lesser extent Unix systems will receive support. Apple Macintosh systems will not be supported on a formal basis. Support for generic software such as electronic mail programs will be limited to a small number of options, sufficient to cover supported equipment. Systems and packages, which do not receive formal support, will continue to be permitted, but only as far as a self-supporting basis. In the case of software applications packages, the expertise in their use commonly resides in departments. That expertise and its renewal depend on practical experience, and cannot readily be provided from central services. Accordingly central support will be limited to purchase, licensing and mounting on central servers. A central information brokerage will be established giving guidance on sources of advice and information. Management Information Systems group will be providing support for systems and packages specific to the administrative sections by the and by staff within this group have already had relevant training. Central support for hardware and software maintenance and licensing will continue to be provided where this is justified by the quantity of a particular product in a university. Where it is cost-effective, maintenance for a given type of equipment will be carried out by the manufacturer or external third party, under a centrally-established site licence. Adequate and comprehensible documentation will be provided and

maintained centrally for supported information systems, on the World Wide Web and on paper. The Web will increasingly become the primary medium. Where documentation is inadequate special efforts will be made to improve it. Also, central help desk services particularly targeted at students will be maintained. Tailored advice and documentation for disabled students and staff will be provided wherever possible, in consultation with the Disability Technical Officer.

4.7.3 Central Equipment Maintenance Service

The Central Computing Service would provide a central equipment maintenance service. The service might be offered on a contract basis, and a charge to be levied. In the case of PCs running Microsoft Windows (the main category of equipment covered by the service) support must be for hardware and software installation, upgrade and fault fixing. Departments can choose not to take out contracts, in which case they make their own arrangements for support. It is the responsibility of A university to keep the central maintenance service under review. Performance monitoring will be strengthened. Alternative options will be considered, including the introduction of a tiered service, or the outsourcing of all or part of the maintenance function.

4.8 Technology Assisted Learning

A university should recognize the potential of information systems to have a major impact on the way in which students learn and academics teach, and on the breadth of the institution's student market. It should also be recognized that in specific instances the financial costs can be high with little being really understood about the return on investment or efficacy of impact, and that the adaptation of

technology to courses and courses to technology is not an easy task. Nonetheless modest steps, if they are the right steps, can have big effects. Therefore a university's overall policy, led by academic need, should be to develop the use of technology-assisted learning in areas and in ways in which it can have the clearest impact, to review progress on a continuous basis, and to ensure adequate support for staff and students. The main thrust must be towards the use of generic technologies applicable across all disciplines.

Generic tools, such as email, bulletin boards, the Web, and networked collaborative software, can cost relatively little to implement and be relatively easy to use. Their use in teaching and learning will be explored and developed. These of audiovisual services will also be expanded as described in the next section. Adequate documentation and training in their use will be provided. Another issue to take into consideration is that a university will not put great effort into the production of homegrown CAL packages: this is a task for larger or more specialised institutions. It will rather identify and if necessary adapt the best examples produced elsewhere. Use of the small CAL production facility in the Teaching Services Unit will be encouraged and training made available, for those departments, which wish to develop some of their own materials. The Teaching and Learning Advisory Group is the primary forum for relating technology-assisted learning to broader teaching and learning developments in a university. Under the guidance of the Group a Teaching Innovation Fund may be established which will be available for innovations involving the use of technology in teaching. A university will through the Teaching Services Unit provide information and resources on technology-assisted learning, maintain external contacts and provide specific training and support to academic departments on request. Through the help of

the Teaching services unit staff training in basic IT skills will be expanded. Moreover, technological support for distance learning will be specifically targeted, including remote network access, the experimental use of high-bandwidth networks, and the exploitation of generic software tools.

4.9 Audiovisual services

A university should have audiovisual facilities, largely mobile but with some fixed provision in teaching rooms. The uses of such facilities will probably grow rapidly, and experience suggests that demand is suppressed by limited supply in universities. Mobile facilities are low in capital cost, but require substantial staff resource for setup and dismantling, and may yield less satisfactory results. They can be challenging to use for teaching staff not experienced in the technology. What a university should aim to steadily expand audiovisual facilities, and as funds allow to increase the number of fixed installations in selected teaching rooms. Teaching room environment and location must be taken into account. Audio conferencing must be encouraged where it is relevant. Also, the establishment of an advanced audiovisual/multimedia demonstration room must be considered, as part of the learning resource center. In terms of developing available services a university will capitalise upon research expertise within the institution, notably in the Computer Science and Electronic Systems Engineering departments.

