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ABSTRACT

This document is one of five manuals designed to improve management practices in Ohio two-year colleges. The purposes of this manual are to document specific recommendations for desirable management practices in each of the areas of computer services and to make available criteria and guidelines that can be used to evaluate institutional performance. The first chapter is introductory and discusses computer utilization in instruction, institutional research, administration, and public service; it also discusses the purpose, scope, goals and objectives, functions, and management of computer services. Chapter II discusses the process of planning for computer services-- the factors affecting the process; the time span; the components to be considered; the use of computers in teaching computer languages and concepts, in problem solving, and in information processing; the needs of various kinds of users; cost effectiveness analyses; and the use of committees for planning. Remaining chapters concern the financial implications of computer services, the need to establish standards for computer use, organizational and staffing needs, and inter-institutional cooperation in sharing computer services. Discussions of techniques for forecasting and of hardware and software monitors, examples of existing computer networks, and a bibliography are appended. (DC)

COMPUTER SERVICES

Two Year Colleges

Management Improvement Program

Ohio Board of Regents

MIP

Prepared by a task force of two year college representatives with direction and staff assistance provided by the Ohio Board of Regents

July 1, 1973

Additional copies of the manual are available for $3.00 from the Ohio Board of Regents, 88 East Broad Street, Suite 700, Columbus, Ohio 43215.

Foreword

This manual is one of ten completed in the Management Improvement Program (MIP) during the 1971-73 biennium. In this project, Ohio's 34 public universities and colleges, in an effort directed and staffed by the Ohio Board of Regents, have developed manuals of management practices concerning institutional planning, program budgeting, personnel management, computer services, and schedule building and registration. The project is unique in at least two ways—the improvement of internal management processes is the objective of the program, and the method of undertaking it was mandated by the Ohio General Assembly to be participatory.

House Bill 475, the appropriation act passed by the 109th General Assembly in December, 1971, created the MIP, directing that it be conducted by and within the system of state-assisted universities and colleges under the direction of the Ohio Board of Regents. This legislative action culminated more than four years of active interest by the legislators in improving the management practices of these schools.

In 1967, a joint House-Senate committee, called the Education Review Committee, was created by the General Assembly. Included in its charge was that of monitoring the management practices of the public universities in Ohio. This committee, in conjunction with the Department of Finance, hired a management consulting firm to perform a management study of the nonacademic areas of the 12 public universities and of the state system as a whole. The report of the consultants, published in December, 1969, made about 100 specific recommendations for management improvement. The Education Review Committee remained interested in appropriate follow-up of the study. With the aid of another individual consultant, language was introduced in the General Assembly which was included in the appropriation for the biennium. Some excerpts of the actual language are as follows:

> "The purpose—shall be to design, test, and install, in each such institution, the most efficient feasible internal organization, planning process, financial management, budget preparation and management, auxiliary services management, space management and plant operation, purchasing procedures and inventory control procedures, student data systems including admission procedures and student registration procedures, management reporting systems, data processing, personnel management, and library management.
>
> Each project is to be conducted in cooperation with a committee of representatives from state-assisted colleges and universities.
>
> The director of each project is to be a staff specialist in the employ of the Board of Regents.
>
> For guidance in the conduct of each Management Improvement Project, the participants are to consult the findings as set forth in the 1969 Consultant's Report."

Primarily because the appropriation to carry out the program was not commensurate with the depth and breadth of the tasks spelled out in House Bill 475, the scope of the Management Improvement Program in this biennium

was restricted to five central areas (Institutional Planning, Program Budgeting, Computer Services, Schedule Building and Registration, and Personnel Management). In addition, the original mandate of H.B. 475 was "to design, test and install the most efficient, feasible procedures" in each of the areas in each of the institutions. Because of the limited time, only 18 months, and the participatory method of undertaking the project prescribed in the bill, the immediate objective set forth in the past biennium was the generation of a manual of best practices in each of the five areas.

As stipulated by the legislature, task forces of institutional representatives were appointed and actively participated in the process. Ten such groups were formed; five for the universities and five for the community and technical colleges. Each task force consisted of representatives qualified in the particular subject matter under study. Each group had at least one member from every school. In total, more than 175 college and university personnel from all over the state were directly involved, as well as many others at each institution through formal and informal contact with the appointed members. Each task force met 8-10 times in the year and a half devoted to the project.

As specified in the legislative bill, the Ohio Board of Regents provided direction and staff for the project. Four professional management analysts, two secretaries, and limited part-time analytical and clerical help constituted the manpower to fulfill that charge.

Three major phases constituted the project:

1. **Inventory the current practices.**
   This phase involved compiling the existing practices and procedures in the five areas at each state-assisted school in Ohio. Approximately five months were devoted to this task.
2. **Determine the issues to be addressed in the manuals.**
   Three months were devoted to discussions about the specific issues to be covered.
3. **Write manuals.**
   Nine months were devoted to writing the manuals. This phase included extensive and detailed discussions by the task forces, much drafting and redrafting by the staff and task force members, and finally concurrence with the manual contents.

The Manuals are practical, informative and useful. For the most part, all of the manuals contain general guidelines, principles and broad recommedations for good management within the universities and colleges, rather than detailed and specific procedures. They also include recommendations which call for direct action by the Board of Regents. Basically, the recommendations seek more effective internal management and accountability, while recognizing the autonomy of each school.

Literally hundreds of people have been involved in this project. All members of the Ohio Board of Regents staff, especially former Chancellor John Millett, and Vice Chancellor William Coulter, have made significant contributions to the entire project. The Regents were particularly fortunate in gathering together the staff for the MIP. Dr. Ronald Lykins, Mr. Lawrence J. O'Brien, Mr. Douglas Smith, and Dr. Joseph Tucker brought with them considerable experience and knowledge from administrative and academic aspects of colleges and universities, as well as from private industry.

Their perseverance and leadership in directing and staffing the task forces were superb. Special thanks must be given to Mrs. Betty Dials, the secretary for the program, who was an inspiration to all.

Many agencies in other states, including colleges, universities and state systems, were contacted and in some cases contributed helpful data to the program. Applicable professional organizations were also contacted and did help.

But more than any other, however, the contributions made by the individual task force members must be mentioned and expanded upon. The more than 175 personnel from the 34 colleges and universities who were the official representatives for their schools contributed long hours, data, ideas, constructive criticisms, changes, and encouragement. They not only worked collectively in the task forces, but also were required to spend considerable time on the respective campuses gathering data together and communicating with many campus constituencies to make sure that their schools were fairly and adequately represented.

The two-year college computer services task force members were:

Gerald Chaffee, Associate Professor of Data Processing
Sinclair Community College

Terry Begley, Records Coordinator
Hocking Technical College

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FOREWORD

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William B. Coulter, Vice Chancellor for Administration
Ohio Board of Regents (Chairman)

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Ohio Board of Regents (Task Force Director)

Without their sincere participation, this manual would not exist.

Gerald L. Shawhan, Director
Management Improvement Program

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Preface

The management of computer services to satisfy the increasing needs of Ohio's community and technical colleges becomes more critical as all of the schools expand their use of computers in the instructional and the administrative functions of the institutions. With this expansion comes the need to wisely and efficiently use the institutional resources to best satisfy the various computing needs of the users. Ohio's colleges recognize this need and are striving to improve the management of computer services on the campuses.

As one step in the process this manual has been developed with a number of purposes in mind. First; the overall aim in developing the manual has been to document specific recommendations for desirable management practices in each of the areas of computer services. Thus the intent was to make the manual useful for the various institutions in their quest to improve their own management practices. Another purpose has been to make available to the institutions some criteria and guidelines that can be used to measure their own performance. Finally, a purpose has been to provide a logical and organized discussion of the process of providing computer services to institutional planners, administrators and other interested parties.

This manual recognizes the different stages of development of computer services at the various colleges in Ohio. The needs of the various colleges in Ohio are representative of colleges nationwide. Although the manual was written for community and technical colleges within Ohio, the basic principles and recommendations contained herein should be of value to other public and private colleges and universities throughout the nation.

To achieve management improvement through implementation of the recommended practices in this manual will require a commitment of the institutions, the Ohio Board of Regents and the Ohio General Assembly. Most noteably in this will be the requirement for the colleges' presidents and senior level administrators to become genuinely involved in the decision making in the computer services area. They must make the decisions regarding the level of institutional resources devoted to computer services and in what manner these resources are most productively utilized.

The development of this Management Improvement Program Computer Services Manual has been accomplished through a spirit of cooperation among the colleges and the various Task Force members. Credit should be given to these Task Force representatives who devoted their time and energy in order that a good manual results. The Management Improvement Program within Ohio is a clear indication of the desires of Ohio's publicly-supported colleges to improve their internal management practices.

Lawrence J. O'Brien, Director
Computer Services Task Force

COMPUTER SERVICES

Two Year Colleges

1. INTRODUCTION

Computer Services in Higher Education

The role of the computer as the heart of the new technological revolution in higher education is considered by some to be the first great technological revolution in five centuries; as important as the introduction of the written word or the textbook. The impact the computer can have on higher education is almost without bounds. Although the computer can have that tremendous an impact on Higher Education the problems associated with the utilization of the computer are equally as large.

1. The process of providing computer services to all needs of higher education is quite costly. The expense can become excessive if care is not exercised.
2. The computer which represents a significant portion of the institutions' resources, is typically not well understood by the top level decision makers.
3. The capabilities of the computer are not being fully exploited on most campuses throughout the nation.

It is hoped that with the aid of this manual on computer services management practices the public two-year colleges in Ohio will be able to exploit more fully the computer on an even more effective basis.

Definition of Computer Service

Computer services is used in this manual to refer to the process by which the capabilities of computer systems and staffs are made available to assist people at the institutions (students, faculty, administration, public, other institutions) to accomplish their objectives. Computer services is, as its name implies, a service function. The assistance may be in the gathering, storing, preparing, processing, displaying or reporting of information in any of the four functional areas of the college:

Instruction

Instruction is the major reason that each campus requires access to the capabilities of a computer. In addition to training students in the profession of computer programming, many of Ohio's two-year colleges makes computer knowledge a part of most students' curriculum.

Research

At the two-year colleges, the level of research with and about the computer is small but increasing. Some faculty and students utilize the computer's

capabilities to assist them in experimenting within their field of specialization, while others employ computers in research on the instructional process.

Administration

As the two-year colleges expand, needs increase for utilizing the computer's ability to provide cost-effective approaches to those areas requiring repetitive activities (student registration and scheduling, payroll, inventory control, external reporting). In addition, the use of computer services for implementing practices internally is increasing in areas such as management planning and control systems, Planning, Programming, Budgeting Systems (PPBS), recommendations of the Planning Manual, etc.

Public Service

Many of Ohio's publicly supported two-year colleges provide equipment and staff capabilities in order to meet the computational needs of local educational institutions. These needs include high school grade reporting, test scoring and student scheduling. This service to off-campus users, which generally results in a savings to the taxpayers, is accomplished on an "as available" basis with the colleges highest priority of student instruction taking precedence. In order to meet the needs of these areas it is necessary to project future needs, plan courses of action, acquire and maintain reliable and efficient hardware and software, and support an organization composed of computer operators, programmers, analysts, designers and other auxiliary personnel. It is also necessary to evaluate service being provided and make appropriate corrections to improve effectiveness and efficiency.

Purpose of Computer Services

The purpose of computer services is to use the available resources (human, hardware and information) in the most efficient manner in order to assist the various users on the campus to attain their objectives. These objectives cover a wide spectrum. Examples range from assisting a faculty member to acquaint business students with the computer's capabilities, to assisting a registrar diminish waiting lines; from assisting a student or faculty member in solving a complex problem, to training a student in computer programming.

The budget of the Computer Service Center limits the level of human and hardware resources available. Within this constraint effective use of the human, hardware and information resources to perform a service can be measured in terms of:

1. How responsive the service is to the needs of all potential users.
2. How well the system performs in terms of:
   (a) Throughput — total amount of work performed over a given period
   (b) Response Time — time between submittal of data and receipt of results
   (c) Availability — degree to which service is ready when needed

Scope of Computer Services

Almost every student, academic department and administrative organization in the college is affected by computer services. Computers are used at least in some of the two-year colleges in Ohio for:

- Computer Programming Education
- Computer Theory and Application Education
- Computer-Assisted Instruction (CAI)
- Computer-Managed Instruction (CMI)
- Registration and Scheduling
- Admissions Procedures
- Inventory Control
- Management Reporting
- Public Service Support - High School Scheduling
- Public Service Support - High School Grade Reporting
- Statistical and Mathematical Research
- Business Modeling and Simulation
- Studies Related to the Improvement of the Instructional Process.

The computer services function must be responsive to all of these requests for service, and must simultaneously provide cost-effective service to each of its users.

Goals and Objectives of Computer Services

The goals and objectives of computer services must relate to the goals and objectives of both the college and the individual users. The former is necessary since computer services is an organization within the college. The latter is necessary since computer services is a service function. Specific goals and objectives of computer services will be addressed in Chapter II (Planning) but the following primary goals should guide any more detailed goal and objective setting.

1. Provide the computing resources necessary to support that proportion of instruction to be carried on through **informational technology.** This is estimated to be near 20% of the on-campus higher education instruction by the year 2000.*
2. Provide the means to acquaint **all** students, faculty and administrators with an understanding of the importance and pervasiveness of computers.
3. Provide information processing support to those administrative areas where increased effectiveness warrants the additional computer service expenditures.
4. Make the provisions for and implement a large scale data base concept that will assist management planning and control systems.
5. Provide information processing in the areas of research and public support in accord with the institutions' objectives in both of these areas.

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* **The Fourth Revolution-Instructional Technology in Higher Education.** Carnegie Commission on Higher Education. June 1972 McGraw Hill Book Company, Hightstown New Jersey

INTRODUCTION

Functions of Computer Services

The overall function of the computer service organization is, as its name implies, to provide a service to the institution. This service can logically be subdivided as follows:

1. System development activity which designs various information systems and generates the procedures (manual and computer-based) to implement them.
2. Operations activity which carries out the processing of data within completed information systems.
3. Consulting activity which involves making computer services users aware of the capabilities and limitations of computers, as well as providing specific assistance regarding systems, equipment, software and procedural issues.

Computer Services Management Process

To serve the computational needs of the entire college community, the computer services organization must accomplish the following series of actions:

1. Evaluate, in concert with the various users, the long-term and short-term computational needs of the college community.
2. Determine the strategy of computer services with respect to the above needs in accord with top management policy and institutional goals and objectives (i.e. which needs will be addressed; which needs will be deferred to a later date).
3. Develop a series of alternative activities to achieve the goals and objectives within the limits of available resources.
4. Evaluate alternate series of activities.
5. Implement selected activities for acquisition of equipment, software, space and personnel.
6. Measure and evaluate service in relation to both the current needs and possible alternative use of available resources.
7. Manage all computer resources including the systems development activity and the operations activity in the most cost-effective way possible.

Problems in Providing Computer Services

The problems associated with the delivery of computer services to all the varied users are not easily solved. These problems complicate the computer services management process.

1. The range of different types of users is quite large - probably larger than in business or government - each of these many users (approximately one quarter of a million within Ohio's public universities and colleges) exhibiting different needs results in a wide variety of services.
2. The costs of computers and the related hardward and software are relatively high, and computing expenditures have grown rapidly within Ohio's institutions. These expenditures must be justified on a cost-benefit basis. However, it is not always easy to justify this cost effectiveness for certain applications since the value of the output is often difficult to quantify. (Examples are on-line registration and computer-assisted instruction)
3. The computer which represents a significant portion of the institution's resources is typically not well understood by the top level

decision makers. Exaggerated claims by vendors that have not materialized have caused some decision makers to be wary. In addition, the dynamics of the field and the language of the profession make it much more difficult for upper management to exert an active, forging influence.

4. Capabilities of computer hardware and software have changed rapidly in the past and will continue to change. Hence, in an area as dynamic as this one, personnel must stay abreast with changing technology since old assumptions do not necessarily apply to new problems.
5. The capabilities of the computer are not being fully exploited on most campuses throughout the nation.
6. Computer services does differ from other service functions on the campus in that many of the future needs of the users must be suggested or identified by the Computer Service organization rather than requested by the user.
7. Computer Services can be adversely affected by lack of communications within the institutional organization. This is a significant problem in administrative data processing (ADP) in the area of consistency of data bases between organizations on campus.

Purposes of Manual

The purpose of the manual can be described as is usually the case from a number of different directions. First, however, the case can and should be made that there is need for such a manual. It has been generally agreed that computer services management needs improvement. That is not to be taken in a negative sense, since one can always improve, i.e. "you **can** argue with success." However, a number of problem areas (lack of long-range planning, lack of inter-institutional cooperation, lack of upper management familiarity with data processing capability) have been identified by previous studies (Warren King Report) and the validity of a number of them are generally accepted.

Primary Purpose

The **overall purpose** of this manual is to **document specific recommendations for desirable management practices in each of the areas of computer services.** The intent is to make the manual useful for the various institutions in their quest to improve their own management practices. These changes toward the practices described in the manual may come about at a time when institutions are already planning a change in their practice or procedure and thus the manual can provide direction. Changes toward the recommended practices may also come about after a self-comparison by an institution after being made aware of a recommended practice that has been used successfully in another institution. This situation will be true as regards assisting the less experienced institutions to study and possibly implement the methods of the more experienced and the better equipped schools. This is especially true in the dynamic areas of computer services where technological change and managerial innovations continually alter the demands for computer resources.

Secondary Purposes

Another purpose afforded by the manual is **the availability to the institutions of a yardstick that can be used to measure their own performance**. The guidelines or criteria presented in the various areas will enable the institutions to judge how well they are utilizing the resources available for computer services on their campus. An attempt has been made to provide quantative criteria wherever possible. Where this was not feasible, guidelines of a qualitative nature are included to assist the user.

A **third purpose** of the computer services manual can be described as **educational** in that an attempt was made **to provide a logical and organized discussion of the process of providing computer services**. This discussion should be of value to a broad spectrum of administrators and faculty on the campus as well as its intended audience; specifically those directly responsible for the planning for, or the providing of computer services.

Although not a stated purpose of the manual, a result of the participatory process followed in developing the manual will, by itself, help to improve computer services management in the various institutions. That is to say, the task force formed to work in conjunction with the Board of Regents staff has caused the various institutions to become more aware of what each is doing and to facilitate an exchange of information. This information exchange is a first step in the overall process of increased inter-institutional cooperation in the computer services area.

