COMPUTER-BASED INFORMATION SYSTEMS DEVELOPMENT:
A MANAGEMENT PERSPECTIVE

by
Richard W. Bratcher

Major Paper submitted to the Faculty of the
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of
MASTER OF ARTS
in
Urban Affairs

APPROVED:

J. M. Lévy, Chairman

P. K. Edwards

J. W. Dickey

December, 1984
Blacksburg, Virginia
TABLE OF CONTENTS

INTRODUCTION ................................. 1

Chapter
I. COMPUTER BASED INFORMATION SYSTEMS ........ 3

   Information Systems
   Computer Based Information Systems
   Basic Steps of Information System Development
   Personnel Involved in Development of an Information System
   Types of Information System Development

II. SIS: AN INFORMATION SYSTEM APPLICATION .... 17

   Introduction
   The Virginia Community College System
   An Informational Need at New River Community College
   The Student Information System
   Development of SIS

III. THE END-USER MANAGER'S ROLE IN SYSTEMS DEVELOPMENT .... 27

   Introduction
   Commitment
   Identifying the Need and Defining the Problem
   Research of Computer Alternatives
   Manager's Role in System Design
   Working with the Computer Specialists
   Design Review and Redefinition
   The Manager's Role During Programming and Testing
   Implementation

IV. ISSUES OF CONCERN IN A DEVELOPMENT PROJECT .... 41

   The Need for Definition in Management
   Quality vs. Quantity
   Implementation From the Start
   The Failibility of Man: Man vs. the Machine
   Concluding Remarks

BIBLIOGRAPHY ................................. 53
ILLUSTRATIONS

Figure

1. Basic Components of an Information System ............ 4
2. Basic Components of a Computer Based Information System .. 7
3. SIS Data Bases ........................................ 23
INTRODUCTION

Information is the life-blood of most organizations. It is used to support planning processes, management decisions and the day-to-day operations of the organization. The quality and timeliness of information will greatly affect the operations and decision making within organizations. Today's society is increasing the demands upon organizations for timely, high quality information. Computer based-information systems are a tool being used by organizations to meet these informational needs and support their operations and decision-making processes.

The development of a computer-based information system is a process that requires specialized training. Managers may find that this process is beyond their area of expertise and seek aid in the development of an information system from trained computer specialists. This places the manager in a somewhat difficult position. He is ultimately responsible for the information used in or produced by his organizational unit. On the other hand, he must depend on a complex information system developed by others.

Within the process of development of an information system for his organizational unit, the manager has an important role. This role is as important to the quality of the information system being developed as the role of the computer specialists. Through an understanding of information systems, the information systems development process and his role within that process, the end-user manager (departmental/office manager) can help insure that the information system being developed
directly addresses his informational needs and has a positive impact within the organization.

The purpose of this paper is to provide a knowledge base for managers concerning the development of information systems. The following chapters will describe information systems, the development of information systems, the end-user manager’s role in the development of information systems, and recount some observations of a large development project. In order to provide a context for understanding, the paper will draw upon the experience of the development of a computer-based information system for use in Virginia’s public community colleges.
Information Systems

In practically every activity of each day, human beings are required to process data. From the simplest daily action to complex management and planning decisions, people must rely on data they have gathered and stored. The individual pieces of data are put together and changed into a form that can be used to direct actions and guide decisions. Information systems are the combination of all the components involved in this process of gathering data and changing it into a useful form.

Information systems range widely in their complexity, but all have common basic components (Figure 1). The three basic components of an information system are an input component, a process component and an output component. Input is the mechanism used to collect data and enter it into the information processing stream. Processing is the mechanism which accepts the data, changes it into a useable form and stores it until needed. Output is the mechanism which accepts the useable information and makes it available. The makeup of these components will vary dependent upon the environment in which the information system exists, its complexity, and its purpose.

An information system in its simplest form is a human being. Throughout his or her life, a person collects data via the five senses which is stored in the mind. When information is needed to support a
Fig. 1. Basic Components of an Information System
decision or an action, the mind searches out this stored data and transforms it into a form that is useable at that time. The information then becomes available for the person to use.

As a person's environment becomes more complex, more data becomes available. At some point, the human being begins to rely on aids in processing data. The first step is probably to write data and information on paper and store it for future reference. In organizations, data has historically been stored in great quantities in paper files. For decision-making purposes, a human being would process this stored data and make it available in a useable form to the administrators or decision-makers.

In today's highly complex environment, informational needs can far exceed the ability of the human being as the focal point for data processing. Data exists in such large quantities and the processing needed can be so complex, that even groups of human beings working together cannot take all of the data and turn it into useable information in a reasonable amount of time. In order to solve this problem, computers are now being used as the key to data processing.

Computer Based Information Systems

The terminology "computer system" has many meanings. It has been used to refer to computer hardware systems, computer software systems, and computer based information systems. Hardware systems are the collection of equipment that is tied together to make the computer functional. Software systems are sets of computer programs that are tied together to solve a particular problem or set of problems. The
computer based information system "integrates hardware, software, and human resources with the aid of management and support resources" \(^1\) in order to process data to provide information to support organizational activities and decision-making (Figure 2).

Development of a computer based information system is based upon the need for some type of information. The system is then designed around this need. The optimal information system design is based upon an analysis of the organization, its activities and its needs. The software systems and hardware systems can then be designed with specific goals in mind and be developed to operate as an integral part of the larger organizational information processing and decision making system. Since many organizations have common informational needs, it is possible to develop information systems for use in more than one organization. This type of development requires a fairly high level of flexibility in the system design and a willingness upon the part of the organization to accept a system that may not meet all of its needs.

Computer based information systems can support four basic informational needs within an organization. These needs are strategic planning information, management control information, operational control information and transaction processing. Strategic planning information is usually needed to support forecasting and long-range decision making within the organization. Management control information is needed for administrators and managers to make decisions concerning short-term

---

Fig. 2. Basic Components of a Computer Based Information System
planning and resource allocation. Operational control information is needed to make day-to-day decisions in the general operation of the organization. The final category, transaction processing is the capability of an information system to process collected data that does not necessarily support decision making. Transaction processing is the computer equivalent of filling out forms and shuffling papers. Information systems can be designed to support any one or all of these types of informational needs.²

Dependent upon an organization's needs and resources, computer based information systems can be developed around batch-oriented software systems, online software systems, or some combination of the two. A batch oriented software system is one that is based upon entry of the data en masse via some type of key-punch device. Data is gathered over time and periodically punched in computer-readable form and sent to the computer for processing. Information is then produced in printed report form and distributed manually to the users. On the other hand, on-line systems allow users to enter their own data via cathode ray tube terminals (CRT's) at any time. The data is generally processed immediately and information is available to them at any time through the CRT. Due to the relative high-cost of true on-line systems, organizations will often develop hybrid software systems with some on-line and batch capabilities.