4.9.1 Videoconferencing

Videoconferencing will be important to a university in several respects, both in increasing efficiency through saving time and money, and in opening up new possibilities. It will provide support for teaching and research internationally,

nationally and regionally. In particular it will provide one part of a strategy for marketing a university's academic strengths. It will act as an administrative tool, for interviews at a distance, and for remote meetings. A university will heavily promote the use of its ISDN-based group videoconferencing service as well. As a matter of modern needs a university must seek to establish a dedicated videoconferencing room. In addition a university will experiment with the use of high-quality ATM-based videoconferencing as networking infrastructures allow, with the longer term aim of establishing a full ATM-based service. The research interests of Computer Science and Electronic Systems Engineering will provide a basis for such experimentation. In addition, the use of videoconferencing will be tried continually and will move towards service provision. In particular the possibility of establishing a small television studio in a university should be investigated, with the aim of facilitating access by the broadcast media organisations to University staff.

4.10 Print Services

It is expected that in a university three kinds of support for networked printing. Broadly corresponding to levels of print quality and complexity: desktop printers and departmental printers, including MIS support for administrative printing; central Computing Service printing services, with automatic charging mechanisms and full network connectivity; and printing services provided by the Print Unit, with poor network connectivity. In addition to this there is a substantial amount of non-networked photocopying in a university, with the Copy Shop economically providing for large runs. The Print Unit provides a printing design service, which includes implementing a university's corporate identity. The Unit has been the subject of a SUMS review.

A university will continue to support different levels of print service, while encouraging greater integration where appropriate. It is recognised that, with changing technology, there is likely to be steady improvement in printing quality available on the desktop and provided by the Computing Service. At the same time the Copy Shop and the Print Unit may in turn offer higher quality printing and new services. The gradual networking of photocopying services throughout a university will be put under careful investigation. External colour printing services for special purposes will be used where there is no internal provision, in consultation with the Print Unit. New low-cost colour printing services will be introduced where there is demand. Integrated costing and charging systems are being introduced in the Print Unit, and network connectivity of Print Unit services is to be improved, and. The design software used by the Print Unit will be reviewed, and users' problems of networking addressed.

4.11 Telephone Services

A university's telephone services and data communications services must be completely separate. ISDN6 will be available in LTB4, and will be used to support a university's group video-conferencing service. An independent service provider shall provide telephone services to individual rooms in some student accommodation, and a card-based telephone service will be available to all students through any internal extension. Voice mail and Interactive Voice should be introduced, and a pager system should be supported. Note that it is University policy to install Category 5 wiring of the correct specification for both telephone and data services in all new accommodation. Also, further expansion of voice mail and IVR will be encouraged. Set apart A university will investigate franchising to independent service providers the installation and running of telephone services for a

university. Wherever possible the installation of cabling for data networking in student accommodation, where not already provided, will be included in the arrangements. At the same time, the charges levied on students by independent service providers will be monitored. On the other hand, ISDN will be extended for videoconferencing within a university as required. The pricing structure within a university for ISDN calls should be reviewed, to remove any danger of stifling expansion through artificially high charges. Online and hard copy telephone directories will be produced and maintained in a manner, which keeps them reasonably up to date. The hard copy directory will be revised and reissued twice a year. In addition to these efforts, A university will appoint consultants to review its telephone services during the next few years, including the future of the PABX and the possible introduction of Computer Telephone Integration technologies.

4.12 Information and Communications Technology Infrastructure

4.12.1 Campus Network

A campus network with adequate functionality, performance, reach and external connectivity will remain a vital underpinning for all information systems in a university. A university will be fortunate in having a compact campus, on which it will be possible to establish a pervasive and high quality network, currently based on Ethernet with an FDDI backbone. A university will continue to upgrade and improve the campus network using appropriate technologies as resources permit. The solutions deployed will as far as possible leave the way open to the rapid and easy adoption of future technologies while preserving existing investment to the maximum. Particular efforts will be made to maximise the reliability of the network. A study will be made of options for

the future development of the campus network, covering options such as ATM, Gigabit Ether, and wireless networks.

4.12.2 Networking Student Accommodation

It shall be a university's policy to encourage student ownership of computers, with network connections provided wherever possible. This shall involve both the networking of student accommodation owned by a university, and the provision of dial-up access.