Summary of Purposes

In summary, the stated purposes of the manual can be categorized as follows:

1. To provide a means of sharing the effective computer services practices that have been developed at different institutions.
2. To provide practical and useful ideas which can be used to improve computer services practices at the individual institutions.
3. To provide some criteria and guidelines which can be utilized by individual institutions to evaluate their present processes.
4. To provide computer service planners and administrators, as well as other interested parties, a logical and organized discussion of the process of providing computer services.
5. To provide a means (or vehicle) for future dissemination of information in accord with the original purpose and content of the manual.

Disclaimers

In order to better understand the intended use of this manual, almost as much emphasis should be placed on stating what the manual does not purport to accomplish.

1. The manual does not state the one best practice for many of the areas, simply because it is impossible to define a best practice in those areas. In coming to a determination of best, there are typically different indices of performance that may be minimized or maximized (i.e., are we trying to minimize cost or maximize performance, or maximize service or minimize time, etc.). In addition, the resources available will also affect determination of best, in that the resource level can constrain the possible approaches.

Therefore, wherever a practice was considered best for the entire spectrum of institutions it was recommended. Otherwise, a number of recommended practices or guidelines are included.

2. The manual is not intended to be a rule book. It cannot be followed blindly, thus decreasing the number of decisions to be made by computer service management. No such luxury exists in the real world.
3. Uniformity for uniformity sake was not pushed. Where uniformity would result in an improvement in the effectiveness of computer services, it was recommended. However, the real and significant difference between institutions, in emphasis, organization, tradition, environment, etc. were recognized and taken into account.
4. Recommended practices and guidelines were generally agreed to by the participants, but that is no indication there was unanimously agreement on all issues.

2. Planning Process

Introduction

It should come as no revelation that dollars and time invested in computer services planning will be returned manyfold in effectiveness and economy of utilization. Any effective organization requires planning, especially long-range planning, if it is to be successful in utilizing its available resources. This requirement is magnified for a two-year college's computer services organization primarily because the needs of the various users and the technology are both so dynamic.

This chapter will discuss the general process of planning, and then proceed to concentrate on the process as applied to computer services. The steps and outputs of the process will be discussed together with appropriate definitions. Emphasis will be given to those facets of planning, such as determination of goals and objectives and comparison of alternatives, that are most critical. Long-range planning, covering a period of 3-5 years will be stressed in the chapter since the process will automatically result in a short-range (one year) operating plan thus saving considerable duplication of effort.

Overview of Process

General Planning Process

Planning is generally accepted as the first of the four functions of management. The others are organizing, implementing and controlling. Planning is the first, and forms the basis for the other functions. Planning can be considered the most critical and yet typically it is not given the needed attention since there is no immediate payoff. But as one author has summarized the prominence of planning, "If you can't plan it, you can't do it." This might be more aptly stated, "If you haven't planned it, you probably shouldn't do it."

Computer services long-range planning is particularly critical for a number of reasons:

- Rapidly changing character of the systems and computing field
- Changing nature of user needs
- Scarcity of resources (primarily capital and talent)
- Lead time required for development of complex systems
- Changing face of the computer services market place

The planning for the computer service function within a college is similar to the planning of any organization entity, yet it does involve unique factors that need to be addressed. The general planning process will be

described first, followed by those issues affecting computer services planning.

Steps in the Planning Process

The planning process is defined as a management process that attempts to predetermine a course of action. The process is both cyclic and iterative and calls for each organizational unit in an educational institutional unit to accomplish the following steps:

1. Establish **goals and objectives**
2. Determine **alternative programs** to achieve objectives
3. **Calculate resource requirements** for programs
4. **Determine priorities** of programs
5. **Allocate resources** to highest priority programs
6. **Evaluate** program progress

Definitions of Terms in the Process

Definitions of the key terms used above are summarized here:

Goals — the desired end result set for a program—generally set for a long period of time (i.e., 5-10 years). Goals and objectives are often used interchangeably but they differ in terms of time frame, sequence and measurability. Goals are long run and the end result; objectives are short-range and are steps in the direction of attaining a goal.

Objectives — the measurable attainments or desired results set for programs over a short period of time (i.e., one year). Objectives are generally thought of as progressive steps toward a goal. Thus, a series of objectives should lead to one's goal.

Objectives should be **written** and meet the following requirements:

1. It must relate to a goal
2. It must be measurable or observable
3. It must specify the method of measurement and criteria for evaluation
4. It must state the time period for achievement

Programs — a group of related activities used to achieve a goal or objective.

Alternatives — collection of different programs to accomplish the same objectives or goals.

Resources — personnel, space, operating support services and equipment which are converted into dollars and cents.

Priorities — establishing the relative importance of specific activities.

Allocating — subdivide, schedule and assign the available resources between different activities.

Evaluating — a systematic process for determining or estimating the effectiveness of a particular program or program component. Evaluation of programs is based upon a comparison of actual results with desired results or objectives.

Outputs of the Process

The planning process results in plans which are the output of the process. The plans should be documentation of the entire process. They should be formal written documents that state the goals and objectives,

the programs and activities considered, the assumptions made and the analysis used, the conclusions regarding programs to be pursued, the allocation of resources for these programs and activities, and the policies that are to govern the use and disposition of the resources. The plan must include milestone dates that can be used for control of the activities or programs. It is recommended that the interval between milestones in the plan be no greater than one month so that corrective action can be taken before activities progress too far in the wrong direction.

Computer Services Planning Process

As with any service organization the planning process must begin with an assessment of the users' needs. These needs together with the goals and objectives of the college can be used to establish the computer services goals and objectives. A number of issues affecting the goal setting are discussed in this section. The comparison of alternatives for computer services and the types of plans that result from the process are described.

Factors Affecting Computer Services Planning Within the Colleges

The procedures that are described in the remaining sections of this chapter, as well as elsewhere in this manual, are desirable practices for a computer services organization. However, a number of factors such as organizational size, stage of development of organization, and size of workload affect the amount of effort or degree to which the practices can be implemented. This is due to the level of resources available to different size computer services organizations. The spectrum of computer service organization being addressed in this manual is indeed great. In some of the smaller technical colleges there are only one or two people on the computer services staff. In other larger technical and community colleges there is a like number of staff for each of the functions of computer services (i.e. operations, programming, systems analysis, management, administration, etc.). This variation in size of computer service organizations is best illustrated in Exhibit 2.1* which shows four levels of organization and the associated staff positions. It should be obvious that college computer centers presently at level 1 cannot devote as much time and effort to the desirable planning practices in this chapter as could organizations that are presently at a higher level. However, all computer service organizations should attempt to follow the practices to a degree consistent with their present capabilities. In this manner all colleges will tend toward the desirable practices described, some to a lesser degree than others.

Time Span of Process

The planning process, as defined herein, is a cyclic process, phases of which should be constantly in progress within the computer services organizational unit. The planning process results in outputs called plans, that may be categorized as short-term or long-term with the degree of detail decreasing as the term is increased. If reasonable detail is required for the first year of the long-range plan, a one-year operating plan will automatically result, thus eliminating a significant duplication of effort. It is recommended that

* **Organizing the Data Processing Activity**, IBM Corporation, form C20-1622-0

computer services formalize a long-range plan (5 years) to assist institutional management and itself better utilize the resources available to them. The planning process should be formal, including requirements for written plans and specific organizational and procedural machinery for review, evaluation and approval. This long-range plan is necessary to assure that the objectives of the institution and the computer services organization objectives are being simultaneously satisfied.

Elements of Computer Services Planning

To make the planning process described above more useful to computer services planners and those studying the subject, additional details and emphasis are necessary. In addition to expanding upon the crucial steps in the process, the elements that should be addressed in a planning document should be examined. These elements include:

Users Needs:

- Statements of types of users needs
- Statement of users future needs

Goals & Objectives:

- Statements of goals and objectives of the college
- Statements of computer services goals and objectives

Present Performance:

- Assessment of current status and degree to which users needs are fulfilled
- Assessments of major strengths and weaknesses

Environment

- Forecasts of technological developments in hardware, software, personnel practices and management techniques

Classification of Computing Activities on Campus

The three types of computer usage which appear on many college campuses can be categorized functionally as follows:

1. **Teaching Languages and Computer Concepts**

This function is the best understood and most universal application of computing in postsecondary higher education. Ohio students are trained in a number of languages including COBOL, FORTRAN, BASIC, PL1, RPG and various assembly languages. The principle method of providing this service is via batch processing where student jobs are submitted and later picked up at a particular center. Interactive student programming, wherin a student uses a terminal to submit, correct and execute his program has been provided in some schools as a means of teaching languages. Because of the immediate response much less time is required to get a program operating. Interactive processing is attractive from an instructional standpoint but is more complex and more expensive to provide than batch processing. It is usually not cost effective to provide interactive processing unless many user terminals are being serviced (Exhibit 6.1 of Chapter VI illustrates that 200-300 terminals are typically required to achieve economy of scale on a large CPU).

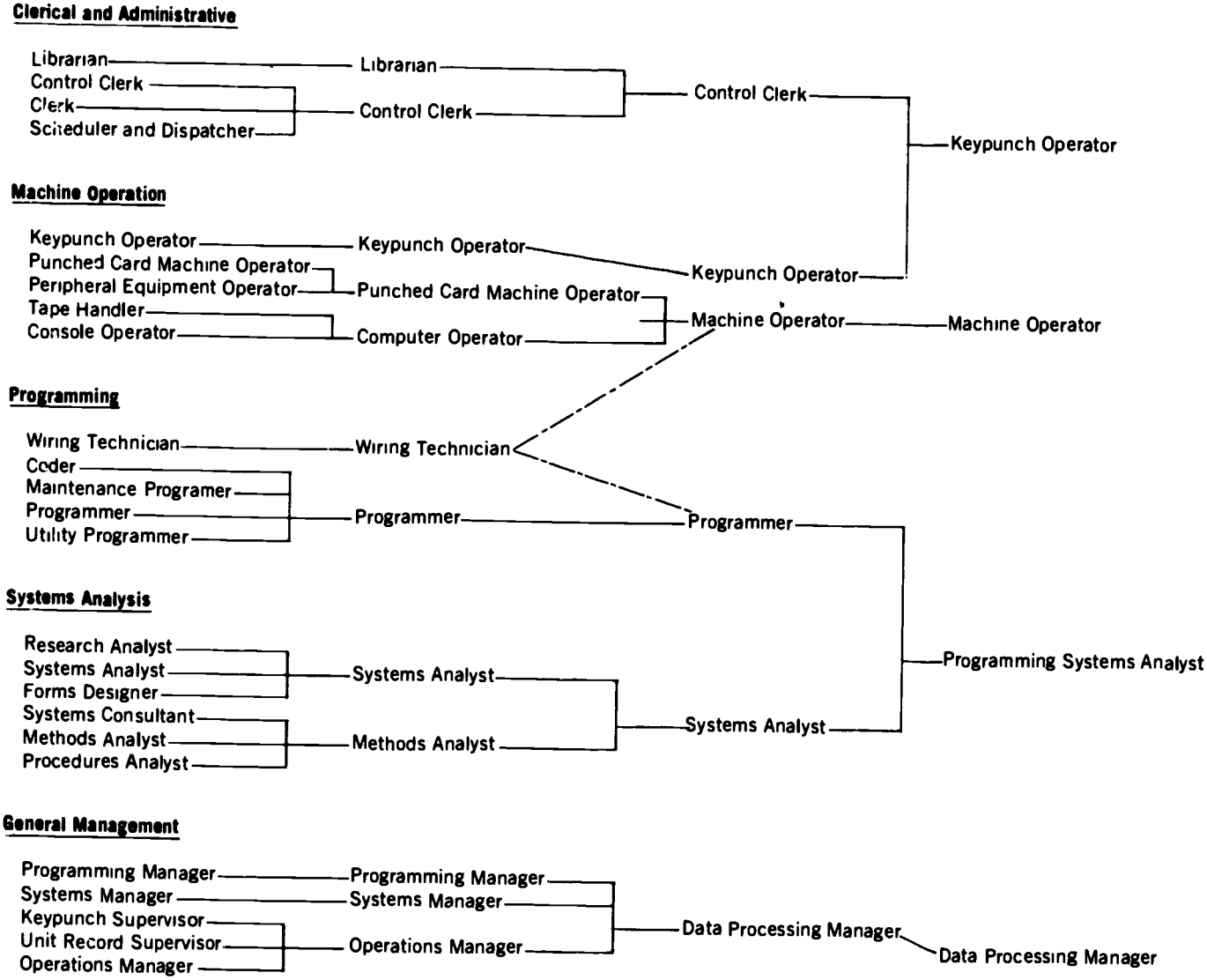


EXHIBIT 2.1 LEVELS OF COMPUTER SERVICES ORGANIZATIONS

2. **Problem Solving**

The use of computers in problem solving ranges in complexity from simply providing a compiler which a researcher on data processing can use to write programs designed to solve problems, to providing elaborate statistical and data manipulation packages for more extensive research. The simplest function, compiling and testing services, is very similar to the teaching function whereas more complex problem solving applications overlap somewhat with production processing discussed below. However, in the midground, there is some amount of activity supported in the development of complex programs and in providing "one-time" calculation services. There are considerable advantages in sharing information on the less frequently used languages and tools for problem solving as campuses develop expertise. For example, a person developing course material for CAI can be aided considerably by knowing more about what others are doing or have done in this "problem-solving" area.

3. **Production Processing**

A variety or computer services involve providing support to a production process. Examples include such things as payroll, student registration, student admission, the production of learning through CAI courses, and a variety of testing and major public service data collection and reduction applications. As previously mentioned, there is a grey area between problem solving and production, although in this area it is generally clear to the user whether he is "testing" a program (perhaps with voluminous data) or expecting a production run. The most important aspects of production processing are the generally rigid requirements from a timing and control standpoint.

Needs of Campus Computer Services Users

The computer services needs of the four user areas on the campus must be individually satisfied. If these needs are incorrectly serviced the potential use of the computer will be inhibited.

1. **Instructional Users**

The instructional users include: students running small programs to learn languages; students applying computer-assisted problem-solving techniques; students requiring some consultation and educational advice regarding hardware and software; faculty exposing students to computers and developing instructional material (CAI). The needs include both good elementary languages and good instructional languages and fast turnaround. Instructional users generally desire on-line capability for student terminal use including CAI and basic problem solving.

2. **Administrative Users**

The administrative user is generally most interested in the results of computing and not at all in the process. Although sometimes he may care enough about an application to become directly involved in its implementation, he will generally prefer that level of service providing the least and most indirect exposure to the computer. He has a significant need for techni-

cal support in both the problem definition and the systems design as well as programming. He requires additional service in the operational control of the integrity and timeliness of data bases. Generally, a single language is desirable.

3. **Research Users**

The research user should come to understand those kinds of questions the computer can best be used to answer, and the techniques that are easy and those that are difficult for a computer to apply. Many researchers begin at a level of service at which they are in direct contact with the computer, via their own batch job programming or via terminals. Many continue in this mode. However, as familiarity is gained, some researchers may become more like the administrator, desiring system and program design in order to obtain the effect they have specified. There is a need in research for many languages, diversity of hardware, numerous software libraries and high speed core. The number of research users, presently and projected, at the two-year colleges is quite low.

4. **Public Service Users**

The application areas are quite diverse and require many large application system programs. These may be developed on campus but are usually acquired as packages and tailored for use. There is a need for testing, analysis and data collection services. There is a need for a staff to provide packages tailored to specific non-technical users. The applications include high school student scheduling and grade reporting, board of election data processing and reporting, and municipal data processing.

Statement of Users Future Needs

Having discussed the computing needs on campus in general, it remains to discuss how the future needs of users can be established.

As with any organization providing service to a captive market, the satisfaction of users future needs can become self-fulfilling prophesies if care is not exercised. Thus, the users must be involved in establishing their future computing needs either independently or better still after consultation with computer services. The failure to involve users in defining their future needs results in excess resources in some areas and unfulfilled needs in others. The methods suggested for involving users in defining their future needs (formal meetings and user committees) are discussed below.

Institutional Goals and Objectives

Computer services goals must flow from the goals of the institution itself. Ideally, the institution should publish a statement of goals and objectives for the guidance of its management, staff and other interested parties. This requirement is being addressed in the accompanying Planning Manual of this Management Improvement Program. In the event that the goals and objectives are not documented, the computer services director must have verbal access to the chief executive officer (vice president or president) in order to obtain a verbal statement of institutional goals and objectives.

A number of specifics must be known in addition to access to the statement of goals and objectives:

- What are financial plans or problems of the college
- What are plans or problems in the areas of capital funds? (Affects lease-buy decisions, facilities expansion or modernization) pansion or modernization)
- What is the size and availability of operating budgets? (Affects the scheduling of programs, training and travel of staff)
- What are the plans for growth in areas requiring new computer services? (general enrollment growth, faculty research, new degree programs, planning, programming, budgeting system implementation).

Issues Affecting Goals and Objectives Formulation

In addition to establishing the institution goals and objectives the following issues must be addressed in establishing goals and objectives for computer services:

1. Assessment of current status and the degree to which present user needs are being satisfied.
2. Assessments of current strengths and weaknesses of computer services.
3. Prediction of impact of technological changes in hardware, software, management techniques and personnel policies via forecasts.

Each of these issues are addressed below.

Assessment of Current Status

A number of factors must be considered in determining the current status of computer services on campus. The major factors include:

- A complete inventory of equipment resources — type, location, age, accruals, educational allowance
- A complete inventory of software resources — application programs acquired, campus developed systems, vendor supplied software — purpose, availability, initial cost and recurring costs, last use and revision, responsible analyst and user, if appropriate
- A detailed statement of equipment utilization — CPU usage, disk usage, tape usage, printer usage, and terminal usage — hours scheduled, metered and actually available on a monthly basis — mix between instructional, research, public service and administrative usage — percentage of computing for production, checkout, compilation and testing
- A statement of last year's expenditures — operations, unit record, applications, systems analysis, administration, equipment (including depreciation if purchased), software, maintenance, miscellaneous
- A personnel inventory — names, levels, educations, skills, previous experience
- A list of significant accomplishments — is there a lack of same,

problems with users due to users lack of understanding or computer services deficiencies — where should corrective action be taken?

Strengths and Weaknesses

Based upon the assessment of current status, the strengths and weaknesses in a number of critical areas can be established. It is advantageous to quantify as objectively as possible the strengths and weaknesses of the organization.

- Facilities and Equipment — adequacy of space, expandability of space, adequacy of CPU, disks, terminals, printers, core, software, etc.
- Personnel — skills needs vs. skills available.
- Management—how well do subordinate managers plan and control? How well are personnel developed, motivated, and kept informed? Are projects adequately planned and monitored?

Forecasting Technological Changes

The developments of long-range plans requires the knowledge, or more precisely, the best estimate, of future technological changes. Upon investigation many of the so-called technological breakthroughs will be found to have much smaller impact that the marketing literature would lead one to believe.