The hardware and software systems, regardless of their configuration, are only components of the overall information system. Human beings are involved in the information process in many ways. Entry operators are responsible for accurate, complete and timely entry of data into the system. Computer operations personnel are responsible for maintaining the hardware systems to ensure their availability. Systems development personnel are responsible for maintenance of the software systems to ensure processing efficiency, accuracy of the information, and pertinence of the information provided to the operations of the organization. End users, those people who make use of the information provided, are responsible for gathering the data, interpretation of the information they receive and for relating to systems development personnel any shortcomings of the computer system. Computers, computer software, data, information and people are all components of the computer based information system.

Basic Steps of Information System Development

Development of an information system is a process. There are seven basic phases within this process. These phases are need identification, problem definition, research of the alternatives, design, programming, testing, and implementation. Even though each of the phases in the development process can be uniquely identified, they are highly interrelated.

Need identification is fairly self-explanatory. A member of an organization perceives a need for a computerized information system. This perceived need may originate from a feeling that there must be a
better way to accomplish the tasks at hand, or it may originate from a more analytic source. At this point, there is general understanding of what the informational needs are. A clear understanding of ramifications of the need and the processes involved in the information flow must be discovered in the problem definition phase.

The problem must be defined clearly in order to identify the best solution. This problem definition phase of systems development is a time of analysis. The processes in the area of the organization where the need has been perceived must be analyzed carefully. This analysis must also include the interaction of this area of the organization with other parts of the organization. Informational flow within one part of an organization may affect other parts of the organization or the organization as a whole. The problem definition is critical to the entire systems development process. It is the basis for decision making throughout the process.

The next phase of development is to research the alternatives available. The end-user must discover what is available to him and what would best suit his needs within the constraints of his budget. This research must include the different types of information systems that can be developed and the types of development available to him. Once the decisions as to the type of system and development desired are made, the actual design of the system can begin.

Design of the information system is the production of a model of the system. The capabilities of computers is matched to the specific problem. Specifications are then layed out as to how data is to be
stored, the type of equipment to use, the number and functions of
the programs, the way in which information is to be provided, and how
the system is to be used. This design is then used as a plan or
"blueprint" for programming of the system.

Programming of the system is the phase of development where the
information system is actually created. The computer instructions are
written according to the design specifications. There are many
different ways in which programs can be written. Programmers must
choose between these alternatives depending upon the demands of time,
need for program efficiency and function of the individual program.
Programs can be highly complex. Once a program is written, it must be
thoroughly tested.

Testing of a program is the measurement of how well the program
works. Two general measures for testing programs are technical validity
and organizational validity. Technical validity is a measure of the
quality of a program from the standpoint of the efficiency of its
operation within the computer and the accuracy of its output.
Organizational validity is a measure of the quality of the program from
the standpoint of the effort involved in using the program and the
adequacy of the output in supporting the organization. 3 Testing often
indicates the need for changes to programs and for the development of
new programs. Programming and testing are a cycle. This cycle ends

3 Randall L. Schultz and Dennis P. Slevin discuss the use of
both technical and organizational validity as measures in evaluating
successful models used in decision making in Implementing Operations
Research/Management Science (New York: American Elsevier Publishing
when the tests indicate that the programs are acceptable for use in a production environment.

The final phase in the development of an information system is implementation of the system. Implementation is the process of putting the system into use or production. This phase includes planning for the introduction of the system, education and training of the users, installation of the software and hardware, and cutover to the system. Implementation of the information system requires great care. Regardless of the quality of an information system, its success will depend greatly upon its implementation. Most tools become inadequate in the hands of ill-equipped and untrained users.

These seven phases of the systems development process are highly interrelated. The process has a definite beginning, the identification of a need. At any time in this process, the need to cycle back to a previous phase may be indicated. Also, the development process may not have a clearly defined end. Changes and enhancements may be made to a computer-based information system years after it is put into use.

**Personnel Involved in Development of an Information System**

The development of a computer-based information system can involve a number of people throughout the organization and outside of the organization. The personnel involved can be grouped into the three basic categories: end users, organization administrative personnel and the development team. These are general categories of people that will be involved in systems development and the actual make-up of these groups will vary from one situation to another.
The end users are the group of people within the organization that will use the information system and the information it provides. This category can be divided into primary and secondary end users. The primary end users are the group that will use the information system directly. These are the people who are responsible for the functions being supported by the system and responsible for the information provided by the system. Secondary end users are any other people within the organization that make use of information provided by the system.

The primary end user is the most important of these two types of end users. These people must be involved highly in the development process. Upon their shoulders falls the responsibility of defining the problem at hand and aiding in the design of the system. The information system is being developed to directly support their work. They are the ones responsible for the information. The manager or managers within this group are the individuals who are ultimately responsible for the activities within that part of the organization and for the information provided by the information system. In most cases, non-management personnel within the end users group will be responsible for providing the data input into the system.

Organization administrative personnel other than the managers within the end user group are also involved in the development of information systems. Their involvement is less direct than the end user manager, but highly important to the success of the project. Administrative personnel in places of responsibility over the primary end user manager must be willing to commit organizational resources to the information system, support the information system politically within the
organization and coordinate changes within the organization that may result from the implementation of the system. The scope of the responsibility of these administrators in the development process will vary dependent upon the scope of the operations affected by the information system, the amount of resources needed for the project, and the overall impact of the system on the organization.

The development team is made up of the computer specialists involved in the problem analysis, design, programming, testing and implementation phases of the information system development. In typical data processing environments this group will consist of a data processing manager, systems analysts and systems programmers. The DP manager is responsible for management of the computer facility and the other data processing personnel. In some cases, he is the first point of contact for an end user desiring an information system. Problem analysis, design of the information system and coordination of systems development activities are the responsibilities of systems analysts. The systems analysts will work directly with the end users and with the programmers who produce the computer programs for the system.