4.12.3 Remote Access

Remote access to the campus will grow in importance, as students who are not in networked accommodation acquire personal systems, as the volume of part-time courses expands, and as staff makes more use of computer facilities in their work. Part time courses are likely to involve a high proportion of mature students who may already have their own systems or who may more readily be able to afford to buy them. In addition, a university will support remote dial-up access, both through encouraging use of the ULAKNET national dial-up service and through the provision of high quality dial-up facilities on the campus. The former will be particularly suited to students and staff outside the local call charge area, but will require the individual to take out a yearly subscription. The latter will serve those local to the campus, and will also help in the management of service by supporting secure remote fault diagnosis and systems management. The campus dialup service shall be replaced in the near future. The system will have the capacity to support 30

lines, and can be upgraded beyond that level. Demand will be monitored and requirements kept under review.

4.12.4 External Network Connections

A university relies on its external connection to ULAKNET in much of its work. The future will likely see a growth in demand for high-quality and high-speed networking for high-quality videoconferencing, distance learning, collaborative research, cooperation, and marketing of courses at home and overseas. Generally, the campus networks are connected to ULAKNET through link offering 512 Kbit/s outbound and 512 Kbit/s inbound. Therefore it is likely that capacity will remain sufficient in the shorter term, particularly in view of the steps being taken to contain traffic volume. However, demand for bandwidth would be growing, and capacity might not be sufficient if a university began to make significant use of high-bandwidth applications involving images. The situation will be monitored. Moreover, it is a university's policy to support network connections to educational institutions wherever possible. A university will monitor and if necessary control off-campus network use, by encouraging use of the campus Web cache and news server. It may become necessary to enforce use of the cache and news server by blocking direct off-campus traffic. Network charges are borne centrally. However, the possibility of charging back to departments will be kept under review.

4.12.5 Services Provided on the Network

A university will develop standard network services, including electronic mail, the World Wide Web (including Web caching services), news group access, directories, and network infrastructure services such as name, authentication and

licence serving. As staff and students come to rely more on these services, there will be an ever-greater need to ensure availability and reliability. This will be taken into account in resource planning. Meanwhile, a university will exercise caution in introducing new interactive Internet services such as Internet Relay Chat and Internet telephony. The criteria will be clear applicability to academic work or administration, and compatibility with existing services and the available level of network provision. Also, a university will maintain adequate file backup procedures for central file stores, and will provide advice and support to departments for file backup.

4.12.6 Computer Platforms

A university will continue the transition to Windows NT as the operating system of choice on PCs, with the aim of achieving greater reliability and manageability. However, for a time there might be a need to retain non-NT capability in order to support some application packages. As part of this transition, a university will continue to test the use of Windows NT thin client/fat server technology. However, any wider deployment of the technology would need to take into account both its efficacy and the costs, which following takeover of the technology by Microsoft may be less attractive than it seemed formerly. In any case, there would be no blanket migration to the technology. Other types of network computer technology will be assessed and exploited as appropriate. The majority of personal computers in a university generally run Microsoft Windows. There may be a need for a sizeable minority of Apple Macintosh machines, to be used for niche purposes. It is anticipated that Apple Macintosh computers may continue to be acquired and used as niche equipment, while thin client technology could be used to assist those who

wish to make the transition to Windows NT while getting useful life out of legacy equipment.

Unix systems will continue in widespread use, particularly in departments and for some network services, for the foreseeable future.

4.13 Training

The training of both students and staff in basic information technology skills will be of fundamental importance. A university intends gradually to establish coordinated plans for both forms of training.

4.13.1 Students

Students will increasingly need generic skills in IT to support their coursework, for word-processing assignments, for access to information sources, for communication and for running applications and learning packages. In addition, IT competence is becoming a vital transferable skill-readying students for future employment. For this reason, a university will seek to establish common IT literacy induction courses for all students, leading to a basic level of competence. There will be a need to identify responsibilities for course provision and for coordination. The content of IT literacy courses will reflect the standard general-purpose systems used in a university. This means that, in addition to the basic skills of keyboard and mouse use, the courses will concentrate on Microsoft utilities, email, and World Wide Web use and information access on PC platforms. Unix and Apple Macintosh skills will, in general, not be covered. Also, thought will be given to the extent to which IT literacy courses should be tailored for different departments or schools, and whether they should be formalised as part of the curriculum. The options of

establishing University certificates in IT literacy will be considered. The needs of disabled students will be born in mind, and health and safety issues will be adequately covered. As the number and scope of courses based on distance learning increases, frequently involving the use of dial-up services from work or home, special training and targeted documentation will be developed. IT training for postgraduates will become available through the Computing Service, alongside staff training. This will be on an individual basis, and resources will be limited. Consideration will be given as to how best to provide for postgraduate training in the context of coordinated training plans as well as establishing an IT literacy resource centre, including books and videos for self-paced learning. This could be part of a learning resource centre.