- What are hardware projections? Will cost of equipment decrease or will only cost per computation decrease? How should these factors affect buying, leasing, renting? What is the outlook for third party acquisition and for continued vendor support for older models?
- What are effects of and trends in costs of core storage? Will decreasing core costs hasten interactive computing?
- What are economies to be realized from commercial time-sharing services or for services from other institutions? Will higher education regional computer center services become available for this college?
- What effects will remote job entry stations and mini-computers have on centralization vs. decentralization of computing facilities?

Many of these technological estimates can be made by members of the staff or faculty who have the appropriate expertise. Lacking this, the journals, conferences, discussions with vendors and suppliers and with other college and university computer services directors, are methods of obtaining estimates of the future.

Since the techniques of forecasting are critical in this phase and others, a discussion of the major methods of forecasting is included in Appendix 2.1.

Methods of Formulating Goals

Goals once set forth will guide all subsequent planning. Thus, their actual formulation involves decisions which only the top executives of computer services and the institution can make. The role of staff assistants is to find devices which aid these decisions. Executives will recognize that the information which must be merged into direction - giving statements

of goals can only be dealt with in a subjective way. Some of the methods available for this task include:

1. **Intuitive Judgment**

In this method, which requires little or no structuring of the task, the most experienced computer services executives become thoroughly familiar with the background data (needs of users, availability of technology) and then ask, "What does this information tell us?" A Computer Advisory Committee or Computer Council is an excellent vehicle for gathering the executives together. Despite its appearance of simplicity, this method brings to bear the greatest experience and best judgment available and it is the one most often used.

2. **Quantitative Rating and Ranking**

Another method of formulating goals is to assign some kind of comparative values to the individual factors that must be combined and reconciled. It should be recognized that this is not a mathematical exercise in the conventional precise sense.

Users of this method of formulating goals should be aware that it is difficult to assign meaningful values to the kind of information involved. Moreover, making judgments in this piecemeal fashion can lead to large cumulative errors. An experienced drector's intuitive grasp of the whole interplay of influences on goals may be closer to the truth.

3. **Creative Reasoning**

This is the most subjective method of synthesizing information into statements of goals. It calls for a differenct kind of intellectual activity from the methods mentioned above. It emphasizes creative thinking rather than judgment born of experience. Here the question is, "What are the possible new ways in which this factor or combination of factors can be made to work to best total advantage?" Computer service planners on the college campus have a potentially powerful resource available to assist in this method. Members of the faculty may, through participation on computer committees or individually, be a vital asset in this method and should be consulted. Many institutions have faculty members who have advised business firms on their computer services planning, etc., and these faculty should be brought into the institution computer services planning process.

A number of other techniques have been advanced to assist in the formulation of goals. One technique involves brain-storming sessions of appropriate computer services management, users and institutional administration. An inventory of possible goals results from the sessions. Mini-Delphi type techniques can be used to converge toward the most appropriate goals for computer services.

Another mechanism for goal determination based upon writings of Robert F. Mager is included in the companion Planning Manual of this Management Improvement Program.

Although goals of individual institutions will differ, there is a common thread that relates to the instructional, public service and research activities

of each institution. In addition, since the institutions must operate as efficiently as any viable business, efficient administration forms a component of the institution's goals.

Examples of Goals for Computer Services

The following list of statements are examples of goals of computer services within a two-year college.

1. To provide the computing services required for educating a sufficient number of persons about the computer to meet the societal needs for computer specialists, users and literates.
2. To satisfy the educational goals of all EDP career development students, and to furnish additional computer-related skills so that EDP graduates may be more competitive in their job seeking.
3. To improve the efficiency of using the computer in instruction **about** and **with** the computer.
4. To insure that access to the computer and associated instructional materials is possible wherever its use is cost-effective.
5. To improve the cost-effectiveness of instruction with the computer where such improvement will lead to a consequent improvement in the cost-effectiveness of higher education.
6. To provide the necessary hardware and software for the efficient utilization of computing by campus users employing the computer in their research.
7. To provide the administrative areas of the college those computer services necessary to implement modern practices of business administration including, for instance, maximizing the use of historical and current information.
8. To provide computing services to administrative areas where expanded use of the technology will allow more efficient operation.
9. To assist the management of the institution to make better decisions on the use of human and capital resources.

Expansion of a Typical Goal into Specific Objectives

The above goals must be expanded into specific objectives, that is, steps necessary to accomplish the goals, if they are to have utility. To illustrate the necessary detail, goal No. 2 above will be expanded into four sample objectives.

Goal (Example):
To satisfy the educational goals of all EDP career development students, and to furnish additional computer-related skills so that EDP graduates may be more competitive in their job seeking.

Specific Objectives (Samples):

1. Provide for instruction on medium-small disk oriented systems and data terminals for at least 80% of EDP students by Winter Quarter, 1975.
2. Provide interactive time-sharing terminals as a training component where each programming student writes at least one program in a time-sharing mode by Fall Quarter, 1975.

3. Include data file labeling conventions, data file retention and protection policies in the programmer curricula by Fall Quarter, 1974.
4. Provide for the exposure of EDP students to the latest operating systems of various vendors (Burroughs, Honeywell, IBM, NCR) via arrangements with nearby industries or school having such equipment. Have all second year EDP students by 1975 participating in the activity.
5. Acquire access to the necessary simulation programs that allow EDP students to be exposed to the operator-operating system interface of present day computers. Actual operation of each computer is not possible but the simulation programs should be obtained and made available to the faculty by Fall, 1975

Estimating Project Resource Requirements

Since the resources are not unlimited, there will be a constant trade-off between the dollars and talent available, the projects to be undertaken and the services to be provided. This is a significant component of the planning process since the institutional administration may be more interested in the financial implications than in the technical content of programs. Thus, emphasis shall be given here and the details of the trade-offs involved in various alternatives clearly spelled out and verbally explained, if possible. For example, "If expansion is required in this instructional project with no increase in resources, the following administrative services must be curtailed."

The resources component of the plan should be expressed in **dollars**, **staff** and **facilities** requirements and be broken out according to program. The resources requirements should be projected quarterly or yearly depending upon the projection interval and available information. These projections will be a valuable tool to the computer services director especially in spotting future problem areas. In the facilities section the requirements should include the why and when as well as the dollars involved.

Priority Assignments

The programs and the required resources should be ranked via assignment of priorities so that in the event of changes in the financial or personnel situation planning will not have to be repeated. As the plans are updated annually, the priorities must be altered as users needs change. For example, some users, when not provided service they requested, may have acquired alternate solutions that they now prefer.

Additionally, many times, knowledge of resources gives a good indication of how priorities must be ranked.

Comparison of Alternatives

After goals and objectives are established, alternative courses of action should be devised which offer promise of fulfilling them. Comparison of the alternatives is then necessary. After intensive evaluation, one or more of these is tentatively chosen as the strategy, i.e., the program to be pursued. Tests should then be applied to insure the choice is a wise one.

At the heart of this decision making should be the analysis technique known as cost-effectiveness or cost-benefit analysis.

Cost-Effectiveness Analysis

Cost-effectiveness analysis refers to a number of techniques for evaluating the effect of proposed changes in a system and on the expected costs of the system. The analysis measures the additional utility of a program change and compares it with the marginal cost of making the change, thus giving the planner a guide for choosing among alternate ways of achieving a particular objective.

Cost-effectiveness analysis is essentially the comparison of two or more alternatives with regard to their cost and effectiveness in performing some functions. There are actually five distinct criteria by which one of the alternatives could be judged superior in cost-effectiveness to the others.*

1. **Lower cost, equal effectiveness** — The superior alternative is less costly than the other, but equally effective.
2. **Equal cost, higher effectiveness** — The superior alternative is no more costly than the others, but is more effective.
3. **Higher cost, higher effectiveness** — The superior alternative is more costly, but it is also more effective. The increase in effectiveness is judged to be worth at least the increased cost.
4. **Lower cost, lower effectiveness** — The superior alternative is less costly, but it is also less effective. The cost saving is judged to at least compensate for the reduced effectiveness.
5. **Lower cost, higher effectiveness** — The superior alternative is less costly and also more effective than the others.

Which of these criteria is to be satisfied in a given analysis will depend on the objectives and constraints of the decision maker. If the budget is fixed, criterion 2 is appropriate. If it is important to save money, either criterion 1 or criterion 4 is appropriate; and if increased effectiveness is essential, criterion 2 or criterion 3 is appropriate.

The exhibit below illustrates a cost-effectiveness comparison.

Alternate	Cost*	Effectiveness*	Criterion from above by which alternate is more cost-effective
Current situation	10	10	-
Alternate A	9	10	1
Alternate B	10	15	2
Alternate C	15	20	3
Alternate D	5	9	4
Alternate E	5	15	5

* Cost and Effectiveness specified in some units

Exhibit 2.2 CRITERIA FOR COST-EFFECTIVENESS ANALYSIS

* **Framework for Decision**, R E Levien and S M Barro in **The Emerging Technology**, R. E. Levien, A Carnegie Commission and Rand Corporation Study, McGraw-Hill Book Company, 1972

The fifth criterion that seldom arises is illustrated in the exhibit. It is where costs could be reduced (i.e., 5) and effectiveness increased (i.e., 15).

Aside from the fifth criterion cited above, most two-year college computer service decisions should be justified via one of the first four criteria in Exhibit 2.2.

Possible Cost-Effectiveness Criteria

In an era of tight financing for higher education, resulting in reduced or "no increase" budgets for computer services, criterion 1 or criterion 2 will be applicable. Equal effectiveness for less dollars or slightly higher effectiveness for the same dollars are possibilities. If budget cuts are mandated, criterion 4 may be selected wherein the alternative that reduces effectiveness the least is superior. Where increased expenditures are possible from increased budgets or reallocations of funds criterion 3 should be used to determine the superior alternative.

Determining Cost and Effectiveness

In applying cost-effectiveness analysis care must be exercised in determining cost and effectiveness. Cost for computer use must include all applicable factors. Direct costs (hardware, software, staff, forms, supplies, communications, travel, etc.) as well as indirect costs (custodial services, space, management time, air conditioning, utilities, etc.) should be factored in. If a computer system is to be cost-saving, for example, in an administrative area, the outlay for the computer system must be more than offset by decreases in some or all of the other components that make up the institution's total budget. Cost determination, although requiring more effort than is currently in use, should not be a difficult task. This is addressed further in Chapter III.

Effectiveness determination, however, is not as easily accomplished. In the administrative areas, improvements in effectiveness can usually be determined quite readily. In addition to taking advantage of the computer's superlative clerical abilities to perform faster and more efficiently those tasks previously done manually, the computer should be utilized to gather and process cost data previously unavailable.

In the instructional area, effectiveness is difficult to ascertain because of the basic problem of specifying the output measures in higher education. In addition, the lack of output measures for conventional instructional techniques is exceeded by the lack of measures for the new instructional techniques that utilize computer services. **The task force recognizes the problem and suggests the following guideline regarding instructional effectiveness. Judgments regarding the relative effectiveness of computer instruction should involve the instructional personnel at the academic department level at the individual institutions.** A judgment that computer instruction is superior or equal to conventional instruction is a subjective judgment that should be made locally.

Regarding the cost in the instructional area, the task force recommends that the institutions devote more effort to establishing cost data on a course by course basis. This data will be needed much more in the future in making the decision regarding where on the campus computer-based instruction

should be implemented. Computer costs can usually be quickly estimated, although not always accurately, by those who claim computer-assisted instruction and the like are too costly. For a valid comparison, the costs of present teaching methods should be established before cost-effectiveness analysis can be utilized.

In many of the cost-effectiveness trade-offs involved — more interactive terminals vs. more remote job-entry stations—more core vs. faster CPU — the computer services organization must solicit the opinions of the various users. This is yet another instance that requires the planning process to be as participatory as possible and to reach as far down into the institutional structure as is practical. The users (students, faculty, researchers, administrators, outside users) must be involved in providing input to the trade-offs as well as in the entire planning process to the extent that their contributions are significant.

Timing-Users Plans and Computer Services Plans

From the standpoint of the computer services organization, computer services planning can best be accomplished after the preparation of plans by the user organizations. It is also advisable that user organizations work together to develop their computer services plans. These two techniques should allow maximum visibility for the planners, and result in the most efficient and effective strategies. Since this probably is not feasible at many institutions, a balance must be found between computer services planning independent of its users and planning after all users have finalized their plans. Thus, the computer services planning must be iterative wherein during the first stage best estimates of user needs are made based upon present use and projected use. During the second stage the plans will be altered based upon input from users.

Interaction with Users During Planning

Because the needs of the four computer services markets differ and because responsibility for the other organizations making up the markets falls outside computer services, planning must be a joint venture. There must be a useful dialogue between user and provider.

Formal Meetings

One approach is to schedule discussions between user organizations (Engineering Technology Department, Business Department. Registrar, Treasurer, etc.) and computer service management prior to and during the planning activity of the user organizations. Formal sessions between user groups and computer services at mutually agreeable times are more beneficial than simply having computer service personnel available for consultation at the pleasure of the user. The former requires an interaction while the latter only allows for it. Formal meetings force the user to contemplate his needs. To conserve time, each user organization should be contacted regarding the utility of a formal meeting. Benefits are derived since the computer service personnel are aware of the latest equipment and techniques available as well as related applications used elsewhere.

During these sessions computer services' role is merely advisory. The responsibility for the planning process remains within the user organization.

These sessions allow the user organization to obtain estimates of the technical feasibility and the associated costs of various strategies. In addition, the computer services personnnel have the opportunity to familiarize themselves with the users work and suggest alternate approaches that are presently available or are expected to be within the planning period. The user is thus brought abreast of the state-of-the-art in a manner most useful to him — specifically, how the advancing state-of-the-art affects his needs.

As a result of the discussions between users and computer services, the users (departments, offices, etc.) should develop a computer resource section of their plan much as they do the personnel component. This section should include estimates of capacity/time/cost requirements for software development and hardware.

User-driven Computer Services Planning Approach

To accomplish the above user-driven type of planning, the Task Force makes the following recommedations:

1. **Institutional managment require that all offices compose a five-year plan that includes a computer services component.**
2. **In addition, once each year all academic and adminstrative offices submit to computer services, a written plan in as much detail as is known, concerning their computing needs and plans for the following two years.**
3. **Computer services interprets the above plans, constructs an institution-wide computer services long-range plan, includes estimates of the resources necessary to achieve the stated objectives.**
4. **The budget development for computer services follows from the institution-wide computer services plan with the determination of priorities accomplished at a level above computer services management.**

Committees for Planning

Many institutions involve one or more committees or councils as another method of integrating user needs into computer services planning. Committees help to resolve conflicts between users needs, and ascertain the feasibility of servicing differing needs. A guideline to be followed suggests that committee members represent all segments of the campus. No user should lack a clear line of communication to his representative.

Another useful committee structure (Computer Advisory Committee) at the two-year college level involves representatives of business and industry from the areas where most of the colleges' graduates are employed after graduation. Representatives should include both technical and managerial personnel from firms that use computer equipment in their operations. These representatives can provide advice in equipment and software feasibility studies and selection proceedings, as well as recommend changes in curriculum to enhance the graduates' market potential.

Top administration should be represented on the committee to insure the needs of the users will be known when institutional budget decisions are being made and, possibly more importantly, that decisions reached by the committees will carry sufficient weight for implementation.

Content of User's Long Range Plan for Computer Services

Each long-range plan for computer services generated by user organizations should list the specific programs and a general description of the programs the user organization wants to implement over the time frame of the plan. The description should include:

- Process explanation
- Equipment necessary for implementation
- Data required and source
- Report formats, if known
- Program milestones
- Similar systems(s) in use at other institutions
- Summary of tasks to be performed

The plan document should be generated by the user organization after discussions regarding feasibility, duplication and cost are held with the computer services management.

Responsibility for Developing Computer Services Plan

The overall responsibility of the planning must lie with the computer services director. At each phase of the process, such as establishing goals and objectives, he should consult with his principal subordinates to gather their opinions. At each critical phase (establishing goals and objectives, for example) the director should also try to obtain the approval of the administration so that planning does not proceed too far on invalid assumptions.

Many of the responsibilities can be delegated to subordinates, for example:

- Assessment of current status
- Technological forecasts
- Detailed planning in support of goals and objectives

The subordinates should be encouraged to include participation of as many of the computer services staff as feasible in the various phases. This will increase motivation, educate the staff regarding future directions and their justification, and in some cases elicit options not previously considered. As mentioned a number of times above, the participation of the users is a necessity.

Responsibility for Review

The computer service director should include as the last step in the process, a detailed check to insure that the plan is consistent. Are the schedules such that they coincide with and complement each other? Do the programs insure that they support the goals and objectives of the computer services organization as well as the institutional goals and objectives?

Components of Plan

As mentioned above, the plan that results from the planning process should be a complete documentation of the process. As such, it should include;

- The goals and objectives considered and adopted
- The different activities and programs postulated and recommended
- The cost-effectiveness analysis employed and the assumptions used
- The recommended programs including budgets, schedules and milestones

- The criteria to be measured for progress verification

In addition, the plan should be structured to include a number of subplans or components of the plan.

- Hardware schedule — time phasing of hardware changes
- Software schedule — compilers, data base development
- Personnel development plan — training, conferences
- Financial plan — dollar and facility requirements
- Detailed project plans — applications development
- Short-range plan — one year operating plan

The one-year operating plan should contain sufficient detail to insure that additional short-range planning is not necessary. The one-year operating plan component should be updated each quarter without the need to update the long-range plan on more than a yearly basis. In addition, the milestones in the one year operating plans should occur at least monthly. This assures tight feedback control to eliminate an unstable situation due to efforts in the wrong direction.

3. Financial Implications of Computer Services

Overview

The financial implications of computer services are indeed important. The costs for computer services are growing faster than most other costs in higher education nationally. This fact taken alone can be, of course, misleading. It can be successfully argued that a large proportion of the computer services budget increases result in additional exposure and experiences for students that are truly necessary in today's society. This applies obviously to the student intent on a career in computer applications, but also to all other students whose lives and careers will most certainly be impacted by computers. Applications of the computer to the business problems and decision making on the campus can also justify a good portion of the budget increases. In summary more is being spent on computing on campus but much more is, or at least can be, accomplished because of computers.

This chapter addresses the issues of the amount of resources being expended for computer services. The topics of cost saving suggestions and rental purchase guidelines are included as well as a discussion of the determination, reporting and allocation of costs back to users.