End users, organization administrators and the development team must work together to produce an information system that meets the needs of the organization and succeeds once it is completed. The manager within the group of end users is the keystone of this success. He is directly responsible for the organizational area and functions being addressed by the information system. It is the end user managers responsibility to report the need for an information system to organization administrators
and to explain that need to the development team. The role of the end user manager will be discussed in greater detail in a following chapter.

Types of Information System Development

There are several different types of development for information systems. Four of the most common types of information system development are in-house development, cooperative development, contracted development and vendor development. These types vary mainly in who comprises the development team and the degree to which the information system is designed specifically for an organization.

In-house development refers to the development of an information system using personnel from within the organization. The personnel resources involved can range from an individual within the end-user department to a fully staffed data processing center. Since the work is being performed by in-house staff for the organization, the system can be developed around specific organizational policies and procedures with specific organizational goals in mind.

Cooperative development refers to development done by two or more similar organizations to produce an information system to serve their general needs. This type of development generally utilizes the in-house staff of either all or some of the organizations. The information system will lose a certain amount of organizational specificity due to the need to serve multiple organizations. Each organization, no matter how similar, will have a unique character and differences in the way they conduct business. As the number of organizations involved in the development increases, so will the generalization of the system.
Contracted development entails the contracting of a firm to develop an information system for an organization. The contractor fills the role of the development team. If the contract is for a single organization, this type of development can lead to a high level of specificity of function for the organization. Due to the fact that the development team is separate from the organization, a high level of communication is necessary between the organization and contractor to achieve this specificity.

Finally, vendor development refers to the development of generalized systems designed for use in any number of organizations and sold in the market place. This type of system is usually the least specific to an organization's policies and procedures. Most of these systems provide only a set number of functions to the user. Some of the more sophisticated systems can be tailored to the individual organization somewhat by the vendor at the time of purchase.

The manager contemplating the use of an information system will need to make a decision as to what type of development to use. This decision will depend greatly upon the resources available within the organization. The type of development will affect the role of the end user manager as to specific activities of involvement in the development process. Conceptually, his role will remain the same.
Chapter II

SIS: AN INFORMATION SYSTEM APPLICATION

Introduction

The application of computer-based information systems in organizations varies widely. Their purpose is based upon the informational needs and the operational process of an organization. To understand this purpose, one must first have an understanding of the organization. The system application described in this paper deals with the needs of Virginia's public community colleges. The following sections of this chapter describe the Virginia Community College System, administrative informational needs at one of the colleges, the computer-based information system designed to meet those needs, and its development.

The Virginia Community College System

The Virginia Community College System is a series of twenty-three state-funded, two year colleges. They were established to provide the opportunity for all people in the state of Virginia to enhance their skills and gain knowledge. The colleges are dispersed across the state to allow geographic accessibility and maintain a relatively low tuition to allow monetary accessibility to their programs. The colleges' programs place an emphasis upon occupational-technical, transfer and developmental curricula, continuing education, and community service. Additionally, each college is charged to serve the specific educational
needs within its service region. The colleges' programs are designed to offer up to an associate degree level for their graduates.

An Informational Need at New River Community College

New River Community College is one of the semi-autonomous colleges operating within the administrative hierarchy of the Virginia Community College System. The college has its own administration that is responsible for its operation. Five administrative areas report to the President of the college. These areas are Management Services, Academic and Student Services, Business Services, College Relations and Affirmative Action. The largest quantity and most varied administrative information of the college flows through the Admissions & Records Office of Management Services.

The Admissions & Records Office is the focal point for control of a student's entry and attendance at New River Community College. This office is responsible for the admission of students to the college, registration of students in classes, maintenance of academic records, and the recruiting of prospective students. These functions require the use and processing of large amounts of data and information concerning the individual students and the college.

During the admissions process, information concerning the individual student is collected. Included are student demographic data and information concerning the student's academic and military history. This information is used in the approval of the students application; communications with the student; approval of veterans, financial and
special aid; and compilation of student population statistics for administrative decision making.

The registration process requires information about both the college and the student. College information includes course and curricula offerings, class schedules, faculty and advisor information, and a variety of reference information. The individual student information used in registration is the student's desired class schedule, academic standing at the college and academic history. This information is used to place students in classes and for decisions concerning the final class offerings for a particular quarter and the use of college facilities.

Maintenance of academic records is concerned with the processing of the information that flows through the Admissions & Records Office. All of the student and college academic information must be accurately collected and kept up-to-date. As a student's situation changes, the information maintained about the student changes. For instance, if a student changes living quarters, the current address for the student must be entered into his record to allow mailed communication to reach him. All of the academic information for the college is maintained and retained for transcript, accountability and planning purposes.

Finally, the recruiting function of the Admissions & Records Office requires information that originates outside of the college. Office personnel require information concerning local area high schools, other colleges and universities, specialty schools whose students would be served by special college programs, and industries in need of specialized training courses. This information is used to allow
communication about the offerings of the college and to recruit students for attendance at the college.

The information used and maintained by the Admissions and Records (A & R) Office is vital to both the operation of the college and the future of the student. As a result, this information must be accurate and available in short period of time. In any given quarter, the A & R office will process information on up to 3000 students, 600 classes, and 90 faculty members. The total number of student records being maintained is approximately 25,000. The sheer quantity of records and information processing done by this office makes the use of paper records as the sole source virtually impossible. Over the years, computers have been increasingly used to support A & R's information processing needs.

The Student Information System

There are several applications for information systems in a community college. Information systems could be developed to support the student admissions process, class registration process, student graduation process, student accounts receivable, and grade reporting. Additionally, one comprehensive information system could be developed to support multiple processes. The recently developed VCCS Student Information System (SIS) is such a system.

SIS is a comprehensive information system that is being developed to address information needs at a college concerning student information. This includes student admission information, registration information, grade information, academic history, student accounting and student
special awards. A subset of the system is now being implemented across the VCCS. This subset consists of the portions relating to the informational needs and functions of the Admissions and Records Office.