4.13.2 Staff

Staffs, likewise, will need basic IT skills. Learners will always look to teachers to have IT skills matching in many respects their own, and IT skills will be needed to make use of new technology-based approaches to teaching. Email and the World Wide Web are an established part of University administrative processes. Word processing, spreadsheets and database access mechanisms will help improve efficiency. A university will aim to build on the staff training currently provided through the Computing Service and the Staff Development office to develop an integrated approach. The Staff Development office will take the lead in this. A training strategy will be developed. The services of external training bodies such as Net skills will be fully exploited. Differing needs and skill levels will be taken into account. In addition, much thought will be given as to how to establish training for staff in best practice in the use of technology in teaching.

4.14 Environmental Issues

The spread of information systems throughout the campus, in particular desktop computers, could possibly put new demands on the working environment. Good working practices will need to be enabled and encouraged. In particular, efforts will need to be made to minimise the risk of IT-related disorders such as Work-Related Upper Limb Disorder and Repetitive Strain Injury. The Occupational Health Office will continue to provide advice on the purchase and use of equipment. Furniture needs to be chosen so as to provide the correct conditions for use of PCs. Surfaces will need to be of adequate depth to house screens. Rooms should be laid out to avoid screen glare. In some environments air conditioning may become necessary as the volume of installed information systems equipment rises. Disabled staff and students may have special requirements. A university must take these changing needs into account in estates planning. At the same time, constraints of cost, space, environmental impact and location will need to be reflected in the deployment of information systems. Information systems are a common target for theft, both petty and organised. Damage or loss of computing systems can be very disruptive, however, quickly replacement systems must be made available. Responsibility for the physical security of systems resides with departments and sections. The Security Office, in close collaboration with the Computing Service and MIS, will provide advice and where appropriate adopt specific measures.

4.15 Resources and Organization

The organisational structure for the management of information systems is broadly as follows:

- *Computing Service*: infrastructure; central academic services; central institutional services; implementation of library information systems; training;
- *Teaching Services Unit*: central support for technology-based learning and audiovisual services;
- *Library*: user aspects of library information systems; applications development;
- *Management Information Systems*: central administrative systems; support for administrative sections;
- *Estates Section*: telephones; print unit; campus systems;
- *Staff Development*: training;
- *Administrative sections*: specific applications and associated support;
- *External Relations*: Web standards;
- *Academic departments and centres*: departmental computing and support; training; departmental administrative computing.

The committee structure is as follows:

- *Budget Sub-Committee*: receiving strategy, plan and budget, and setting budget envelope as part of overall budget planning;
- *Finance Committee*: approving budget envelope;

- *Information Systems Strategy Committee (Council and Senate)*: recommendations on and monitoring of overall information systems strategy; detailed budgeting within the budget envelope;
- *Computing Service Management Group (Senate)*: advising on management of Computing Service; monitoring quality and reliability of central services;
- *Computer Users Advisory Group*: advising CSMG and ISSC on IS strategy and the management of the Computing Service;
- *Administrative Computing Management Group*: overseeing information systems in MIS and administrative sections;
- *Website Steering Group*: steer the overall developments of a university's Web pages.

A university will continue to monitor the effectiveness of the management and committee structures, and will look to the Information Systems Strategy Committee to ensure adequate coordination and to advise on resource levels. It is recognised that the quality of information systems provision and support depends on the level of staffing available, and that the right balance between resources for staffing and other financial needs has to be struck.

CHAPTER 5

SUMMARY AND CONCLUSION

The MIS strategy's main objective is to be practical and be aligned with the business of a university. The strategy, therefore, is presented two parts. The first part summarizes policies and development in teaching & learning, research, and institutional infrastructure. The second part discusses strategies for the different kinds of information systems and associated services in a university such as infrastructure central support.