Ratio of Equipment to Other Expenses

Financial Measures

Historically, 50 percent or more of the budgets of college computer centers has been devoted to equipment. As the unit cost of computation decreased with improvements of hardware, the software and programming costs increased because of more complex applications as well as higher compensation to people employed in data processing. The percentage of equipment expenditures decreased to about 40 to 45 percent for most colleges according to a recent estimate.* The technical and community colleges of Ohio reported expenditures for computer services totaling $2.4 million in 1971/1972. Of this amount $1.1 million was for equipment which represents 46 percent of the total.

PSAC Recommendation

A guideline that is frequently quoted regarding computer services finances was included in a recommendation by the President's Science Advisory Committee (PASC) in 1967. In that year the PSAC recommended that by 1972 the expenditures for **instructional** computing for undergraduates should be about $60 per year per student. The panel based this estimate

* **"Computers in Service"**, Charles Mosmann, Jossey-Bass Publishing Company, 1973.

at the time on the use of highly efficient regional computer centers with extensive time sharing, and included the costs of terminals, communications and all aspects of computing.

Data regarding instructional computing costs per student was not accessed as part of this study. Most of the colleges employ their computers in both the academic and the administrative areas and since most colleges do not have a cost determination system implemented, comparable records were not available.

The Task Force therefore recommends the two-year institutions form a committee charged with gathering financial data for computer services that can be used by the institutions for comparative purposes.

Determining/Reporting/ Allocating Computer Services Costs

The acquisition of a computer is not a one-time expense even when the computer has been purchased. Programming and operations staff, maintenance and supplies are recurring expenses. If the computer has been purchased, there is also a depreciation expense since the computer will be replaced in a number of years. Issues arise regarding how these expenses should be determined and reported, and if the college should financially support computer services as overhead or have individual users share in the expense in some proportion to their use. This section addresses these issues.

Effect of Computer Services Organizational Growth

Initially, when a computer services organization supports only a few departments and performs a limited number of tasks, cost determination, reporting or allocation is not a problem. In this case there may be excess time available on the computer and the staff of the organization may have the time available to support all user requests for service. This case presently exists in a number of Ohio's technical colleges where the computer is presently underutilized. As enrollments increase and as the use of the computer expands on these campuses, a new situation will develop. As the usage of the service expands and the organization takes on more duties, other college organizations begin competing for the service. In an economic sense the computing resource (equipment or personnel) becomes scarce.

Following the theory of economics, some method must be found to ration the scarce resource. The methods used to ration can be classified under the term price, where the price to be paid to obtain service does not include only money but also other items such as time or inconvenience. Rationing can be on a "first-come-first-served" basis, "all administrative data processing at night," "debugging before production runs", etc. When the computer resource has grown to a significant portion of the college's total resources and still remains scarce, the point is reached where it is advisable to have users share the cost of the resource in relation to their use (allocation of cost). Long before this point is reached, college management should be kept aware of the utilization of computer services, who the users are and what their use amounts to in dollars and cents (determination and reporting of cost). Exhibit 3.1 illustrates the three levels involved.

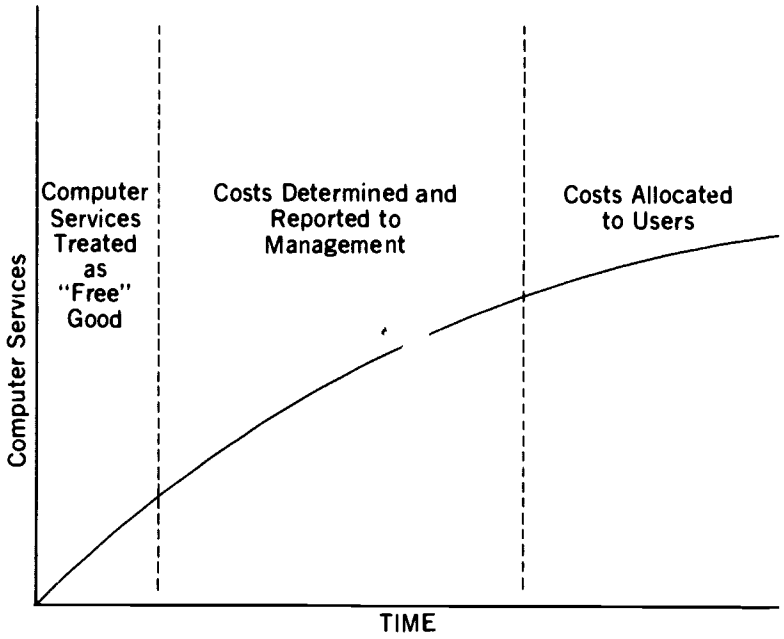


EXHIBIT 3.1 Growth of Computer Services

"Free" Good Approach

Most higher education computer centers initially treat computer services as a "free" good much as the library is treated as a "free" good. Proponents of this library analogy argue that, even as usage grows, the users should not have to be concerned with the cost of the services they use. This is, they argue, how it is the library. However, the library analogy does not hold true since the incremental cost of one library user is beneath the level of notice whereas one user of the computer can monopolize significant resources, at the expense and inconvenience of other users. If the growth of computer usage is to be in line with that which is necessary for educational purposes the user should have some reminders of the value and scarcity of the computer services resources available to him. These reminders minimize user attempts to monopolize as much of the equipment as possible, as well as encourage users to attempt alternate, less expensive methods of data processing that may be more cost-effective.

Additionally, in an era when tight financial situations require difficult decisions to be made on campus, cost information is a necessity. Costs must be known for each campus program as well as for the contributing factors to each program if valid decisions are to be made. As the Carnegie Commission has recommended, "When a college or university launches a move toward more effective use of its resources, no step is more important than a careful analysis of costs . . . there is little incentive to save on what are 'free' goods."

Pricing Policy

Once the costs of providing computer services are determined, a pricing policy must be established. Price is what users are charged for the service, while cost represents what the provision of the service consumes in college resources. The difference between price and cost is profit or surplus. It

may happen that in order to stimulate utilization of certain resources or services price will have to be set below cost (a negative surplus). In other situations a positive surplus may be desirable. Having touched upon the concepts of costs and prices, the remaining sections of this manual will treat them alike. That is, a zero surplus or profit situation in the college computer center will be assumed.

The critical factors in determining and reporting costs are that realistic and equitable pricing policies be employed and that reporting of utilization and costs be as current as possible.

Realistic pricing policies include:

1. Recover all costs (direct plus indirect) plus surplus if desired.
2. Provide user control over the cost of jobs (user selects resources to be used).

Equitable pricing policies include:

1. Provide reproducible charges (consistent charge for same job).
2. Provide different charges for different resources.
3. Provide for user selection of turnaround (charge for fast turnaround).

Reporting of utilization and associated costs must be as current as possible so that the users and those responsible for users can take appropriate action as needed.

Determination and Reporting Cost—Recommendations and Benefits

Most of the two-year college computer centers provide service to a number of different users (instructional, administrative, public service). The Task Force recommends that in these colleges users of the computer center be assigned user numbers and monthly utilization statistics and total (direct plus indirect) costs be provided to each major account.

The benefits of computer services cost determination and reporting are that both the users and management can make better decisions. Each is made aware of the amount of institutional resources that are being used to accomplish the task being attempted.

Costs—Direct and Indirect

The direct costs should include factors such as hardware rental, software rental, staff compensation, communications, travel, forms, supplies and depreciation, if applicable. The indirect costs should include space, environmental control, custodial services and other appropriate sources of overhead.

Methods for Determining Pricing Policies

A number of philosophies can govern how computer prices for various users are determined. As stated above, the guidelines should be policies that are realistic and equitable.

The simplest method is not to calculate a monetary charge but rather to determine the usage of the computer on some utilization basis (i.e., CPU hours). This is not sufficient since the units involved have to be transformed into dollars before cost-benefit decisions can be made by, for example, department heads.

Another approach is to divide total computer services expenditures by estimated hours of usage to obtain a working dollars per hour rate. (Since estimated use will be inaccurate, the rate, and therefore expense, to each cost center will have to be recalculated at the end of the accounting period.) This approach is simple to implement but it has two drawbacks. If the mix of jobs is such that some utilize I/O, disk, and tape resources significantly, while others utilize primarily CPU power, a fixed hourly rate may be discriminatory. In addition, if other than a batch job environment exists, a fixed hourly rate that charges time-sharing users the same as batch users is not equitable, since time sharing requires more expenditure of resources. These drawbacks may not create a problem in some colleges where there is little variation between the jobs' use of computer resources and where there is no time-sharing service available.

Pricing Algorithm with Priority Factor

An alternate approach to price determination that minimizes the above problems involves two aspects. First, an algorithm is developed that takes into account all the significant areas of expenditure. Secondly, a factor (sometimes called priority or category) is used to increase or decrease the price of service as a function of the responsiveness of service (i.e., immediate turnaround, overnight, time sharing, etc.) This is a multiplicand such as:

Standard Service	1.0
Overnight	0.5
Immediate	3.0
Time Sharing	2.0
Idle	0.1

The multiplicand is multiplied by the rate calculated from the algorithm resulting in a net rate for individual users.

An example of a price algorithm is included below. The algorithm is included as an illustration of what might be useful in a relatively large computer center. Smaller computer centers could employ the most appropriate components of the algorithm for their use.

$$\text{Price} = P_f \left[\text{CPU} + \left(\frac{\text{core}}{16\text{K}}\right)^{1.25} \times \frac{\text{minutes used}}{5} + \frac{\text{cards read}}{250} + \frac{\text{lines printed}}{500} + \frac{\text{cards punched}}{100} \right] \text{dollars}$$

Where

P_f	Priority Factor (as described above)
CPU	Central Processor Unit time in minutes
core	Core storage used
Minutes used	Time that core storage is in use in minutes

As an example, if a job used one minute of CPU time, used 16K of core for five minutes, read 250 cards and printed 500 lines, the price would be $4.00 for standard service and $2.00 for overnight service.

It is recommended that those colleges implementing a cost determination system include in the pricing algorithm a computing priority factor, taking into account the cost of various types of service as well as institutional objectives regarding expansion or contracting of various types of service.

The benefits of including a priority factor in the pricing system are that differentials that result can be used to distribute workload and hence achieve higher utilization of the hardware. Under a pricing system employing a priority factor, heavy users would increase their work at night and weekends in order to reduce their cost. This would result in better service and reduced costs to other users. Discussions regarding night and weekend work should not be misinterpreted. The Task Force is not recommending that night and weekend shifts be implemented but rather that if they are already available, the cost of service on off hours should be reduced in order to increase utilization.

Cost Allocation

When computer service costs are determined for each college user, the logical next question is, "Should costs be allocated to those departments utilitzing computer services?"

Advantages

The arguments for cost allocation are that the resources being utilized by way of computer services should appear on departmental and/or program budgets so that management can be aware of how effectively its resources are being utilized. Costs are a necessary ingredient for cost-effectiveness analyses and cost comparison studies. In all likelihood studies such as these will increase during periods of scarce resources.

In addition, with allocation of costs the user can decide for himself whether certain tasks are worth doing. The user also has a stake in improving the efficiency of service.

Disadvantages

The primary arguments against cost charge-back to departments is that it works against a policy that may exist on campus for growth in the utilization of computers. This is a valid argument and is appropriate for small schools which have not come of age in computing.

When users are experimenting to determine the capabilities of computing, it is difficult to allocate costs and expect users to be able to justify the costs of what they are doing. The financial controls to support the budgetary system may not be worth the effort if the computing resources are small. The computing capacity may also be more than adequate so that no controls are necessary for the present.

Each of these arguments both for and against charge-back may have some merit for some of Ohio's colleges.

It should be noted, however, that growth of computing can be provided for under a charge-back system. Departmental budgets for computing can be increased each year. To minimize the problem of users requiring service and having no funds, a portion of the computing budget can be held back at the vice-presidential level, for example. This would insure the necessary computing funds for those instructional or administrative departments that estimated incorrectly.

Cost Allocation—Recommendation and Benefits

As suggested in Exhibit 3.1, there is a time in the growth of the computer center where it becomes advantageous to install a cost allocation procedure.

The procedure would involve having each college cost center (department, program, etc.) budget for computer services for the next budget cycle. The budgets would be developed by the departments and/or programs after each department has consulted with the computer services organization. This development would occur during the planning process as described in Chapter II. As a consequence, the budget for the computer services organization would reflect the sum total of the individual departments or program budgets. The computer services budget would tend to become user-driven which is beneficial. The funds reflected in the department budgets for computer services would be restricted to computer services and could be further restricted to the college's own computer center. This latter approach would guarantee that funds for computing would go toward expanding the on-campus organization whereas not requiring the funds to be restricted might result in making the college computer center become more competitive.

It is difficult to define the point in the growth of a college computer center where cost allocation should be installed. The point may be a function of the size of the computer services budget, the budgeted dollars per student, the number of direct personnel involved or some other factors. **The Task Force feels that there are many institutional factors involved and therefore the decision is best made at the institutional level. The Task Force does recommend, however, that the colleges develop plans for gradually shifting to a practice of requiring budgets of departments and/or programs to include a charge for computer services.** This recommendation implies that computer services must be given the capabilities to provide the agreed upon services.

Cost Saving Suggestions

Much of the thrust of this and any management improvement manual should be to reduce costs wherever practical. In this section are listed a number of specific areas that could lead to additional cost savings:

1. Purchase credits on equipment
2. Use of students as part-time employees
3. Multi-vendor equipment acquisition
4. Lease or purchase of equipment from third party sources
5. Competitive bidding
6. Inter-institutional development of ADP packages
7. Use of off-campus facilities for specialized computing needs
8. Making staff talents and/or equipment available to non-profit, public concerns for a fee

Purchase Option Credits

Most manufacturers include a purchase option as part of their standard rental contracts. A percentage of the rental payments for a specified time interval is used as credit if the equipment is subsequently purchased. Typically, the equipment must have been under continuous rental by the customer. Within Ohio some vendors treat all the colleges and universities under authority of the Board of Regents as a single customer in applying

the purchase credits, even though the equipment may be transferred from one institution to another.

For example, one of the vendors present policy is to allow 50 percent of the first two years of rental payments (approximately 25 percent of list price) to apply toward eventual purchase (Purchase Credit policy). Because of the single customer account, one university or college may purchase equipment that had been previously rented by another institution with the maximum savings being near 25 percent. This has been done by a number of the universities in the past and recently by some of the two-year colleges. The practice is particularly attractive if the rental equipment has a large educational allowance (20, 30 or 40 percent) which had been provided in the past.

A variation that demonstrates the utility of the purchase credits in Ohio recently occurred between the University of Toledo and Michael J. Owens Technical College. Owens was in the market for two pieces of IBM input-output equipment that had an IBM combined list price near $75,000. The price from a third party for the IBM equipment was about $55,000. Toledo had been renting both units from IBM and the purchase price was $42,000, the purchase credits being fully accrued. An arrangement was made between Toledo, Owens, and the Board of Regents whereby:

1. The University of Toledo purchased the equipment from IBM.
2. The Board of Regents then approved Owens College' purchase of the equipment from Toledo for Toledo's cost plus an amount to cover Toledo's additional rental payments over the expected rental period.
3. The University of Toledo then rented the same type of units from IBM

The additional rental payments were due to the fact that the older units had a 20 percent educational allowance whereas the new unit had only 10 percent.

In this situation, approximately $13,000 was saved directly by Owens College and indirectly by the State.

Other variations of this application of vendor purchase credits combined with higher-than-present educational allowances are possible and it is recommended that they be considered by the colleges.

To facilitate this, **it is recommended that a system be established whereby information concerning potential release, acquisition or sale of equipment be collected and disseminated by a central agency.** If the activity is justified, a monthly notice could be sent to all institutions notifying them of the equipment from each manufacturer that is entering, leaving, or being transferred within the state. The Board of Regents staff is a potential central agency.

Use of Students as Part Time Employees

A number of students at the community and technical colleges should be both capable and desirous of part time-positions in I/O control, keypunching, operations, applications type programming or program modification. Attempts at some institutions within Ohio and nationwide have had favorable results.

The students benefit in that many prefer this type of work as opposed

to non-profession related part-time positions. The students can learn, earn and gain valuable job related experiences.

There are some problems associated with this approach. One is that a training program may be required for some positions and this is time consuming.

Multi-vendor Equipment Systems

It may be sound economically to explore the possibility of buying the various components of a computer system from more than a single vendor. There are a number of firms that offer, for example, peripheral devices that are compatible (so called plug-to-plug compatibility) with the major manufacturers CPU. The lease or purchase cost differentials for these disk drives, tape drives, add-on core storage, etc. are typically a significant cost savings area. The devices may also offer additional appeal from the capability standpoint. One of the trade-offs that must be made for the potential cost savings and/or performance improvements is the complexity of the decision-making in evaluating multi-vendor proposals on a component rather than a systems basis. Additionally, problems may arise on finding the faulty component when problems develop within the system. Different vendors may accuse each others equipment of causing the problem and the computer services director must exert pressure to have the equipment returned to the operable status. With these problems taken into consideration, many institutions have justified the approach on the improved cost savings achievable. With smart shopping the college can obtain competitive or better performing equipment at a lower price. The college must, of course, assure that adequate vendor support and service is available for their geographical area.

Third Party Sources for Computer Equipment

Computing equipment can, of course, be leased or purchased from companies other than the original equipment manufacturer. On a piece of new equipment from a major manufacturer the monthly rental payments may be based upon a pay off period of, for example, four years. A third party leasing company may purchase the equipment from the manufacturer and lease it to a college at a lower (10 to 15 percent) monthly rate. The leasing company uses a longer pay off period, with resulting lower monthly payments, under the assumption that the useful life exceeds four years. Support and maintenance are still available for the system from the manufacturer. Usually the third party firm will require the college to enter into a fixed-term lease to assure the firm's profit margin. In considering this approach a college must balance the cost savings against the assistance that a manufacturer provides to his clients in terms of specialized support services.

Used computer equipment is also available for purchase or lease from third party companies. Equipment at substantial savings can be found, but care must be exercised to insure the particular model or configuration quoted is, in fact, available when the contract is to be signed. The third party market is very volatile and bargains depend upon the marketplace as well as the schedules of present owners for releasing equipment.

Competitive Bidding

Talking to a single salesman simplifies the decision-making regarding new or additional equipment. It is also an expensive luxury that should not occur. There are, in almost all cases, multiple vendors who have equipment that can support the needs of the college.

The colleges should prepare a formal request for proposal (RFP) and send it to all interested and qualified firms. The responses should be evaluated and a decision made regarding which vendor or combination of vendors best satisfies the needs. In the event the college does not have the expertise and/or staff time to evaluate the proposals and participate in the negotiations a consultant can be hired for the effort. New institutions should make certain the computer services director is hired before hardware negotiations and acquisition have occurred.