The version of SIS being implemented in the VCCS is an interactive computer-based information system that supports five basic functions centered within the Admissions and Records Office. This initial version supports the processes of admissions, class scheduling, grade processing, registration and student data maintenance. The interactive (online) computer environment will provide the capability for immediate change of data and easy access of up-to-date information to support the activities involved in the five processes. 4

The online nature of SIS provides the ability to move the data management functions of student information from the data processing department to the Admissions and Records office. Prior to the implementation of computer based information systems, data was typically maintained on paper by the A & R office. The introduction of a batch-oriented computer-based information system (Student Information Package) forced the intervention of the data processing department into the data maintenance process due to the highly technical nature of computing. SIS, through its online capability, removes many of the technical difficulties of maintaining data via a computer system. This allows the Admissions and Records office to regain control over their data.

Control of data by the end user is only one feature of SIS. Another feature is the immediate access of up-to-date information in a variety of

forms. The user can access a detailed display of an individual's record or summaries of groups of records through a CRT in his work area. User maintenance of the data omits the delay of waiting for the data processing department to input the data and return printed reports. In other words, the user has immediate access to the most up-to-date information possible. Additionally, the processing speed of the computer allows the user immediate access to subsets and summarizations of information.

Several offices will be involved as users of SIS. The Admissions and Records office, as the primary end user, will be involved in the entering of data into SIS and in the coordination of communication among other offices in the college concerning student information. The Business Office will be involved to some extent due to their responsibilities as they relate to registration. The data processing office will be involved in a technical advisory role, and as a support group for offices if back logs of work appear during peak activity periods such as the first day of registration. The Financial Aid, Counseling, and Division Chairmen offices will have inquiry access to SIS information needed to support their functions. These other offices will be involved with SIS due to the need for SIS information in their areas of responsibility, but the Admissions and Records office will be the hub of activity.

SIS works with a myriad of college information. This information is organized and stored in nine data bases. The data base technology provides for fast and efficient storage and retrieval of the data. Figure 3 is an illustration of the SIS data bases.
Fig. 3. SIS Data Bases
Development of SIS

The development of SIS actually began around 1970. At this time, a consulting firm, McManis Associates, was hired to study the management information needs of the VCCS. This study resulted in a 1972 recommendation by the firm to develop a comprehensive Management Information System consisting of 24 subsystems. The study included a plan for central development of the system by VCCS personnel. It also contained recommendations concerning the personnel and hardware necessary to complete the project.

During this period, the VCCS data services staff produced a batch oriented student related information reporting system, the Student Information Package. This system was implemented across the VCCS by 1972. The system was housed on a computer at The College of William and Mary and the colleges accessed the system through remote job entry (RJE) terminals.

Over the years, the VCCS attempted to move toward the recommendations of the 1972 McManis report. A lack of funding and personnel retarded the development of the system greatly. Consultants were engaged to produce some of the recommended subsystems, only one of which was successfully implemented. In the meantime, several of the colleges purchased their own computers and began development of information systems to meet internal information needs and reporting requirements to the VCCS central offices.

In 1980, the then new Chancellor of the VCCS directed that a formal master plan for computing be drafted. This document outlined the goals of computing within the VCCS, the resources needed to achieve these
goals and strategies to achieve the goals. The document included a recommendation to meet the informational needs through a cooperative effort of the colleges and data services. Also, a recommendation was made to meet the student information reporting and management needs across the VCCS through the conversion of an existing system developed cooperatively by five of the colleges. This system is the Student Information System, SIS.

The development of SIS is a somewhat hybrid type of development. Original development of the system was a true cooperative effort by the five "Hewlett-Packard" (HP) colleges. Problem definition and design of the HP system was based somewhat on the VCCS SIP system with input from the various offices and departments within the five colleges. The new version of the system has been developed in a cooperative effort by the data processing staffs of seven of the twenty-three community colleges and the VCCS Data Services staff. The majority of the design for the system is based upon the already existing HP student information system. Most new design work for the system has been purely technical in nature and has not involved the end users to a great extent.

While the design of SIS is based specifically around the goals and functions of Virginia's community colleges, this style of development is more typical of vendor developed systems. The five colleges that originally designed the system accounted for more than 30% of the total enrollment of the VCCS. It was assumed that since this system effectively served these colleges, the system would in turn effectively serve the other colleges within the system. As a result, seventeen of
the colleges will essentially receive a pre-programmed package designed to meet their general needs. On the other hand, due to its development by community colleges within the VCCS, the system will address needs unique to the Virginia's community colleges.

Programming and testing of SIS was carried out by the seven community college staffs of the development team. The programs were written and initial program tests were run at the college assigned that portion of the system. Systems testing was then carried out at one of the colleges in a cooperative effort between the data processing staff of that college and its end-user (Admissions and Records) staff. This testing took place over a period of about four months. As a result, implementation of SIS at this first college was indistinct from the system test other than the date of cutover to total dependence upon the new system. Implementation at the remaining colleges is to be carried out in a more systematic approach.  

---

5 The author discusses this implementation process for the entire VCCS in detail in the unpublished document "VCCS SIS: Implementation Plan"
Chapter III

THE END-USER MANAGER'S ROLE IN SYSTEMS DEVELOPMENT

Introduction

The manager of an office or department that is intending to make use of a computer based information system can be involved in the development of that system in many ways. The number and nature of the activities that the manager may undertake will vary dependent upon the type of development for the system, but his overall role will be much the same. The role of the manager in in-house development undertaken by a large data processing shop is the most clear cut. This will be discussed and it will be left to the reader to apply the concepts addressed to other types of system development.

The primary end user manager is in a key position in the information system development process. He can have input into the process through the organization and through the development team. His involvement through the organization encompasses the provision of the necessary organizational commitments required for the project. Additionally, the manager has opportunity for involvement in each step of the basic systems development process. This chapter will outline this involvement and provide examples.

Commitment

There are three general categories of organizational commitment needed for a smooth and successful development of an information system.
These commitments are personnel resource commitments, non-human resource commitments and management commitments. The primary end user manager is ultimately responsible for the obtainment of these commitments and the management of the resources.

Personnel resource commitments refer to the commitment of existing personnel to the project and to the hiring of any additional personnel needed. Commitments of existing personnel include commitments of time and resources for training of personnel. Departmental personnel must be given the time to participate in the development process. Office and departmental staff are often the best informed as to the actual operations of their part of the organization. Their intimate knowledge of the everyday organizational processes can be very important as input in the definition of the problem, design of the system and testing of the system. They must also be given any training necessary for them to use the system. Implementation of an information system can shift responsibilities and change work behaviors. Existing personnel must also be given the necessary training to cope with a changed work environment.