Technical infrastructure makes up the backbone of the IT system. It is crucial for the information to be accurate precise and timely. Each department has an independent technical structure but also serves as building blocks of the overall system. The independence native of each department has reduced the hierarch and increases the pace of decisions making process, thus enabling the info to be easily transmitted to the system.

Top management's fast and reliable access to information is of particular importance for these MIS systems. While accessing this information, the security of the system must be taken into account and necessary measures must be put in place.

Therefore, this study goes further in detail discussing, the security aspect of the MIS system and its applications.

The importance and prominence of MIS systems in the institution is to ensure the most effective and productive use of valuable resources such as time and money.



GLOSSARY

Abbreviations are not expanded where the expansion does not enlighten and is in any case not in everyday use by practitioners.

ATM A networking technology which provides not only for very high speed (25 Mbit/s to over 1 Gbit/s) but also for mixed types of traffic (data, video, telephony, ...) with adequate service quality for each. (Not all high speed networking technologies will support high quality videoconferencing for example.)

CAL Computer Assisted Learning: used to mean interactive learning packages typically running on a desktop computer.

Category 5 A standard for cabling premises which, if properly adhered to, is suitable for both telephony and high speed data networking. The recommended standard today.

CTI Computer Telephone Integration: enabling networked PCs to handle many of the functions of fax and telephones, including initiating, receiving, manipulating and terminating calls. The communications themselves continue to pass over the local telephone network, whether or not this is integrated with data communications.

Ethernet The ubiquitous network technology for local and departmental networks, and for connecting individual computers. Offers varying speeds up to 10 Mbit/s.

FDDI A high speed network technology (100 Mbit/s) which has been in use for some years now. Cannot offer the service guarantees for different types of traffic (for example videoconferencing) that ATM can, but is the workhorse of University network backbones.

Gigabit ether An emerging Ethernet technology supporting speeds of up to 1000 Mbit/s. Increasingly seen as a strong rival to ATM as a standard for high speed networking.

Internet Relay Chat A system on the Internet for holding multi-way text-based "conversations", in which the participants type in their contributions. Has little academic use at the moment, though some predict it will become an important form of cheap remote collaborative working, notably for research.

Internet telephony The use of PCs furnished with microphones and loudspeakers or headphones as telephones to communicate with other similarly equipped PCs, with the Internet as the transmission medium. Telephone charges are low or, for institutional users, zero. But the quality is variable between poor and execrable, and there is concern about the load on the Internet and competition with other traffic.

ISDN A network technology that will carry mixed data, video, telephone and so forth. The term is commonly used today for lower speed integrated networks available from BT and other providers as a dial-up service, like telephones. ISDN2 is 128 kbit/s, ISDN6 384 kbit/s.

IVR Interactive voice response: a mechanism supporting recorded responses to telephone callers, which guide the caller through options. Evidence that technological progress can be downward as well as upward.

MBONE A technology for using the Internet efficiently for simultaneous communication between several sites. Is used to support videoconferencing over the Internet. Quality tends to be low to medium, but may be better in future with technology development.

PABX A university's telephone exchange.

Supervision A technology developed at a university providing low-cost video-cameras communicating with a central monitors over a standard data network

ULAKNET The TURKISH academic network.

Videoconferencing Use of tailor-made video systems or computers to communicate sound, vision, and images over a network. Ranges from cheap desktop systems, providing low quality communications between PC, via medium quality systems which may be portable or semi-portable (roll-about) to large-scale fixed installations in dedicated rooms. Low quality videoconferencing typically uses the Internet directly or via the MBONE service. Medium quality videoconferencing may use ISDN2 or ISDN6; the former is just acceptable, the latter good. High quality videoconferencing typically uses ATM, satellite or dedicated links, and can reach television broadcast quality.

Video-on-Demand A technology whereby multiple video streams are delivered from a server computer over a network to computers or televisions on demand.

Web cache A central server through which World Wide Web accesses from users' machines may be routed. The cache holds copies of recently accessed pages. If a

user requests one of the cached pages, it is returned directly, so reducing network traffic.

Windows NT A form of Microsoft Windows operating system. It is more robust and secure than Windows 3.1 and Windows 95, but requires more powerful computers.

X Windows A system and protocol for running a program on one computer (the server) while controlling the program and displaying output through a windows user interface on another computer (the client) connected to the server across a network.



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