The RFP should indicate the needs of the college and should address at least the following points:

1. **Hardware requirements**
2. **Software requirements**
3. **Benchmark programs that will be run**
4. **System support services**

The evaluation process, including the assumptions employed, should then be documented including all the significant conclusions.

Inter-Institutional Development of ADP Systems

A significant area of cost savings potentially exists within the design and development of Administrative Data Processing programs and systems. It is generally recognized that at many colleges the development and maintenance of ADP systems represents a good portion of the staff and computer time. Cooperative efforts in joint development are a potentially rewarding area. **In order to investigate the problems and benefits from inter-institutional cooperation in the ADP area the Task Force makes the following recommendation.**

ADP Systems Recommendation

A committee of two-year college personnel directly involved with college administrative data processing be organized. The committee be managed by a working group composed of interested members of the committee and chaired by a member of the staff of the Ohio Board of Regents. The committee will accomplish the following:

1. **Develop an inventory of presently used administrative data processing systems within the two-year colleges.**
2. **Share and publicize systems developed or acquired by one institution that would be appropriate for other institutions.**
3. **Seek to develop systems in common when the requirements can be made similar enough at various colleges.**
4. **Act as an advisory body to the OBR with regard to the Uniform Information System (UIS), modification thereto, and development or acquisition of similar information systems.**

Off-Campus Facilities for Specialized Needs

University Computer Centers, Regional Computer Centers, commercial service bureaus or time sharing firms provide service that, while it may be required or desired by users at the college, cannot be cost justified on campus. This might include interactive processing for student or faculty use, specialized libraries or application packages. The use of an off-campus facility having the necessary capabilities may be cost-effective if the alternative is to expand the on-campus hardware or software at substantial cost. Time sharing firms are in a very competitive business and careful shopping can oftentimes due to various circumstances, result in exceptionally reasonable service for short periods of time.

Use of Staff and/or Equipment by Off-Campus Users

Many of the colleges presently provide computing services to the local secondary educational facilities and/or other public organizations and receive some consideration in terms of additional external income. A guideline in this area is that the college not become dependent upon this external income since there is no way of guaranteeing that it will continue. Changing circumstances may force the college into a situation where considerable time must be spent marketing the services they provide. This use of college resources is difficult to justify in terms of the goals and objectives of the institution.

Providing computer services to a private firm is subject to the same problem and still another. Unless the service that the college is providing to the private firm is unique and not available elsewhere, the college may be challenged by a competing commercial firm. The argument can no longer be made that the taxpayers are benefitting in the same sense as when the college computer center assists secondary schools. There have been precedents across the nation where a university was prohibited from providing a service to a commercial firm that was in competition with another private firm. In most instances the case cannot be justified that the computer services being offered is unique and not available elsewhere in the community.

The Task Force recommends that:

1. **Colleges provide services to public community users to the degree consistent with the college's goals and objectives.**
2. **Colleges should exercise caution not to use the external income generated to acquire additional equipment, but rather should support outside users with the facilities necessary to support the college.**
3. **Colleges should not become involved in providing service to private firms unless the case can be justifiably documented that the service is unique and not available elsewhere.**

Rental/Purchase Guidelines

One of the most basic of all computer services management decisions regards whether equipment should be rented or purchased. A number of factors must be taken into account:

1. Time value of money
2. Maintenance and insurance costs
3. Resale value of equipment as a function of time

4. Useful life of equipment
5. Support of manufacturer

The following numerical example indicates the possible alternatives and the different conclusions that can be reached under different sets of assumptions.

Illustrative Rental/Purchase Example

Rental Cost for computer system

$5,000 per month for 24 months	$120,000

Purchase cost for computer system

Purchase cost	$225,000	
Maintenance ($600/month for 24 mos.)	14,400	
Resale Value (24 months hence)	(135,000)	
Net Purchase Cost		$104,400

A first impression is that purchase is the better option since it results in a savings of $15,600 over 24 months.

However, the conclusion is based upon comparing dissimilar expenditures since in the purchase example dollars are spent initially. Whereas, in the rental case dollars are expended over the twenty-four months. Because of the time value of money (a dollar being more valuable today than tomorrow since, for example, it can be invested) the dollars for rental and purchase cannot be compared unless they are referenced to the same point in time.

The technique to accomplish the comparison involves the present value of money. Present value is defined as:

$$PV = \left\{ \frac{1}{\left[1 + \frac{r}{100}\right]^n} \right\} D_n$$

Where D_n dollars that are to be spent n months from now

r present rate of interest—(% per month)

PV present value of the dollars to be spent

and

$$\left\{ \frac{1}{\left[1 + \frac{r}{100}\right]^n} \right\}$$ is called the discount factor.

The discount factor is less than one indicating the present value of money is less than what must be spent in the future. This can be illustrated in a situation where $100 is owed to an individual with payment due one year hence. If $95.24 is deposited today in a bank paying 5 percent interest, the $100 will be available one year from today.

By computing the present values of the cash flows over the twenty-four months for the rental and the purchase options (Exhibit 3.2) (assuming a 5 percent interest rate), it can be demonstrated that rental is now the option that saves more dollars ($2,528.00).

Rental Advantages

In addition to cost savings possible from renting, certain risks are avoided The contract may be cancelled on short notice if the equipment does not perform adequately or is not as cost effective as another available system. Rental also offers the flexibility to stay abreast of any significant changes that occur in the technology. Rental does not require the large outlay of cash that many times may not be available. Some users also feel that the support of rented equipment will be more complete than that provided purchased equipment. Evidence does not exist to support this assumption however.

Purchase Advantages

Purchase offers the advantage that if the equipment can satisfactorily meet the college needs for 6-10 years, purchase will result in cost savings.

A hybrid approach should be explored wherein the items with the longer useful life such as the CPU's are purchased while items exhibiting shorter useful lives such as peripherals are rented or leased. Such action should result in substantial cost savings and at the same time minimize the risk of obsolescence of the computer system.

Recommendations

Within the state of Ohio publicly supported colleges acquire computer equipment in basically two ways: equipment is leased or rented with the college's operating funds, or the equipment is purchased with capital funds made available from the state after approval by the Board of Regents, the Department of Finance and the Controlling Board. Many of the colleges could not sustain the equipment they presently have (obtained via purchase with capital funds) if they had to meet monthly rental payments out of operating budgets. In some instances it may be more beneficial from an economic or other standpoint that the equipment be rented or leased rather than purchased with state capital funds. **The Task Force recommends that the staff of the Board of Regents investigate the practicability and desirability of using state appropriated capital funds for renting and/or leasing computer systems, in addition to purchasing computer systems as is currently the practice.**

Rental Option

Month (N)	Cash Flow	Present Value of $1.00 at 5½% Rate	Present Value of Cash Flow
1	$ -5,000	.99585062	$ -4979.25
2	-5,000.	.99171846	-4958.59
3	-5,000.	.98760345	-4938.01
•	•	•	
•	•	•	
•	•	•	
23	-5,000.	.90879636	-4543.98
24	-5,000.	.90502542	-4525.12
		Rental Total	$ -113969.38

Purchase Option

Purchase Cash Flow		$ -225000.00
Maintenance Cash Flow ($600/month for 24 months)		- 13675.68
Resale Value of 135,000 (24 months hence)		
135,000 x .90502540		(122178.37)
	Purchase Total	$ -116497.31
	Rental Savings	$2527.93

EXHIBIT 3.2 CASH FLOWS FOR RENTAL/PURCHASE EXAMPLE

4. Internal Procedures

Standards

Standards in a computer services installation are the procedures and rules under which analysts, programmers, operators and users work. The standards establish procedures to follow to obtain the best results. The term standard denotes a discipline which provides both guidelines and yardsticks. As a guideline, standards are used to establish uniform practices and common techniques, while as a yardstick, standards are used to measure the performance of the computer services functions. It is neither necessary nor desirable that all two-year college computer services organizations adopt and conform to the same standards. However, it is beneficial and necessary that each institution establish a set of standards for the use of the staff and users.

Reasons for Standards

Establishing a set of computer services standards is necessary for the following reasons:

- Since computer services is an integral part of the institution, both the administration and the users are entitled to a high level of quality services that adherence to minimal but precise standards encourages.
- Since the area of computer services is so dynamic, the changes that occur often will be simplified if systems are designed and programs are written according to standard methods.
- New staff members will be able to contribute effectively faster if a set of standards exists and is available for introducing personnel to the standard procedures.
- The staff will find a convenient reference to checklists and agreed procedures useful in their work.

Basis for Standards and Techniques for Change

There should be a reason for each of the procedures described within the standards manual. The standards will be useless unless they are adhered to. To increase adherence it should be stressed that the best standard is one that is more easily complied with than avoided.

It is impossible to produce a standards manual or sections of a manual, instruct the staff to read the manual, and then expect immediate compliance. A training session for those who will be affected will be needed for each major set of standards introduced.

Each standard should be subject to review and improvement at any time to insure that it is up to date, realistic and useful. It is essential to establish some way for personnel at all levels to contribute to the standards manual. It should be stressed that each member of the staff has an obligation to recommend changes in writing to his supervisor. Each recommendation should be taken under consideration and the originator should receive a reply stating what has happened to his recommendation.

The standards manual should be a living document. Methods must be provided to allow revisions to existing standards, define the needs for new standards and eliminate efforts which have produced no valuable results. Regularly scheduled reviews of material help to keep the standards manual up to date.

Standards Manual Recommendation

The standards manual is the medium through which the installations standards are documented and carried to all staff members. The standards manual serves as a reference book, therefore a consistent structure and an excellent index should be provided.

Each college computer services organization should have a standards manual that is updated periodically with copies available to appropriate staff members, users, students, faculty and administrators. Exhibit 4.1 below is an illustrative example of the breakdown by sections of a standards manual for a college computer services organization. This model for a standards manual includes many sections that may not presently be appropriate for many of Ohio's two-year colleges, because of size of staff and scope of operations. As an organization grows, the sections and subsections listed in Exhibit 4.1 should be reviewed to determine which are appropriate for their circumstances.

Benefits

The benefits of a "living" standards manual for the organization is to insure continuity and consistency of its functions over time, as well as to increase the level of quality service to the students, faculty, administrative and other users. Additional benefits in reductions in costs will result, since the costs of training new personnel will decrease. Other benefits include: reduced dependence on individuals by incorporation of uniform methods and practices; reduction of future costs due to program changes or conversions.

EXHIBIT 4.1

Sections of a Standards Manual (Illustrative Example)

Section	01.	Introduction
	01.01	Contents
	01.02	Standards Policy
	01.03	Manual Revision
	01.04	Glossary of Terms
Section	02.	Management
	02.01	Mission

02.02 Organization
02.03 Training Policies
02.04 Project Initiation and Implementation
02.05 Project Control
02.06 Project Activity and Progress Report
02.07 Processing Administrative Applications
02.08 Processing Academic Applications
02.09 Personnel Attendance Reporting Procedures
02.10 Project Scheduling
02.11 Use of Facilities
02.12 User Relations
02.13 User Accounts
02.14 Functional Organization
02.15 Administrative Applications Personnel
02.16 Academic Applications Personnel
02.17 Operations Personnel
02.18 Operating Systems Software Personnel
02.19 Technical Support Personnel

Section 03. Hardware
03.01 Computer Configuration
03.02 Unit Record Equipment
03.03 Character Sets

Section 04. Systems Analysis
04.01 Methods
04.02 System Development Procedures
04.03 Proposal Preparation
04.04 Preparation of Program Specifications
04.05 Controls and Security
04.06 File Description
04.07 Process Chart Identification
04.08 System Documentation and Conventions
04.09 System Test
04.10 System Acceptance
04.11 User Documentation and Education
04.12 Revision of Production Systems
04.13 Optical Scanning Forms Design and Documentation
04.14 File Identification
04.15 Data Base Security

Section 05. Programming Standards
05.01 General Programming Guidelines
05.02 COBOL Standards and Techniques
05.03 ASSEMBLY Standards and Techniques
05.04 FORTRAN Standards and Techniques
05.05 JOB CONTROL
05.06 Forms and Forms Design
05.07 Disk Allocation
05.08 Program Library
05.09 Message Standards

Section 12. Confidentiality Standards
- 12.01 General Policy
- 12.02 Software
- 12.03 Data

Section 13. Use and Charges
- 13.01 Equipment Utilization and Charge Policy
- 13.02 Procedures for Time Recording
- 13.03 Refunds and Reruns

Section 14. Documentation
- 14.01 Documentation Philosophy
- 14.02 Forms Index
- 14.03 Sample Documentation

Section 15. Glossary

Section 16. Exhibits

Documentation

One of the important areas of standards involves program documentation. The standards for program documentation define the level to which the programmer should support his efforts in writing. Since the main objective in generating a program is typically to have it operate properly, documentation of the program may be given little attention. However, documentation should be a vital part of the computer services organization and its importance and necessity should be stressed. Documentation has historically been associated with ADP but consistent documentation standards are also desirable in the instructional area (i.e., computer-based instruction and computer-assisted instruction).

Reasons for Documentation

There are a number of reasons for having documentation standards and requiring adherence to them:

1. Documentation allows the installation to become less dependent upon its individual staff members who have designed systems and/or written programs. The absence of documentation tends to make personnel indispensable.
2. Documentation is a tremendous asset in any of the following common occurences in a computer services organization:
   a. in completing a system or program in the development cycle
   b. in changing currently operational programs
   c. in program conversions necessitated by the use of a new machine or model of computer
3. Documentation provides the user and the computer services organization management with a clearer picture of the program, its capabilities and its limitations.
4. Documentation should increase the efficiency of the staff by having the programming and machine utilization on a better organized and disciplined basis.

Users of Documentation

The number of users of documentation include the following.

1. Programmers — programmers who did not participate in the original effort need good documentation if they are either required to make future changes or if they are to benefit from the techniques employed in previous efforts.
2. Operators — part of the documentation should include clear and meaningful operating instructions as well as instructions regarding procedures in the event of errors.
3. Internal users — documentation can acquaint new users with the capabilities of the program as well as being used as the basis for acceptance by the users.
4. Management — documentation serves the needs of management in the areas of general information as well as for purposes of review.
5. Outside users — as sharing among colleges and universities increases good documentation is a must. Standarized documentation may be desirable, however, adequate documentation is a necessity.

Levels of Documentation

There should be a number of levels of documentation depending upon the frequency of use of the program and the knowledge of the user. Level one may be appropriate for one-shot programs that will remain within the college and be used by only a few users. The documentation should include a program abstract and operator instructions.

Level two is for all other applications that are designed for use by a single department within the college and not for external distribution. The documentation should include, in addition to level one documentation, input and output formats, formal run sheets, fully documented source decks and a systems documentation folder.

Level three documentation standards are applicable to programs which are expected to be used by a number of people both within and especially outside the college. As an example of a possible documentation standard exhibit 4.2 contains a variation of the documentation standards from the College and University Systems Exchange (CAUSE). **Since many of the colleges presently do not have adequate documentation standards and since adequate documentation is an inhibiting factor in exchange of application programs between colleges, the Task Force recommends that this CAUSE System Abstract be adopted as a minimum model for documentation procedures.** As colleges expand and/or change their documentation standards this model will become the goal for internally generated programs or specified to be used by software firms that are employed by any of the colleges.

Computer Services Role In Confidentiality

Confidentiality of Information

The problems associated with maintaining the confidentiality of particular information on campus existed before the widespread use of the computer began. The use of terminals, concurrent execution of multiple programs within computers, use of data for research, and other factors, both related and unrelated to computing, have caused these problems to increase.

EXHIBIT 4.2

College And University Systems Exchange

SYSTEM ABSTRACT

INSTITUTION : _____
OFFICE NAME: _____
ADDRESS : _____
CITY-STATE : _____ ZIP _____
CONTACT : _____
TELEPHONE : ____-____-_____

ORIGINATOR/DEVELOPER : _____
SYSTEM NAME : Descriptive name, no acronyms
NUMBER OF PROGRAMS : COBOL: FORTRAN: OTHER:
HARDWARE USED : Manufacturer, Model, Core Size, Periphals, etc.
OPERATING SYSTEM : Title, Number, Version, Level, Release, etc.

SUMMARY OF SYSTEM FUNCTIONS: Brief description of the system.

MAJOR POLICY CONSIDERATIONS: Academic, administrative and/or data processing policy implications.

EXCEPTIONS AND LIMITATIONS: Important aspects outside the capability of the system, hardware limitations, maximum file sizes, etc.

MAJOR FILES MAINTAINED:
(1) File name, description (including record size and file size)
(2)
(3)
(4)

MAJOR REPORTS PRODUCED:
(1) Report name, description (including distribution and use)
(2)
(3)
(4)

FIRST PRODUCTION DATE: _____

COMPUTER RUN TIMES: Times and transaction volumes—not costs, since charging rates differ greatly.

Successful Procedures

The following computer services practices and procedures have been used successfully at various campuses for maximizing the confidentiality of sensitive information.

1. Have the user present to the computer center written approval from authorized personnel when confidential data is to be accessed. User office thus defines what data are confidential and computer center regulates its access. Assignment of a data base guardian for each data base is one method for identifying a single point of contact for access, addition and deletion requests for data files.
2. Have the operating system check that job number is one that is authorized to access a particular file. If invalid access is attempted, job is dropped and operator notified.
3. Employ a system whereby the output of a job is:
   - given only to the user who presents a numbered receipt for the job
   - stored in a locked box — the box number corresponding to the account number of the user — with only users of that account number having access to that box — this locked box approach also decreases unauthorized use of someone else's account number
4. Have a system of strict access to computer center and storage areas as well as a secure off-campus location, preferably confidential, for back up of sensitive information storage.
5. Minimizing the number of people running programs that use data considered confidential.
6. Following the procedures regarding data classified confidential by the government — have the computer dedicated to only one program when classified data is being used in order that another program cannot extract confidential data during the processing cycle.

Recommendation

The Task Force recognizes that the methods to be employed for assuring confidentiality of data are closely related to, and will depend upon, the operational procedures for running the computer center at the institution. Operational procedures will differ because of differing environments and traditions on the campuses.

The Task Force recommends that each institution document a formal policy regarding the confidentiality of information; a policy adequate for its campus. The users of the data should be involved in defining what data are to be treated confidentially and to whom such data may be released. Computer services should then implement procedures within the Computer Center to assure the required confidentiality.

Security

Computer service has the responsibility for establishing policy and procedure that will assure that security is maintained for both the hardware and software at the computer center(s) as well as the information residing on files in the center.

Insurance Coverage

Hardware that is leased rather than purchased is, in most cases, insured by the vendor. Purchased computer services equipment is not automatically insured but insurance should be considered if loss of the equipment would impact, in a substantial manner, the attainment of the institution's goals or objectives. The insurance policy should be written to assure that payment is made if damage occurs to the hardware due to any of the possible occurences including both man made damage (i.e. student riots) and other catastrophes (i.e., fire, flood).