In some cases, a highly complex and comprehensive system may require personnel changes. Information system implementation can potentially create new positions and make certain positions obsolete. Computer-based information system impact studies have reported downgrading of jobs, elimination of clerical jobs in some cases, and an increase of clerical jobs in other cases. The personnel impacts will vary from

organization to organization and system to system. In any case, management must be committed to making the required personnel changes.

For example, prior to the implementation of SIS at New River Community College, the data processing shop utilized two full-time and one part-time employee for production control and data entry purposes. The Admissions and Records Office utilized two full-time clerks and one part-time data entry operator. Implementation of SIS has caused a change to take place. The online nature of SIS has allowed the data maintenance function to shift back to the office responsible for the data, the A & R office. This has been a shift in responsibility which then has led to changes in work behavior. The DP shop now only employs one full-time production control technician and one part-time employee. Data entry in DP is now limited. On the other hand, the A & R office now employs three full-time employees and one part-time employee. Additionally, all of the A & R staff are involved in data entry to some extent. Management's decision was to retrain current employees and shift them between offices rather than fire and rehire.

Non-human resource commitments refers to the commitment of funds and facilities to the project. Any information system is going to require a certain amount of money for development. In the case of in-house development, this may simply mean the salaries of the data processing staff. On the other hand, contract development will require a fee to the contractor. Additionally, any computer hardware and programming tools needed for the project must be acquired. Placement of computer equipment can also require modification to current facilities. These
non-human resource commitments must be met in a timely fashion during the development process for the project to reach completion unhampered.

For example, operation of SIS requires a minimum of 4 CRTs, 2 printers and telecommunications equipment. At one of the colleges being implemented, a management decision was made to delay ordering of the telecommunications equipment. Due to the organizational processes, cutover to SIS can take place only within a fairly short window of time each academic quarter. As a result, college employees had only a two week training period as opposed to the normal six week training period. Shortly before cutover and for a period after cutover, special teams had to be sent to help the college employees.

Management commitment is the least concrete of the three categories of commitments. These commitments are more personal in nature and refer to top-level management commitments as well as the commitment of the primary end user manager. The entire management of an organization must be committed to the success of a systems development project. The importance of this commitment is directly proportional to the complexity and comprehensiveness of the system, its impact on the organization, and the amount of resources necessary to complete the project.

Top-level management commitment is the personal commitment of the higher level management of the organization to support the development and use of the information system. In many cases, the end user manager does not directly control the allocation of organizational resources over and above those budgeted to him for normal operations. Higher level management must be willing to support an information system development project through the end.
The primary end user manager must also be personally committed to the project. Due to the key controlling position of the manager in the development process, his commitment is extremely important. The organizational input into the process defines to a great extent the output. In other words, the computer specialists develop the system around the definition provided by the organization. The end user manager is in the position to control much of the organizational input. An uncommitted manager may hamper the organizational input and as a result negatively impact the project. On the other hand, the committed manager can insure the appropriate level of organizational input and promote the development of a quality system.

Commitment of the end-user manager to systems development extends beyond control of the organizational inputs to the process. If top-level management commitment is not pre-existing, it falls to the primary end user manager to acquire this commitment. The manager will need to provide higher level management with information concerning the need of a system, the resources needed to complete the project and the impact the system will have on the organization. Top management must then commit to the project before it begins.

For example, nine months into the SIS project, a high-ranking administrator in VCCS began a move to investigate a contracted information system. This move came at about the same time SIS was entering into final stages of systems testing. Implementation was to occur at the first college following completion of the systems test. This move against SIS eventually stopped, but had a definite negative impact on the whole project. Members of the development team felt that
a good defense against the contracted system was to implement SIS at a college as swiftly as possible. This was done by shortening the systems testing period. At eighteen months into the project, with two colleges on SIS and five colleges waiting in line, implementation had to be halted for a period in order to fix critical problems missed in the systems test.

Identifying the Need and Defining the Problem

Contrary to the pictures being painted by the artists of Madison Avenue, computers and computer power will not automatically improve an organization's performance. First, there must be a need for computing within the organization. The primary end-user manager is ultimately responsible for identifying that need and defining what the problem is. He may rely on expert advise in carrying out these responsibilities, but the ultimate decision is his.

If a problem arises in the operations of the organization, the manager must determine if a need for a computer solution exists. Identification of a need and the definition of the problem are highly related. A need may be perceived, but to truly identify if a need exists, the problem must have definition and must be analyzed. The manager must work through a cycle starting with perception and definition to analysis and redefinition.

Once an understanding of the problem is reached, a determination must be made as to the applicability of the problem to a computer solution. The problem must first be related to the processing of
information. Then, the problem must fall within at least one of the areas of strategic planning, management control, operational control or the processing of transactions. If the problem meets these criteria, then there may indeed be a computer solution.

Next, an assessment of the need for a computer solution must be made. A starting point for this assessment is an analysis of the impact of doing nothing. If this impact is great, research into non-computer solutions to the problem must be made. If non-computer solutions exist, an estimation of cost must be made. Next, a preliminary research of computer solutions can be made. An end-user manager can contact other similar organizations who have used computer solutions to informational problems and discover the costs and benefits. The costs and benefits of doing nothing, implementing a non-computer solution and implementing a computer solution can be compared.

If computer alternatives to the problem exist and appear to be attractive, computer specialists should then be contacted. The end user must at this point communicate as clearly as possible the nature of the problem. The specialists can then analyze the problem from a systems perspective, and aid in the final definition of the problem.

Research of the Computer Alternatives

Computer solutions to organizational informational problems can be quite varied. In most cases, many solutions for the same problem will exist. Decisions between the alternatives will depend upon the resources available for solution of the problem and how much of the problem is to be solved with the computer. Computers and information
systems are tools to be used by people. As with other tools, one can obtain computer tools that are either general purpose or highly problem specific. Also, the user can determine how much of the work is to be done through manual labor and how much is to be done with the tool.