Access to Facility

To minimize security problems in hardware facilities "closed-shop" type of operation is an alternative. In a "closed-shop" only the computer operators, operating system programmers and supervisors are admitted freely. Their admittance may be controlled via key cards, combination push button lock or lock and keys. Other are admitted by prior arrangements and/or visual identification.

Since security of the facility may be violated without actually gaining access, other precautions may be warranted. These include: elimination of windows or replacement of standard glass windows with impact resistant glass; locks on access routes to the computer center that can be instantaneously activated to deny access to the area of the center.

If security of the computer center is a problem at a college methods such as the above may be warranted. The costs that must be paid to achieve the necessary security include the inconvenience caused to staff, students and faculty.

Data Security

Regarding the information that is considered crucial for the operation of the institution — copies of this information should be maintained at a secure, remote site, preferably one whose location is not common knowledge, and the information should be updated on a weekly basis. **The determination of the data that is considered crucial for the institution should be made at the vice presidential level of the institution. Computer services should then institute policies that afford the necessary security for the data while still maintaining a balance with the other needs of the users.**

Data Retention

Although much of the data kept on file by computer services does not have a legally specified retention limit (exceptions are records, supporting claims for Federal grants, payroll, tax records), there should be institutionally defined retention limits. The absence of retention limits will lead to allocation of resources (dollars, space, personnel) at an increasing rate for the achievement of a questionable objective, specifically, storage of unnecessary data.

Data Retention Guidelines

To facilitate the establishment of rules for retention of data not covered by present policy the following guidelines are offered:

1. **Users should be periodically (i.e. each quarter) requested in writing to renew the status of their data files or release them.**

2. **If a user does not respond to three consecutive requests to renew the status, the data should be released by computer services and the user and his office notified in writing of the action taken.**
3. **Users should be encouraged to move seldom used files (i.e., not used in one week) that are presently on active disk to tape or inactive disk.**
4. **In accordance with the recommendation on user cost allocation policy discussed in Chapter III, users should be billed an appropriate amount for disk storage usage on a weekly or monthly basis. The user can then judge his own needs regarding the priority of data on active files.**

Evaluation

As discussed in Chapter II, two very important steps in the planning process involve evaluations. The first involves the determination of strengths and weaknesses of the organization. This determination establishes, in a sense, the first half of the question, "Here is where we are and where we want to go?" Evaluation must also take place continuously, or at least at scheduled intervals, to determine how the computer services organization is proceeding with respect to its present goals and objectives.

Evaluations involve two factors; the criteria for evaluating and the methods employed to carry out the evaluation.

Evaluation Criteria

The evaluation criteria should include clear statements that are related to the objectives of the computer services organization. Following the planning procedures recommended in Chapter II a statement of the objectives should specify the measurable criteria for evaluation. This may involve statements such as:

- 24 hour maximum turnaround time for all jobs starting Fall Quarter, 1975.
- 30 minute turn around time for 90 percent of student batch jobs starting Winter Quarter 1975.
- meeting previously promised application programming delivery schedules on at least 80 percent of all work

Many times the evaluation measures of the organization are also contained within policy type statements that are difficult to quantify. As such, evaluations are more difficult to carry out since subjective decisions are involved. Policy type statements that are applicable for computer service organizations include:

- adequacy of hardware
- availability of software
- reliability of hardware/software
- assistance to users
- concern and understanding toward users
- availability and timeliness of support programming

To be useful, statements concerning the above policies would have to be as definitive as possible and be formal statements that are made known to the staff as well as to all users of computer services.

Methods of Evaluation

The evaluations should be conducted by both the users and the staff of computer services. The methods employed for evaluation should include some combination of the following:

- computer advisory committee meetings
- formal user meetings involving director and senior staff for:
  - academic users
  - administrative data processing users
- informal contact with users
- questionnaires and polls sent to users
- suggestion boxes
- written evaluations by staff members

Inter-Institutional Evaluations

Another technique that has not been employed to date, but one the Task Force feels merits consideration, is a system of inter-institutional evaluations. An approach might involve three phases:

- **Phase I** would involve the generation of an audit type of questionnaire addressing areas such as hardware and software resources, utilizations, facilities and staff skills, inventories and expenditure levels and components.
- **Phase II** would involve the completion of the audit questionnaire by one of the participating institutions.
- **Phase III** would involve analysis of the audit data followed by a visit to the campus by the participating institutional representatives where users and staff could be questioned regarding the audit data and the levels of service actually being provided.

The purpose of the exercise would be for the inter-institutional group to make positive suggestions regarding the computer services effort on each campus.

The task force recommends that a self-evaluation procedure exist for each institution computer services organization and that regular evaluations be made of computer services at each institution. The procedure should specify the frequency of evaluation, the items to be evaluated, the individual responsible for conducting the evaluations, the manner in which findings are documented and the individuals who will receive copies of the evaluation findings.

Equipment Utilization

The purpose of equipment utilization information is to assist computer center management and college management efforts toward insuring efficient and economical operation. In a commercial environment the objective many times is to increase equipment utilization to within 80 or 90 percent of full utilization. However, in higher education, in order to support the educational process, it may become necessary to have under-utilized equipment, especially to support research. This decision regarding near full utilization or under-utilization at college computer centers must be made by the college management since they are charged with resource allocation on their campus.

Types of Utilization Data

Utilization information is many times referred to as utilization statistics since data may be gathered over certain time intervals and inferred for other time intervals. Utilization statistics may be reported in a varied number of ways:

- Hours available for computing — total number of hours per month (30x24=720)
- Hours scheduled for computing — total number of hours per month that center is operating and staffed
- Elapsed time from equipment meters
- Detailed busy and wait times for CPU, channels, peripheral equipment, etc. which is available via monitors

The last approach, involving hardware and software monitors provides the most useful information for present day equipment where tasks within the computer are performed concurrently. Hardware and software monitors are discussed in appendix 4.1.

At present many of the campuses do not have system accounting procedures for measuring equipment utilization.

Recommendation

It is recommended that procedures for measuring utilization should be examined, the most productive set developed and adopted and utilized within the institution. It is also recommended that a job accounting system be adopted at each institution that records job type (i.e., instruction, research, public service, administrative data processing). This will provide management at the institution with useful information to which they presently may not have access.

5. Organizational and Staffing Considerations

Overview

This chapter addresses the issues of the location or placement of the computer services organization(s) within the institution as well as the structure for the organization(s). The advantages and disadvantages of combined or separate equipment facilities are discussed as are the staffing issues of location of personnel, training of personnel and position descriptions and classifications for personnel. An organizational checklist is included for periodic re-evaluation of the organization.

A few basic points should be stressed initially. First, an ideal organization will only be successful if the personnel are qualified and competent. If this is not the case, the type of organization will have little impact. The size of the organization will have a major influence on the organizational structure. Some of the larger institutions will have a number of management levels while the smaller schools may have all of the organizational elements reporting to the computer services director. This is especially true in many of the newer technical colleges within Ohio. Finally, management must constantly monitor the organization's effectiveness in terms of meeting the institutional and computer services objectives. A number of problems may exist within the organization such as personality problems or communicating problems and these should be investigated before organizational change is attempted.

Location/Placement of Computer Services Organization

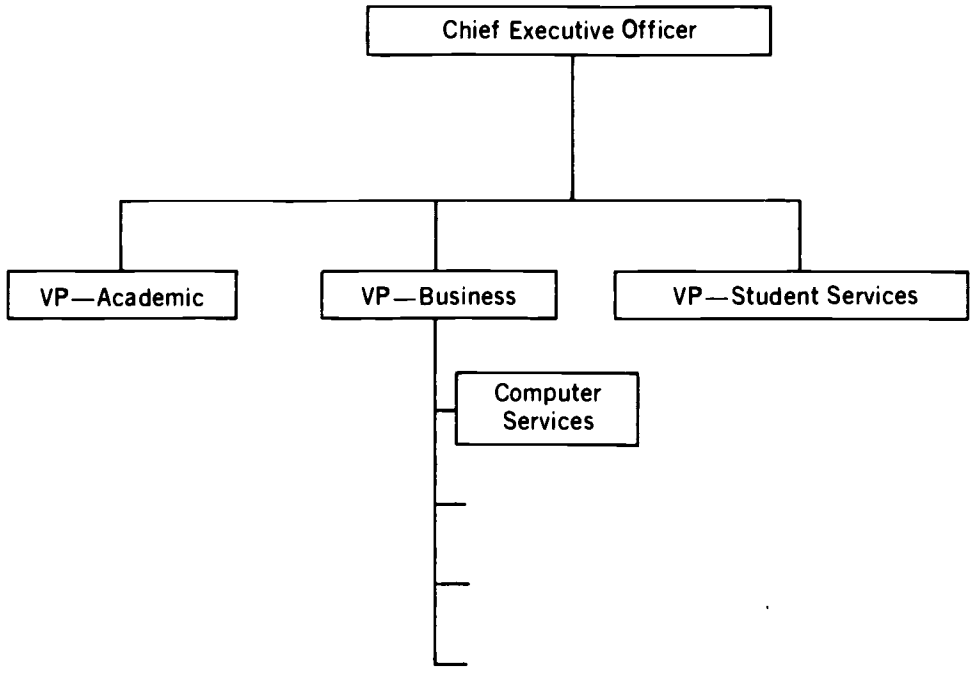
Organizational Considerations

Since computer services is a service organization, its organization must be responsive and maintain good relations with its users. The placement of the organization can help or hinder this, and the question of its location becomes a sensitive one since there are conflicting interests and needs among the users.

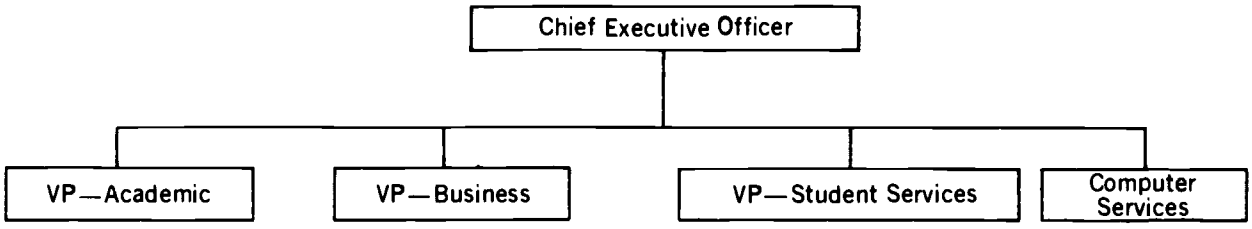
There are at least four alternate ways of locating the computer services organization in any type of structure.

1. Decentralized organizations reporting to each user.
2. Centralized organization reporting to the larger user
3. Centralized organization reporting on a level with, but independent of, the users
4. Centralized organization reporting at a level above the users.

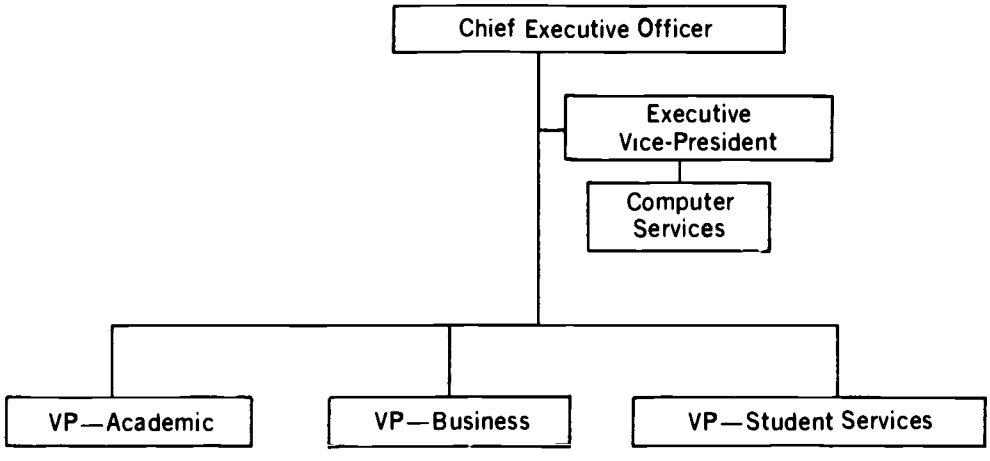
The latter three are illustrated in Exhibit 5.1.



MODEL (2) Centralized reporting to largest user



MODEL (3) Centralized reporting on a level with users



MODEL (4) Centralized reporting at a level above the users

EXHIBIT 5.1 PLACEMENT OF COMPUTER SERVICES ORGANIZATIONS

Factors Involved in Choice

A series of decentralized organizations reporting to individual users (No. 1) is not efficient in most situations because of the total costs of multiple organizations, each with its own managers, programmers and systems analysts. In addition, unless the computing to be accomplished for different users is quite specialized, large multi-programmable computers with lower per unit costs can handle the total computing workload more efficiently.

Computer services organizations reporting to the larger user (No. 2) have come about historically when multiple computer operations were combined and placed under the largest user. If accounting and payroll, for example, had the greatest requirement for computer services, the organization was located under the business officer.

It is a normal belief that if a particular organizational component on campus has organizational responsibility for computer services, its own needs will have priority over others. This feeling is apt to exist regardless of the quality of service and regardless of how statesmanlike the computer services director may be. The solution, which may have to be compromised for other reasons, involves placing the responsibility for the organization in the hands of a more neutral organizational component, either at the same level but independent of users (No. 3) or a higher level (No. 4). This assures more equitable service.

Having the organization independent of the users but reporting at the same level as the users (No. 3) should result in fair and equitable service to all users on the campus. Having computer services report at a level higher than its users (No. 4) has the significant advantage of the directors' greater awareness of the institutions' objectives and constraints on meeting these objectives, thus improving his capability for long-range planning. A disadvantage may exist if the computer services organization does not actually earn its higher placement in the institution.

Officer to Whom Computer Services Reports

A number of options are therfore available with respect to the office to which the director of computer services should report. The options include having the director of computer services report, in a line capacity, to:

1. President
2. Executive Vice President
3. Vice President for Academic Affairs or Provost
4. Vice President for Finance or Business
5. Committee of Vice Presidents representing users

The president's workload on many campuses is usually too heavy to make option 1 feasible. Even if this is the case, when real crisis threatens, the president should devote his attention to the settlement of vital cases and lend his authority to resulting decisions. If, on the other hand, the president's schedule allows, option 1 does offer many advantages and is therefore desirable.

The choice of executive vice president is advantageous for those schools who presently have or contemplate creating an executive vice-president position. The location of the office of executive vice president above those competing for computer service should assure fair and equitable service to all users. In the area of management of the institution and its scarce resources the executive vice president will have a good perspective of the

areas in the institution where the application of computers will result in the biggest payoff. He will also be capable of deciding the proportion of computer services to be devoted to the overall objectives of the institution in the areas of instruction, administration, public service, and research.

The choice of option No. 3 (vice president for academic affairs) or option No. 4 (vice president for business) has many times been made as a result of historical reasons; where computer services first began providing service on the campus. It has also come about as a result of centralization wherein the larger computer center has absorbed the smaller center. As of 1970 the National Science Foundation Inventory of Computers reported that from approximately 500 public higher education institutions reporting 160 had computer services reporting to the chief academic officer. The chief business officer was reported to in 120 schools and the president of the institution in 115 schools.

The fifth option of having computer services report to a committee of officers of the institution has been successful at some institutions. The major problem involves making difficult decisions within a committee atmosphere. Committees of users and/or committees of advisors (usually from the local businesses and industry community) are used at most schools to provide advice for computer decisions, but the final decision rests elsewhere.

Recommendation

No single organizational placement has been found that resolves all conflicts. This is the reason for the variation that exists today. The Task Force recommends that the best placement for computer services depends upon the style and nature of each institution. The guidelines should be that the organization's location encourage equitable user service and allow for a short chain-of-command between it and top management.

Organizational Structure

An approach to organization structuring can follow product, geography, customer type or functional lines. Within a higher education institution only the last two are appropriate. The types of customers can be categorized as instructional, research, administrative and public service. The needs of these four different customers were discussed in Chapters I and II.

The functions can be categorized as:

- Computer operations
- Software programming
- Applications—design and programming
- Internal administration

The last function involves such tasks as customer and vendor liaison, personnel administration, long-range planning, analysis and trade-off studies, standards, procedures and budgeting. These functions are best handled by a staff person or organization reporting to the computer services director.

As discussed previously in this manual the spectrum of computer services organizations in Ohio's public colleges is indeed wide. In some of the smaller colleges all of the above functions are carried out by a one or two person staff. In some of the larger colleges there is a group of professional

people responsible for software programming. Another group for applications programming, etc. In general, the larger the computer services organization, the more likely the functions will be separated into distinct organizational units. This was illustrated in Exhibit 2.1 of Chapter II which showed four levels of organizational size. What follows then is a model that should guide the smaller schools as their organizations tend to enlarge, as well as the schools presently having large computer services organizations.

An overall organizational chart for an organization structured according to functions with the applications area separated by skills is illustrated in exhibit 5.2.

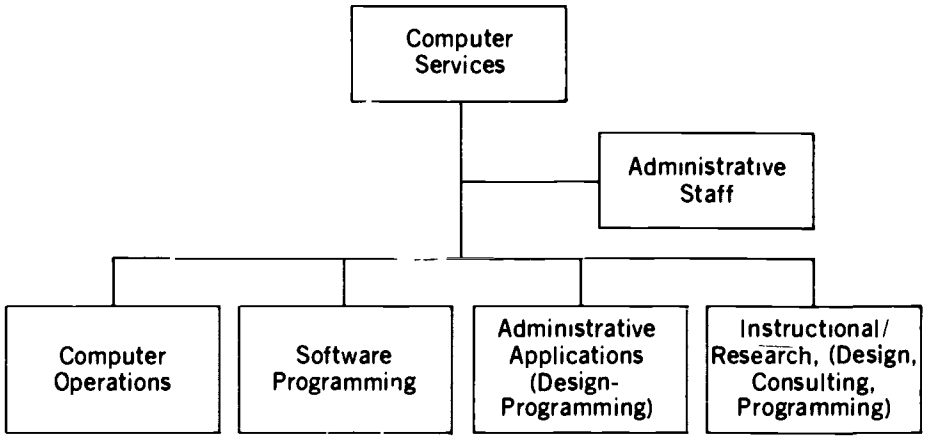


EXHIBIT 5.2 ORGANIZATIONAL CHART FOR BASIC MODEL

This is a basic organizational model which can be adjusted according to the local situation. For example, there may be significant demand for education and consulting that would warrant another unit reporting to the director or the number of software programmers may not warrant a separate unit.