Computer systems analysts can aid greatly in the research of the computer solution alternatives. These specialists can provide the manager with the information he needs. The analyst can describe the alternatives, their benefits, their weaknesses, their general impacts and the resources needed to provide the solution. Choosing a computer solution for a problem can in some ways be similar to purchasing a new automobile. If one is not well informed as to what the alternatives are and how they perform, a person can end up with a high priced lemon. The major role of the manager at this point is to become well informed in order to make appropriate decisions.

For example, during the drafting of the VCCS master plan for computing, an extensive research into the computer solution alternatives to informational needs of the community colleges was undertaken. This research included both hardware and software systems. This research was undertaken by a task force made up of data processing specialists and college business office staff. This task force then turned its findings over to the VCCS Data Processing Committee of College President's. Admissions & Records office managers at the colleges had very little direct input into the research and choice of alternatives. In fact, the first knowledge of SIS for A & R managers is at implementation. At each of the colleges implemented thus far, the A & R office
has requested special changes be made to the system prior to implementation.

Manager's Role in System Design

The design of an information system is based on the definition of the informational problem and the resources available to solve that problem. This problem definition and the resources for the solution originate from the organization and are the responsibility of the end-user manager. The design for the system is the responsibility of the computer specialists assigned to the project. In order to insure quality of the end-product, the end user must communicate the problem definition and resource information to the computer specialists. This communication must continue throughout the design phase. The role of the end-user manager in system design is to make sure that this communication takes place.

Working with the Computer Specialists

Computer specialists work in a complex and highly specialized field. As in any specialization, computing has a terminology of its own and, in most cases, it is not readily understood by people outside of the field. On the other hand, computer specialists designing a system to be used in another field may not be schooled in the terminology and processes of that other speciality. For the two sets of specialists to work together and produce a quality product, a high level of communication must exist. Part of the role of the systems analyst is to bridge the gap between the two sets of specialists. The systems analyst must understand the problem at hand and then translate that problem into a computer
solution. He must then translate that solution into an understandable form for the end-user.

The end-user must provide an understandable definition of the problem to the systems analyst. The person or person’s in direct contact with the systems analyst must fully understand the problem and the organizational processes involved. They must also be able to clearly communicate their needs to the analyst. Good communications from the outset of a project can greatly reduce the effort involved and as a result reduce the final cost of the project.

**Design Review and Redefinition**

Once the initial problem definition has been communicated to the systems analyst, the development team will begin the design work for the system. Specifications and a model for the system will be derived and projections for costs and scheduling will be estimated. The design for the system should then be presented to the end-user for review. This review allows the end-user to judge how well he has communicated his problem and to some extent how well the system will solve his problem.

In most cases, the first round of problem definition communication is not entirely adequate. During the design work, the development team will inevitably raise questions concerning the problem that need to be answered. Also, as the user works with the project, he has a chance to look at the problem at a very detailed level. This close inspection of the problem often leads the user to modification of the original problem definition. The end-user manager must make sure that this communications process takes place. This communication will allow the end-users and
the development team to agree on a design that is feasible and will adequately solve the problem.

The Manager's Role During Programming and Testing

Once a design for a system has been agreed upon, the development team can begin the programming phase of the project. The programs will be written and then tested as to how well they perform from a technical point of view and how well they support the functions of the organization. The functional testing of the system should involve the end-user. The end-user manager should insist that his unit be involved in this type of testing before implementation of the system in a production environment.

Functional tests uncover the strengths and weaknesses of the system. These tests are the first time that the computer solution is actually applied to the organizational problem. The end-user must make the ultimate decision as to the fit of the system to the problem and the organization. This testing phase is a major turning point in the systems development cycle. Weaknesses that appear in the system can indicate a need to return to a previous point in the development process. In the worst case, it can indicate a need to totally redefine the problem. In most cases, modifications to some of the programs may be necessary. Eventually, the end-user and the development team will agree upon a final version of the system for implementation.

The end-user manager's role during this process is not always an easy one. The implementation of an information system will require change in the organization. This new solution to a problem will require
personnel to change the way in which they have approached the problem in the past. Change in an organization can have both positive and negative impacts.\textsuperscript{7} During the functional testing of a system, the changes to the organization resulting from the implementation of the information system will start to become readily apparent. The end-user manager must insure that decisions concerning the information system are based upon analysis of the system and not a resistance to change. Granted, the change to the organization must enter into the analysis of the system, but resistance to change should not be the decision criteria.

For example, the first real opportunity for end-user input into the SIS development came during the systems testing phase. Evaluation of the organizational validity of SIS directly involved the DP, A & R, and Business offices of New River Community College. The processes involved in the flow of information were identified first. SIS was then applied to those processes. The system was installed in a test mode in the offices. SIS was then run in parallel with existing procedures for a period of six weeks. The information flow, the old procedures, and SIS were compared. As a result, certain changes to SIS were requested.

\textsuperscript{7} "Social and technological systems interlock. An apparently innocuous change in technology may emerge as a serious threat to an organization because it would force it to transform its theory and structure. Technological, theoretical and social systems exist as aspects of one another; change in one provokes change in others. And change in organizations has it impact on the person, because beliefs, values and the sense of self have their being in social systems." Donald A. Schon, \textit{Beyond the Stable State} (New York: W. W. Norton & Company, Inc., 1973), p. 12.
Implementation

Implementation is the process of putting an information system into use in a production environment. The actual beginning of use of the system is referred to as cutover to the system. Prior to cutover, the end-user manager must make sure that the system is production ready and installed, all required personnel are in place and adequately trained, and all necessary equipment is in place and functional. Additionally, following cutover, the manager must continue to evaluate the system.

Regardless of the level and quality of the testing of a system, mistakes in the system, called bugs, and inadequacies of the system may still exist. The final and most definitive test of any system is actual use. Following cutover, the end-user manager must maintain the communication link between his unit and the development team. All systems require maintenance over time. In part, maintenance is the correction of problems to the original programs as they appear. Also, most organizations operate in a fairly dynamic environment. Information systems that support the processes of organizations must also remain dynamic. Maintenance of a system also includes the process of keeping the system up-to-date. Enhancement of a system has certain limits. If an organization's informational needs and internal processes change radically, a new information system may be in order.

For example, implementation of SIS at each of the community colleges involves a process of over 22 steps. The process is being centrally coordinated through the VCCS systems offices with the aid of an implementation team. The steps in the implementation process require the involvement of college personnel, implementation team personnel and
systems office personnel. The same process is being used at each college. At Blue Ridge Community College, there has been a high level of involvement of the end-user manager. Each of the steps within the process have been completed on schedule and employees appear confident and ready to cutover. At the same time, Danville Community College has had a relatively low level involvement of the end-user manager. The process at DCC has been delayed several times and basic questions as to the use of the system at the college remain unanswered.
Chapter IV

ISSUES OF CONCERN IN A DEVELOPMENT PROJECT

The experience of working in a large information system development project can be quite enlightening. The development of SIS has been a massive undertaking. It has involved many people from across the Virginia Community College System ranging from the clerical staff at individual colleges to the Chancellor of the VCCS. This process which has involved so many types of people and so many organizations has provided lessons for all who are able to recognize them and willing to learn.

Many of the lessons deal with factors that are beyond the control or scope of the end user manager. This fact, however, does not diminish their importance to him. A manager who is preparing to become involved in such a project can use the lessons of SIS to aid him in his own endeavors. This final chapter is an attempt to describe these lessons as viewed by one participant of this process.

The Need for Definition in Management

The need for definition in management is a lesson in power, authority, responsibility and management structure. While somewhat narrow, power can be defined as the capacity or ability to exercise control. Authority is basically the legitimization of power, or in other words, the right to control. Following in the same lines, responsibility is accountability for power or the actions that are
controlled. Finally, a management structure is the assignment of power, authority and responsibility in order to achieve an end. These four interrelated management factors can greatly effect the outcome of a large development project.

The management structure of the SIS project is a traditional management hierarchy. In such a structure, ultimate power, authority and responsibility lie with the person at the apex of that structure. Portions of this power, authority and responsibility can then be delegated throughout the hierarchy as needed to accomplish the task. If the structure is clearly defined and appropriate persons are assigned to the various positions within the hierarchy, many decision-making and project problems can be avoided.

Lack of clear definition in management can have a deleterious effect on a development project. The lack of definition can lead to gaps in the management structure and an unclear assignment of power, authority and responsibility. In such a situation, informal power structures, power struggles, and the assignment of responsibility without authority can appear.

With an informal power structure, there are persons outside of the legitimate management structure with the ability to control project activities. Since this power structure is outside of the legitimate structure, it is basically operating on its own. It is power without the legitimization of authority and the accountability of responsibility. The control exercised by those persons in informal positions of power is not bound by the goals of the project.
Power struggles can appear in a poorly defined management structure. These power struggles can appear between centers of power in the legitimate management structure and between the legitimate and informal power structures. Since the assignment of power, authority and responsibility are not clearly defined, persons within the management structure can seek to increase their own power. This can lead to struggles over that power. Additionally, the informal power structure can appear as a threat to the persons in the legitimate management structure. A struggle can appear from the legitimate power structure attempting to regain the power and control lost to the informal structure.

Power struggles can be very detrimental to a development project. Much time and energy is expended in these struggles. This time and energy should be used in moving the project to a successful completion. A project of the magnitude of SIS can suffer greatly. If the struggles appear in the beginning of the project, the vital planning efforts will suffer. The objectives of the persons involved in the struggle are to gain power. The objective to move the project toward successful completion becomes secondary. This starts the entire project off in the wrong direction. In some cases, the damage caused in the early phases of a project are irreparable. If the struggles continue throughout the project, attempts to recover from early damage are greatly hindered.

Another phenomena that appears in a project with a poorly defined management structure is the assignment of responsibility without authority. In such a case, power and authority reside with one person. The responsibility for the activities lies with another. This relieves the former person from accountability for his actions and leaves the
latter person struggling to keep the project on track. Depending upon how high in the management hierarchy this occurs and the amount of power the responsible person is able to gain, a situation such as this can be very costly and detrimental to a project.

Clear definition of the management structure and roles of the persons holding management positions will aid in avoiding these pitfalls. This definition, in a hierarchical management structure, should include clear assignment of levels of authority and responsibility. Each node in the management structure will have a certain amount of inherent potential for power. The assignment to each of these positions will need to take into consideration the personal ability to tap that power. A clearly defined management structure can best make use of the talents of the project staff and help move the project toward successful completion.

Quality vs. Quantity

Quality vs. quantity is a lesson in realization of limitations, goal setting, testing and to some degree external pressures. Each organization has certain limitations upon its resources and, thus, the organization also has limitations upon what it can accomplish. Goals that are set by an organization should realize these limitations and be realistic in their scope. These goals should also realize the degree of quality desired as it relates to desired quantities. Tests or performance measures should also be designed to give a clear picture as to when the goal has been attained.
Computer-based information systems have something of a reputation for being able to provide everything the user ever wanted and more. These systems are the same as everything else in life, you get only what you can afford to pay for. If an organizational goal is to provide an information system for its personnel and/or clientele, that goal must be tailored to the resources available. A single simple program for an interactive information system can cost $2000 or more in development personnel salary alone. When multiplied out to a possible 150 to 200 programs within a system, this figure becomes staggering, not to mention the hardware and support personnel costs. The point here is that the information system goal for an organization should lie well within the bounds set by its resources.

Embarking upon a systems development project without realizing the full scope of resources necessary can have disastrous results. The majority of expenditure in development projects is up-front. Benefits and savings are generally long-term. As a systems development project continues it can reach the limits of the resources available for it prior to completion of the project. In such a case, the organization has few choices. One choice is to halt the project. Here, the organization has a considerable outlay with little or nothing to show for it. Most information systems must have a minimum number of programs working in order to provide any function at all. Typically, many of the programs within a system are so highly interrelated that they simply cannot work without the support of the others. In other words, most systems cannot provide any function to the user unless the entire system is completed. Another, alternative open to the organization is
to draw down on resources allocated to other endeavors in order to pay for these cost overruns in the systems development project. A final alternative is to greatly sacrifice the quality of the system. Cost savings can be realized by accepting a system that performs well below expected standards. In other words, you accept quantity instead of quality.

Testing and goal attainment measures for a systems development project should contain a quality factor. This quality factor should be an agreed upon standard prior to coding of the first program. Both the end user and designer should agree upon this standard. The standard does not necessarily have to be high, only agreed upon. This standard should also fit within the scope of the project as it relates to the resources available.