Combined/Separate Equipment Facilities

At present almost all of Ohio's public colleges maintain combined computer facilities for Administrative Data Processing and Academic Computing. The recommendations in this section for combining equipment facilities are therefore unnecessary for almost all of the technical and community colleges. The discussion is included so that as the college computer services staff and workload increase in the future the guidelines and recommendations stated herein will influence future decisions.

Historically, there have been numerous reasons for centers being separate at institutions:

- Thoughts that administrative data processing computer needs were fundamentally different than academic needs thus requiring separate and different equipment.
- Attempts to use common hardware and software before the mid

1960's many times failed because the many needs of various users could not be satisfied simultaneously within the available state of the computing art.
Federal research grants were available to support the growth and expansion of research computer facilities.

Technical Problem

The technical problems of simultaneous use of facilities by academic and administrative users have decreased significantly since the early 1960's. The introduction of faster and larger hardware and the development of software allowing programs to operate "apparently simultaneously" have led to the realization that the difference between administrative and academic data processing are much smaller than earlier thought indicated. This realization has led many universities including more than half the public universities in Ohio to merge ADP and academic data processing with resulting cost savings.

Operational Problem

The operational problem of servicing large numbers of instructional users with short turnaround times as well as ADP users with tight reporting schedules is solvable. This has been well demonstrated at both large and small institutions in Ohio and elsewhere. In addition, as on-line terminals systems become more evident on campuses, in instruction as well as ADP organizations, the computing requirements for the two types of users can be efficiently handled from the same facility.

Recommendation and Benefits

The Task Force feels that under most circumstances the best organization is one that operates a joint center managing hardware for instruction and research as well as ADP. The disadvantages to such an organization are minimal and the advantages substantial:

1. Combining the computer resources into a single organization allows the installation of more powerful and flexible equipment at less cost than two or more separate centers.
2. Computer service personnel, both a scarce and a costly resource, can be used more effectively with substantially less duplication of system support effort.
3. A larger systems programming staff at a combined center will allow more exposure of application programmers to systems knowledge.
4. In the joint center multi-programming capabilities must be more fully utilized resulting in a more efficient use of computing resources than could be obtained at multiple centers on smaller equipment.
5. Large data base manipulations, for both ADP and research applications, will benefit from the consolidation of the hardware facilities.

The Task Force thus recommends that those institutions presently operating separate hardware computing facilities should re-examine their operation with respect to the advantage of a joint hardware center for their institution.

Location of Personnel

Staffing Considerations

One of the issues regarding computer services personnel is their location within the organizational structure of the college. There are at least four different types of personnel involved.

- Machine operators
- Software (Operating Systems) Programmers
- Programmers (Application and Maintenance)
- Systems Analysts

The best practice involves centralization of the first two types of personnel within the computer services organization. Since their efforts are directly involved with the computer and associated equipment, it would make little sense to have these people decentralized about the campus.

The question regarding the centralization or decentralization of systems analysts and programmers is not as easily answered especially for the larger schools. In these colleges some users may have sustained computing needs that could justify having systems analysts and/or application or maintenance programmers located within their organization. The computing personnel in this case would theoretically have a better understanding of the users area and could be more responsive to the user organization needs. However, there are other significant disadvantages to this decentralization such as keeping the analysts and programmers abreast of the changing computer technology as well as decreased effectiveness from separation of talents.

In the smaller technical schools the decision is not as difficult since user organizations are either not large enough or do not have sustained computing needs to justify their own analysts and programmers. Thus the choice of having systems analysts and programmers within computer services is best.

Another approach involves the formation of a separate systems department wherein the analysts and programmers are located. This choice is not only applicable to larger institutions but it may be the future trend for many institutions. In this so called systems department would rest the responsibility for all systems activities within the institution including management analysis, operations research, methods and procedures, organizational and computer systems analysis.

Thus there are at least three choices for locating the systems analysts and programmers on the campus; include them in the computer center organization, distribute them throughout the campus to the organizations they are supporting (ADP's would go to registrar, bursar, student records, etc. and non-ADP's would support instruction and or research) or form a separate systems organization on campus to house the talent.

The advantages and disadvantages of each approach are listed in exhibit 5.3.

EXHIBIT 5.3

Systems Analysts and Programmers Placement Considerations

I. Separate Systems Organization

Advantages:

- Coordinated effort in data base design

- Single point of control and responsibility for data bases
- Pooling of talents results in improved effectiveness
- More responsive to management needs for implementing modern business practices via computers (PPBS, Simulations, PERT)

Disadvantages:

- Increased overhead due to formation of new organization
- By being apart from hardware and closer to application areas, difficulties in staying abreast of the technology intensified.

II. Incorporated into User Organizations

Advantages

- Better understanding of users areas so that productivity in designing applications is increased.
- More responsive to user organization needs

Disadvantages:

- Only viable for sustained user needs
- Same as for separate systems departments (i.e., staying with technology)
- Possible duplication of efforts as more areas acquire their own applications programmer/analysts
- Lack of coordination on data base design

III. Remain within Computer Services Organization

Advantages:

- Coordinated approach should improve overall effectiveness
- Best method of keeping analysts up to date with hardware, operating systems and other software.
- Pooling of talents results in improved effectiveness

Disadvantages:

- Possibility of lack of effectiveness to user — due to imperfect knowledge of users needs and problems

Since almost all of the two-year schools are not large enough to support a separate department and since the colleges will benefit more from the efficiencies and effectiveness afforded of centralized pooling of talents the placement within computer services seems most reasonable.

Recommendation and Benefits

The Task Force recommends that the systems analysts and programmers remain within the computer services organization and be organized into two functional units reporting to the computer services director; one supporting administrative users and the other academic users. The benefits include

improved effectiveness via pooling of talents, and association of analysts with systems programmers. In addition the task of keeping analysts abreast of latest technology will be minimized. The resulting organizational model will have four functional areas reporting to the computer services director.

- Computer Operations
- Systems Programming
- ADP Systems Development
- Academic Systems Programming and Consulting

Training

The American Association of Junior Colleges recently stated, "By far the most critical factor for success in effective computer utilization is competent professional personnel, especially in the area of systems design and applications implementation."

In addition to the acquisition of the most competent staff members initially, training must be employed to keep staffs current and to expand their capabilities. Obviously, training requires the time and effort of the computer services organization management unless all training is to be accomplished at, for example, manufacturers' schools and off-campus seminars. If on-campus training is included, the manager must decide to sacrifice some current capacity for future capacity the training will afford.

If the organization is small, there should still be a training program for the staff. A good approach is to maintain a training program but limit its size to that which will fit the colleges' resources. A technique to conserve resources would be to have the senior member(s) of the staff conduct a two-hour training session once every two weeks for the entire staff. The topics could concentrate on those issues that have the greatest impact on the work being done by the staff at the time, rather than on trying to raise their general level of knowledge of the staff. Members of the faculty and guest lecturers from other college computer services organizations can be invited to conduct some of the training sessions.

A possibility exists in the training area of inter-institutional cooperation. An individual who attends a manufacturer or vendor course from one institution could attempt to disseminate the information obtained either in writing, as a set of notes and handouts, or verbally by recreating the seminar for representatives from interested colleges. Colleges could also combine resources to hire a consultant, manufacturer, or software firm to present a seminar or course at a convenient location within Ohio. Minimizing the expense of travel and accommodations can make this arrangement attractive for many schools with limited training and travel budgets. A pilot project might be appropriate in the area of data base management systems since many of the colleges will be increasing their involvement in this area as the computer assists in the institutional decision-making process.

Job Descriptions and Classifications

Because of the complexity and high cost of computer centers, it is vital that they be organized, staffed and managed with precise personnel goals in mind. It is inconceivable that the personnel requirements of a computer center can be properly expressed and fulfilled unless these requirements are documented in writing and made available to the entire staff of the

department. Such documentation will force the manager to formulate the personnel requirements of the department and will permit staff members to know with certainty what is required of them.

Foremost in the documentation should be an organization chart. **The task force recommends that every computer center create and maintain an organization chart which reflects the title and reporting relationships of every employee in the department.** While the organization chart need not identify employees by name, it should be sufficiently detailed to insure that employee's job title is explicitly represented. This should include not only the titles of full-service personnel, but also those of student, part-time, on-loan, and any other personnel who contribute time to the organization. Because the function of the organization chart is to elucidate the current working relationships of the staff, it should be revised as frequently as necessary and made available to every member of the staff.

An organization chart alone is not enough, however, to inform the staff of the total personnel requirement and the full extent of their working relationships. Although organization charts are frequently devised with direct (solid line; vertical) relationships and indirect (dotted line; horizontal) relationships, the amount that can be graphically represented is limited. The chart should be supplemented by written descriptions of all procedures the staff is expected to follow in day-to-day communication with one another preferable with personnel outside the department as well. Equally important, all personnel policies which staff members are expected to individually observe should be documented in writing. For example, policies on shifts and hours, the taking of leave, confidentiality of information, etc., should be explicitly recorded. **The task force recommends that every computer center create and maintain a detailed and highly precise job description for every title in its organization chart.**

There are at least three ingredients which must minimally be included in a job description if it is to be effective:

1. A statement of the nature of the work performed in the job
2. A detailed and exhaustive list of the specific duties and responsibilities of the job
3. The minimal qualifications an employee must have to perform the job

The statement of specific responsibilities is the most important reason for a job description's creation and, as such, must thoroughly address both the general and the specific requirements of the job. Such a statement should include at the very least:

1. The positions to which this job is reportable
2. The positions which this job directly or indirectly supervises
3. The contacts with all other persons (or offices) which are or are not permitted both inside and outside the computer center
4. The written communication which is required to properly document the performance of the job
5. The power and limitations of decision-making in the job

Examples of the latter might be reflected in job descriptions as follows:

1. A **project leader** may interview applicants and recommend who to hire and promote. A **manager** hires and promotes.
2. A **manager** may solicit product information from a vendor but may

not divulge budget information about the computer center. A **director** may divulge budget information but only request acquisition by the purchasing department.

It should be noted that authority is to be both granted and constrained if the job description is to be effective. Of no less importance is the necessity of listing details of the job such as machines which will be operated, routines which will be performed, the amount of weight which must be lifted, etc.

While the statement of duties strongly implies the qualifications required in a job, an explicit statement of qualifications should also be included. The usual, but by no means only, ingredients on qualifications are:

1. Degrees and/or fields of formal education required if any
2. Special training or skills required over and above formal education, if any
3. Years and type of experience required, if any

If a computer center is inadequately staffed or funded to train employees on the job, the qualifications for a job can be used to exclude from consideration any applicants who fail to have the prerequisite training and skills. Likewise, if a particular type of experience is required for proper performance of a job, the applicable experience should be specified as a prerequisite.

Organizational Checklist

To establish how well the organization is prepared to carry out the functions the following questions must be answered periodically and appropriate action taken:

- Has a formal organizational chart been prepared and is it current?
- Is the plan of organization based predominantly on functions and services rather than around personalities?
- Is the organization adequately staffed to perform its assigned functions?
- Are the required working relationships between all components of the organization understood?
- Does the organizational chart reflect the actual decision-making process?
- Is the responsibility for computer services functions clearly assigned and defined in writing?
- Are organizational policies clearly defined in writing to permit consistent application?
- Are organizational policies reviewed periodically and adapted to changing conditions?
- Is there an effective method of communicating the approval and establishment of new or changed procedures to all users and concerned departments?
- Does computer services management personnel receive regular reports that facilitate direction and control of the operation?
- Are costs analyzed and compared with other institutions or service centers?

6. Inter-Institutional Cooperation

Introduction

"Cooperative activity between or among several institutions has been with us for many years. However, the prevalent pattern of institutional behavior has been, and probably always will be, one of striving for academic excellence through competition. Perhaps the stress and pressures on higher education in the decades ahead will necessitate a more balanced proportion of cooperation and competition." These are the words of an Ohio private college vice-president, but they most likely reflect the sentiment of an increasing majority in higher education.

Expenditures for computing services have grown rapidly within Ohio's public colleges up to the present time. There is little likelihood that this rate of growth will continue since budgets are becoming increasingly tight and increases will probably be near inflationary levels. Yet, unfulfilled computing needs that are presently not being satisfied because of scarce resources, will continue to increase if the use of computers in instruction (e.g., computer-based instruction) and administrative applications (e.g., PPBS) expands as rapidly as projections indicate.

Sharing of institutional resources is one solution. One of the areas where college and university cooperation has been demonstrated to be successful is in the areas of computing. Examples exist nationally (Triangle University Computer Center, Dartmouth College Center, California State University and College Network) as well as within Ohio (Northwest Ohio University Computer Center, Southwestern Ohio Regional Computer Center)

The current trends in hardware, software, data and higher education financial support clearly mandate more inter-institutional cooperation. Hardware trends are still toward decreasing the unit cost of computing by increasing the size of cheap memory and improving the utilization of very high-speed central processing units (CPU) so that more logic and calculations can be performed. Software is becoming increasingly complex and expensive to maintain locally and more is available commercially in a generalized form. Numerous large data bases (e.g., Library of Congress, Census Data) are being made available in machine readable form and the ADP trend is toward large inter-related data bases with less duplication of basic data (e.g., names and addresses) and increasingly complex referencing and classification schemes. These, coupled with the current financial constraints evident in all of higher education, dictate that cost-effective means for inter-institutional cooperation be found.

This chapter will concentrate on the possible areas for cooperation, the cooperative efforts involving computer services within Ohio and the

nation, the suggested approach to defining areas for cooperative efforts, the issues involved and finally the recommendations of the Task Force regarding inter-institutional cooperation.

Types of Cooperative Efforts

Approaches to Cooperation and Associated Caveats

A large number of cooperative efforts exist in the area of computer services across the nation and among Ohio's colleges and universities. Among typical forms are:

- Sharing of computing power
- Sharing of data files and information
- Sharing of previously written general programs
- Sharing of experiences and knowhow
- Joint purchase of items
- Joint program development

Much of the above activity is in existence nationwide. For example,as of 1971 computer power was being shared by at least 36 educational computer networks in the country. Sixty six institutions of higher education were involved in some shared use of computers. Sharing of previously written programs and data files have been encouraged by, and accomplished through, national groups such as CAUSE, EDUCOM and WICHE. A number of institutions, independently and as members of state systems, have joined together for cooperative program development.

Cooperative Efforts Caveats

In considering cooperative efforts certain caveats must be identified. For example, computing power must not be treated as if it were homogenous. The sharing of computing power will achieve the greatest degree of success if a functional approach to sharing is pursued. As previously mentioned (Chapter II) computing in higher education can be categorized as follows:

1. Teaching Languages and Concepts
2. General Problem Solving
3. Production Processing

Functional Approach to Cooperation

Within each of these areas there are significant opportunities for cooperation with respect to hardware, software and data. Furthermore, operating in a functional context permits the evaluation of the cost-effectiveness of a particular alternative or set of alternative opportunities. A few of these are discussed below.

1. Teaching Computer Languages and Concepts

The function of teaching computer languages is the best understood and most universal application of computing in postsecondary higher education. The COBOL language is most frequently used in training students

in Ohio's colleges although numerous other languages are also taught. The principal method of providing this service is through batch processing where student jobs are submitted and later picked up at a particular center.

Interactive student programming can be provided as a means for teaching languages and has gained significantly in academic use, although not in Ohio public colleges to date. Here the student uses a terminal to write and debug his program. Because the response to many errors is immediate, much less time is required to get a program operating. Interactive processing is more expensive to provide than batch processing, although there are a number of opinions regarding the most cost-effective method of providing interactive processing.

2. **Problem Solving**

The use of computers in problem solving ranges in complexity from simply providing a compiler which a student can use to write programs designed to solve problems to providing elaborate statistical and data manipulation packages and a standard data base for extensive research. The simplest function, compiling and testing services, is very similar to the teaching function whereas the more complex problem solving applications overlap somewhat with production processing. However, in the midground, there is a significant amount of activity supported in the development of complex programs and in providing "one-time" calculation services. Potential sharing of compiler services, research support packages and some research data bases (such as the Dartmouth Social Sciences Data Base) should clearly be explored. Also, there are considerable advantages in sharing information on the less frequently used languages and tools for problem solving as campuses develop expertise. For example, a person developing course material for Computer-Assisted Instruction (CAI) in the Coursewriter language can be aided considerably by knowing more about what others are doing or have done in this "problem solving" area.

3. **Production Processing**

A variety of computer services involve providing support to a production process. Examples include such things as payroll, student registration, student admissions, the production of learning through CAI courses and a variety of testing and major research data collection and reduction applications.

Much production processing involves activities that are very critical to the various operations of the institution and which are frequently accomplished in a unique way. For this reason, there has been less cooperative effort put forth in this area. However, there clearly are opportunities for considerable cooperation in various production processing areas.

Two-Year College's Computing Needs

Computing within Ohio's two-year publicly supported colleges covers a broad spectrum from the largest community college with enrollments near 20,000 to the smaller technical colleges with enrollments near 200 students. The largest portion of the computing needs of the two-year schools fall under the first functional area of **Teaching Languages and Concepts** since many of the schools offer the associate degree in business computer programming.

There is an increasing need for the other two functional types of computing, **General Problem Solving** and **Production Processing**, especially at the larger schools.

Recommendation

Under the functional area of Teaching Languages and Concepts the Task Force recommends: ANY Associate Degree program in Business Computer Programming must have access to computer hardware capable of compiling and executing COBOL programs. It is generally agreed that students of computer programming cannot learn necessary techniques effectively without the execution of sample programs. The exposure to the theory of computer programming is not sufficient. Of significant importance is the development of understanding of and utilization of files.

Although there is agreement on the need for access to computer hardware for business computer programming students, the current debate concerning "hands-on" "hands-off" mode of providing such access is by no means a settled issue.

Hands-On Capability

Hands-on capability as used herein refers to a mode of operation whereby the student is directly exposed to the computer hardware to the point where he actually performs the functions necessary to the execution of his problem. He performs the functions normally associated with that of a computer operator position, such as mounting tapes and/or disks, entering input via the card reader, and responding to the various operating system and program messages via the console. In a sense, the students participate in a laboratory environment, with the computer dedicated to their use. This mode of operation is also classified as open shop, since the student may enter the facility and present his data processing task to the computer directly.

Hands-Off Capability

Hands-off capability as used herein refers to a mode of operation whereby the student utilizes an interface function between the presentation of his data processing task and the actual execution of his task by a computer. The student normally submits his task to an intermediary such as a clerk, a scheduler, or a computer operator. The execution of his task is then performed by operating personnel and returned to the intermediary, awaiting the students pick-up of the completed task. In this mode of operation, also referred to as closed shop, the student does not have physical access to the computer hardware.