The development of a complex computer-based information system is a process which can be broken down into many intermediate steps. Additionally, a complex system will have many discrete parts that must be completed. Completion of the intermediate process steps and discrete system parts make attractive milestones for a development project. They provide easily identifiable points of completion. For example, a particular subsystem may contain 15 programs. When these programs are completed, one can easily say that the subsystem is completed. The danger here is to use quantity as a measure of completeness rather than quality.

The testing phases of a development project are extremely important to the end quality of the system and the avoidance of costly project
delays. Program and systems tests provide the only way to discover system shortcomings and problems prior to their implementation in a production environment. Just because a program runs, does not mean it is good. Programs have two basic types of errors that can occur. The first is syntax errors. Syntax in a programming language is very similar to syntax in any written language. It is the way in which the words of the language are put together. The other type of error is logic errors. Logic is the flow of the program and how each program activity is performed, and the order in which it is performed. A program must first have all the syntax errors corrected in order to run. Only blatant logic errors will cause a program not to run. The testing effort to correct all of the logic errors can be very time consuming and require much ingenuity. It is very easy to gloss over testing and continue to another phase within the development process once the syntax and blatant logic errors have been corrected. This is especially true where quality measures have not been designed for the project and where management is oriented only to achieving milestones.

Pressures external to the development project can also affect the quality of the end product. A very typical example of this is resource limitations occurring as a result of an overall limiting of organizational resources due to some external force. A classic example of this has occurred in the SIS development project. During the planning and design phases of the project, educational resources throughout the state of Virginia were reasonably available and appeared to be very sound for the next several years. After the development of the system had begun, the Federal Government decreased drastically its educational
aid to the states. Overall resources for Virginia education became very limited.

The limitation of educational resources in Virginia has had its effects on SIS. A great deal of money has been spent on the project, without a finished product being available. Repeatedly, high level educational administrators have seen this expenditure as an area for savings and attacked the project. This external pressure has created the circumstances for sacrifice of quality for quantity. Unfortunately, the end result of this pressure has yet to be seen. It may be several years before the true nature of the damage to the system is seen.

Implementation from the Start

There are several theories as to when implementation of an information system should begin. These theories range from implementation as installation of the final product to implementation as an integral part of the entire development project. The experience of SIS supports the theory of implementation as an integral part of the entire process. This is not the way in which the implementation for the project has been undertaken, so this support is somewhat negative in nature.

Responsibility for the implementation of SIS was given to a team completely separate from the development team. Additionally, the implementation process began after the completion of a final product. Implementation involves a high level of interaction between the user and the implementation team. During this process, the user is getting his first look at the final product and has his first chance for feedback.
concerning the system. There are two serious faults here. First, the feedback from the user is going to the implementation team. This team must then relay that feedback to the development team. Communications of this sort are rarely as good as direct communication. Also, the implementation team has no power or authority to force the development team to react to this feedback. The second fault with this feedback situation is that it is much too late. User input and feedback is needed throughout the process. Changes needed by users can in some cases indicate a need to change the design of the system and require massive rewrites of the system. Chances are, the feedback will be ignored.

Implementation from the start, integrated implementation, would solve these problems. The integration of the development and implementation teams would provide a direct communication between the user and those responsible for developing the system. Implementation of this sort could also allow continuous feedback throughout the entire process. Users could be involved in the intermediate subsystems tests and allowed to provide input at these points. The end result would be a user who is well educated about the system prior to installation and a system that more fully meets his needs.

The Failibility of Man:
Man vs. the Machine

The final lesson of SIS is the failibility of man. For a person involved in a systems development project, there can be no greater earthly humbling experience. It becomes more and more evident that computers do not make mistakes. They may break, but they never make
mistakes. Computer will do only what you tell them to do. Mistakes are made by man. That man may be the system designer, the programmer, the machine operator, the data entry operator or the user who is interpreting the results.

On the other hand, computers can control. Computers can control organizational processes. The use of a computer in an organization can control the work behavior of people. If the organizations processes are not being controlled properly, or the work behavior is detrimental to the people involved, the blame is not with the computer. It is with people. This is a perspective that is highly important to anyone using a computer. If problems arise, only frustration can result from blaming the computer. Resolution of the problem can only come through identifying the people responsible for the problem and having them rectify it.

Concluding Remarks

The manager of an office or department considering the use of a computerized information system has a definite role throughout the development of that system. Management fulfillment of that role can lead to a higher chance for success of the project. Through input into the development process, the end-user can help shape the tool to best fit his needs. By avoiding the potential pitfalls and obtaining the necessary commitments and resources, management can reduce the chance of cost overruns and delays in the project. Management can also prepare for a smooth transition to an environment using a new technology.

The goal of any systems development project is to produce an information system that will fulfill the needs of the user. This
information system must work within the human organization. The computer specialists who create the tool must first understand that human world of the organization. At the most basic level, a computer will do only what the programmer tells it to do. Without end-user input, decisions and judgements are left to the computer specialists. If the information system does not perform as it should, then there has probably been a human error somewhere.

Organizational processes are driven by the policies of that organization. When processes are automated they should reflect those same policies. The ultimate responsibility for communication of the policy and processes of the organization to the computer specialist lies with the manager. It is also his responsibility to make sure that the end product does in fact support those policies and processes.

Management's role in systems development must be one of commitment. Commitment is vital to the success of a systems development project. Lack of resources and commitment from top-management can ruin an information system before it is ever finished. Development of a highly complex information system may take a considerable amount of time and many thousands of dollars to complete. Payment for a development project is essentially up-front. You get to see the product after you have paid for it. Once you have embarked upon the development project, commitment and good management are the only guarantees you will have of a good product. This is one thing that makes vendor supplied systems attractive to some organizations.

Technological change can change organizations. A time of change is a
time of uncertainty. The end-user manager must discover what changes will take place as a result of a new information system and plan for those changes. The extent and direction of the change can be controlled somewhat by the manager through input in the development process. An end-user manager must be prepared to make the sometimes tough decisions concerning the futures of his staff brought about by change in the organization.

Computers and computerized tools appear to be the wave of the future. That future will depend upon the actions of the present. Managers must be aware of the role that they can play in shaping the tools of the future and the changes that they will bring. The future of any organization is best in the hands of the people responsible for the organization and not in the hands of a computer specialist trying guess what the organization should do.
BIBLIOGRAPHY