Operators vs Programmers Training

Most people involved in computer services education agree that hands-on capability is a necessary requirement, or at least a definite asset, for the training of computer operators. Within Ohio's educational system, computer operator training is carried out at vocational high schools. There is more disagreement between experts when the need for hands-on

capability is discussed for training computer programming students at the associate degree level such as in Ohio's two-year technical and community colleges.

Pro Hands-on Arguments

The arguments for hands-on experiences in the training of computer programmers include:

- Mystery of a black box is dispelled by physical contact
- Students learn from each other by observing fellow students errors
- An additional benefit is the exposure to an operator's work. This includes the changing of disk packs and magnetic tape reels, console replies and loop traces.
- Hands-on method of education provides the fundamental skills necessary for a computer operator's position in the job market — either at an entry level for programmers or for additional duties
- Remote job entry requires high priority for student jobs in order to assure service
- Hands-on permits students to correct errors they have made in a learning environment rather than a working environment

Opposite View of Hands-on

Those who hold the opposite view that hands-on experience is a luxury and not a necessity for training computer programmers that, in many cases, cannot be justifiably afforded by the college include the following points:

- Computer programmer students can be introduced to many of the operator functions such as tape reel and disk pack mounting, reassignment of devices, primary storage partitions and the like in such a short time that hands-on operations is not required continuously throughout the quarter. A few days to a week orientation course is sufficient.
- Programming students can be more efficiently introduced to console replies to operating systems via simulations at a time-sharing terminal. Instead of the students being exposed to random console replies that may occur at the college's computer facility, the student can be exposed to the entire spectrum of possible console replies from a number of different vendor operating systems by use of the simulation package. A version of this commercially available programs allow the student to sit at a terminal, make responses to different console replies, and have the terminal respond to his answers.
- Express batch service available via a closed shop or via remote job entry offers the greatest number of student programming job turnarounds to the greatest number of students. The use of batch monitor systems offer almost instant batch turnaround which is very helpful in learning programming skills.
- With limited funds available for computing resources at each campus, the desire for a hands-on computer on-campus rather than access to a more modern and sophisticated computer off-campus may limit the experiences the student is exposed to.
- Data processing instructors have indicated that the experience

gained from having access to more up-to-date and powerful computers is favored over the hands-on operation of less sophisticated equipment if a choice between the two had to be made.

Summary of Hands-on Hands-off Debate

The current debate concerning the hands-on mode of operation versus batch compiler runs, or terminal mode of operation, is by no means a settled issue. In the next decade it is possible that selected high schools throughout the state of Ohio will provide the proper training on proper equipment to satisfy all computer operator needs in the State of Ohio. Until that time is reached, if ever, business will continue to turn to community and technical colleges for qualified operators. In addition, even though the high school student may be qualified, it will be necessary for hiring corporations to accept the plausibility of high school students being adequate mentally, physically and emotionally mature enough to handle the demanding job. There is no question that good high school programs can train these students, and some students are mature. This hiring process will face the same type of test that the two-year programs are now facing within the hiring community. With some corporations, the four-year, non-data-processing graduate is selected before the two-year data processing degree graduate. At the present time, the hiring practices of some companies are slanted in favor of hiring operators rather than programmers or systems analysts. Included in this group are many people hired as intended programmers, but still put through the operations phase of training. Naturally some of the students were hired for operators positions with no other job thoughts in mind. If operations training becomes a minor part of the current curriculum, it is conceivable some of these students will never find their opening jobs unless companies decide to change their hiring practices regarding the elimination of the operator's job as a prerequisite for the programming job.

The trend in large shops is for operations personnel to do all the machine tests. This means a programming and/or systems person will never have physical access to any computer, unless such hands-on applications is received at the time of training. It would be safe to say that hands-on experience will help the programmer understand his function a good deal better than a programmer with no such comparable experience.

Possible Levels of Computing Service

Access to computing resources can take any of the following forms:

1. Scheduled closed shop utilization of a computer facility.
2. Scheduled open shop utilization of a computer facility.
3. A keyboard terminal, such as a teletype or Cathode Ray Tube online to a computer facility.
4. An on-line keyboard terminal in conjunction with closed shop batch processing at a computer facility.
5. A programmable terminal (reader, printer and small central processor such as a mini-computer) on-line to a computer facility.
6. An on-site computer including a central processor, with necessary peripherals such as readers, printers, disks and/or magnetic tapes. May include communication capabilities to respond to 3, 4, or 5 above.

7. An on-site computer capable of functioning in a stand-alone environment, with the added ability of communicating with a larger, more powerful computer resource.
8. Any combination of the above, where the computer facility indicated could be on-site or off-site.

The choices available to any institution are dependent upon the needs and resources available to the institution.

Trends in Levels of Service

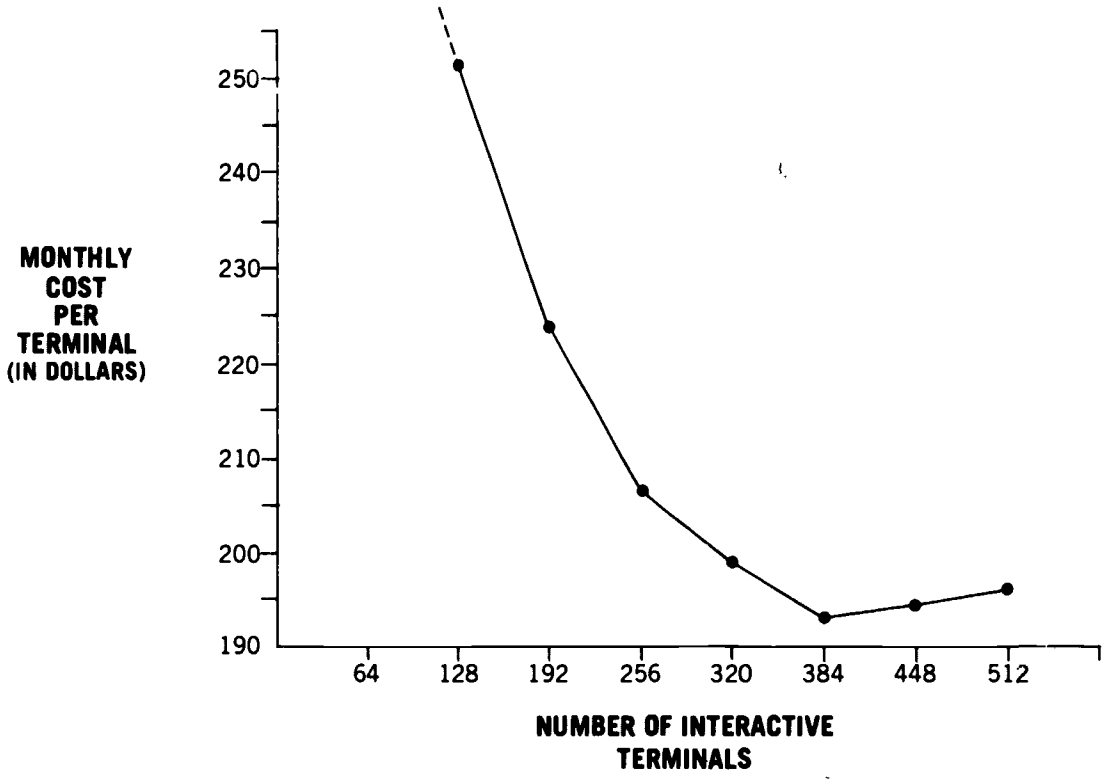
Both small and large schools have a growing need for computing. Increasing numbers of colleges and universities feel that more service can be obtained by a sharing or pooling of resources than by "going it alone". One solution to providing increased services has been the creation of regional computing centers and statewide networks. (Examples include colleges in California, New Jersey, New England, North Carolina, Pennsylvania, etc.) The goal is to provide adequate computing service which is both responsive and reliable. Such service should include the essentials of (1) adequate consultation, (2) adequate software, (3) reliable operation, (4) reliable documentation, and (5) fast turn-around time. The nationwide trend seems to indicate that the combination of on-campus equipment and access to responsive and reliable off-campus computing facilities is preferred to either solution alone.

Hierarchical Approach to Computer Sharing

An approach that takes into account the various positive and negative economies of scale is sometimes referred to as a hierarchical approach to computer sharing. This means that each computing demand is met in the most efficient manner balancing positive and negative economies of scale in hardware and software. Interactive time-sharing is one computing function that exhibits positive economies of scale. This is illustrated in exhibit 6.1* which demonstrates that the cost effective range for time-sharing involves many terminals (i.e., 250-400) supported by a large computer system. The curve and the summary of time-sharing costs are for Control Data Corporation computer equipment. This indicates that time-sharing services should be provided on a regional rather than a local basis.

Two examples where negative economies of scale may point toward local computing rather than shared computing are in the use of mini-computers and in the use of very large CPU's for small student jobs. In some situations mini-computer CPU's may be more cost effective but precautions must be taken that with the addition of the necessary peripheral devices (which are generally of the same price level as for large computers) cost effectiveness is not lost. In the case of student learning type jobs on rather large computers (e.g., IBM 360/91) the cost of overhead on the large CPU for compilation and linkage may make its use locally cost ineffective. However, a detailed evaluation should be made to determine the cost-effectiveness relationship to the individual user as well as all other users of the shared resources. A particular approach may be individually cost effective but at the same time be at odds with the achievement of reduced costs or increased services for all users.

*"A Proposal to the Illinois Universities' Consortium for Computer Services and the Illinois Board of Higher Education", Control Data Corporation 1972.



SUMMARY OF TIME SHARING COSTS

System	No. of Terminals	Monthly Lease Price	Cost/ Terminal	Cost/ Terminal Hour
I	128	$ 32,292	$252.28	$.630
II	192	$ 42,823	$223.04	$.558
III	256	$ 52,711	$205.91	$.515
IV	320	$ 63,549	$198.59	$.496
V	384	$ 74,360	$193.65	$.484
VI	448	$ 87,330	$194.93	$.487
VII	512	$100,300	$195.90	$.490

EXHIBIT 6.1 TIME SHARING SCALE ECONOMIES

Software Sharing

Software programs can be available for general use by a large number of users (i.e., a compiler for use by students in writing FORTRAN programs, or a utility program for sorting files) or may involve only one major user and be written to meet his particular need in a unique way (i.e., an institutional COBOL program for printing grade reports, a researchers FORTRAN program for a model of a physical or social phenomena). In addition, software programs can be interrelated into a complex system of programs where each part must function properly to produce the end results. This is the case with operating systems programs for computers which serve to schedule the machine, balance loads and provide numerous housekeeping and utility services for programmers and users or with such systems as are frequently found or desired in administrative computing (i.e., Student Information Systems, Financial Information System). "Volatility" of software is also a consideration. The volume of expected changes in operating systems, modifications to supporting languages and changes in the policies, rules and requirements of data processing programs seriously effects the ability to share.

It is usually easier to share generalized, less volatile software that serves a large number of users than it is to share a "unique" program which may have a number of volatile procedural, ideological, policy or data assumptions imbedded in its logic. It is also usually easier to share a single function program than a complex system of programs. For these reasons language compilers, utility programs and certain calculation packages are readily exchanged whereas complex models and administrative systems programs are far less easy to share. However, the significant costs of creating and maintaining software suggest that significant advantages may result from joint efforts to develop and maintain even complex systems in a common mode.

Data Sharing

The data used with programs can be internal to the program (as with simple calculation examples used in teaching languages) or external (e.g., supplied by reading cards, tapes, disk, etc., called for by the program). Data can also be static (e.g., census data, a data file for classroom program or resulting from a survey) or dynamic (e.g., student transcript, payroll, expenditure). In addition, data bases and files differ greatly in size, complexity and the security, priority, control issues discussed below.

Shared data is the exception rather than the rule although substantial sharing can take place with well-defined relatively common purpose data bases. Cooperative work can also be profitable in defining data bases, in the common collection of mutually beneficial data and partial, or full exchange of similar data.

However, in the exchange of data it should be noted that static data are easier to exchange than dynamic, and that simple common formats of data promotes exchange more readily than complex-integrated files. In addition, large volume data stored in cards or tapes can present significant problems because transmission may be inefficient and the requirement to centrally store, find and mount tapes or load cards under remote "control" can be very cumbersome.

Security, Priority, Control Issues

These issues are factors in the hierarchial complexity of cooperative use of computers. By definition it is more difficult to share software, data and hardware that requires high security, high priority and tight control. Traditionally, considerations of security, priority, control have been largely determined by the nature of applications and administered by significant people, procedural involvement. Although there is a clear trend in virtually all functional areas to provide more "machine or environment" assured security, priority, control, it is still a major factor with respect to cooperative ventures.

Inter-institutional Cooperation in Ohio

Ohio has a reasonably strong history of projects and interest in inter-institutional cooperation in higher education when one considers the separate Boards of Trustees and relatively unique program, mission, community and size aspects of the institutions. In the area of computing services, examples include:

Hardware

Hardware Swapping

The economical swapping of hardware among institutions such as the sale of The Ohio State University IBM Model 360/75 to Bowling Green State University which resulted in annual cost avoidance of $113,000; the sale of the Model 65 at the University of Cincinnati to Wright State University which resulted in a one time cost avoidance of $84,000. In addition to these examples of the use of accrued credits at one institution to reduce the effective cost for another institution a more complex example, which involved lesser savings, is the one between the University of Toledo and the Michael J. Owens Technical College. Each of these is discussed in Chapter III.

Regional Centers

Regional Centers

Sharing of computing power is evidenced by at least two different ventures:

The development and operation of the Southwestern Ohio Regional Computer Center (SWORCC) by the University of Cincinnati and Miami University; the development and operation of the Northwest Ohio University Computing Center (NOUCC) by Bowling Green State University and the University of Toledo.

Uniform Information System

The Ohio Board of Regents' Uniform Information System

Extensive work of institutional task forces and the use of institutional computer services has been required by the development and implementation of the Ohio Board of Regents' Uniform Information System from 1965 to date. This system is the first and only integrated statewide system collecting

individual student, staff and space inventory and activity data in a common format in the nation. In addition, the use of these data in combination with financial reports supports a reasonably sophisticated instructional resource analysis model, which in turn is integral to the budget support models which in turn are monitored with respect to performance by the Uniform Information System.

Inter-institutional Cooperation Nationwide

In addition to the nationwide efforts promoting exchange of previously developed and tested ADP application programs and promoting joint user development of planning/management tools for higher education, there are a significant number of institutions sharing computers throughout the nation. The technique that involves the shared use of multiple computers physically apart from each other is called networking and the resulting arrangements are networks. The purposes, advantages and disadvantages and factors to be considered for networks are discussed first and then a number of the more widely known networks throughout the nation are examined.

Computer Networks

Time-sharing (T/S) involves the use of one central computer (host computer) by multiple users via terminals that are usually remote from the computer (Exhibit 6.2a). T/S has had quite an impact since its introduction in the early 1960's. Computer networks involve the inter-connection of multiple computer so that users of any machine will have availability of the host machines in the network (Exhibit 6.2b). T/S involves the sharing of **one computer** among multiple small terminals; Computer networks involve the shared use of **multiple stand-alone computers** located physically apart from each other.

Purposes of Networks

Purposes of networks are usually among the following:

1. Cost reduction—jobs sent via telecommunication facility to another location so that more economical service can be obtained
2. Resource Sharing—job sent to another location in order to obtain a variety of service not available locally (applicable to research and possibly to instruction).
3. A combination of the above.

Network Potential Advantages

The Potential Advantages of a Network include:

- Resource Sharing (unique devices, language, application packages)
- Economics of Scale
- Personnel
- Hardware
- Backup
- Load Leveling
- Complimentary Workload Smoothing

- Distributed Data
- Shared Data Base
- Data Standards
- Shared Communications Cost
- Better Management Control
- Maximize Staff Expertise

Potential Problems With Networks

Potential Problems Associated with Networks

- Dependency upon another organization
- Difficulty in providing user assistance
- Disagreements regarding price and responsiveness of service
- Lack of insight into a users unique needs
- Reduced level of service for some users (those users who enjoyed free access to campus computer)
- Old user finds increased competition for computing resource as more users gain access

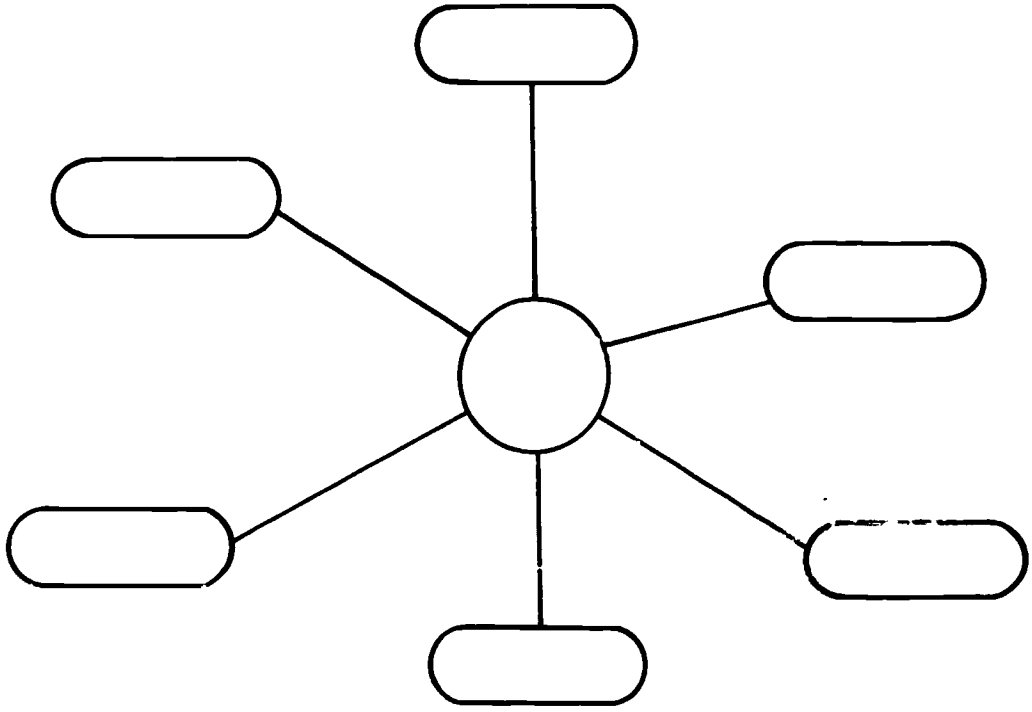
Any number of other problems may arise if the following factors are not considered in the design and operation of the network.

Factors to be Considered for Networks

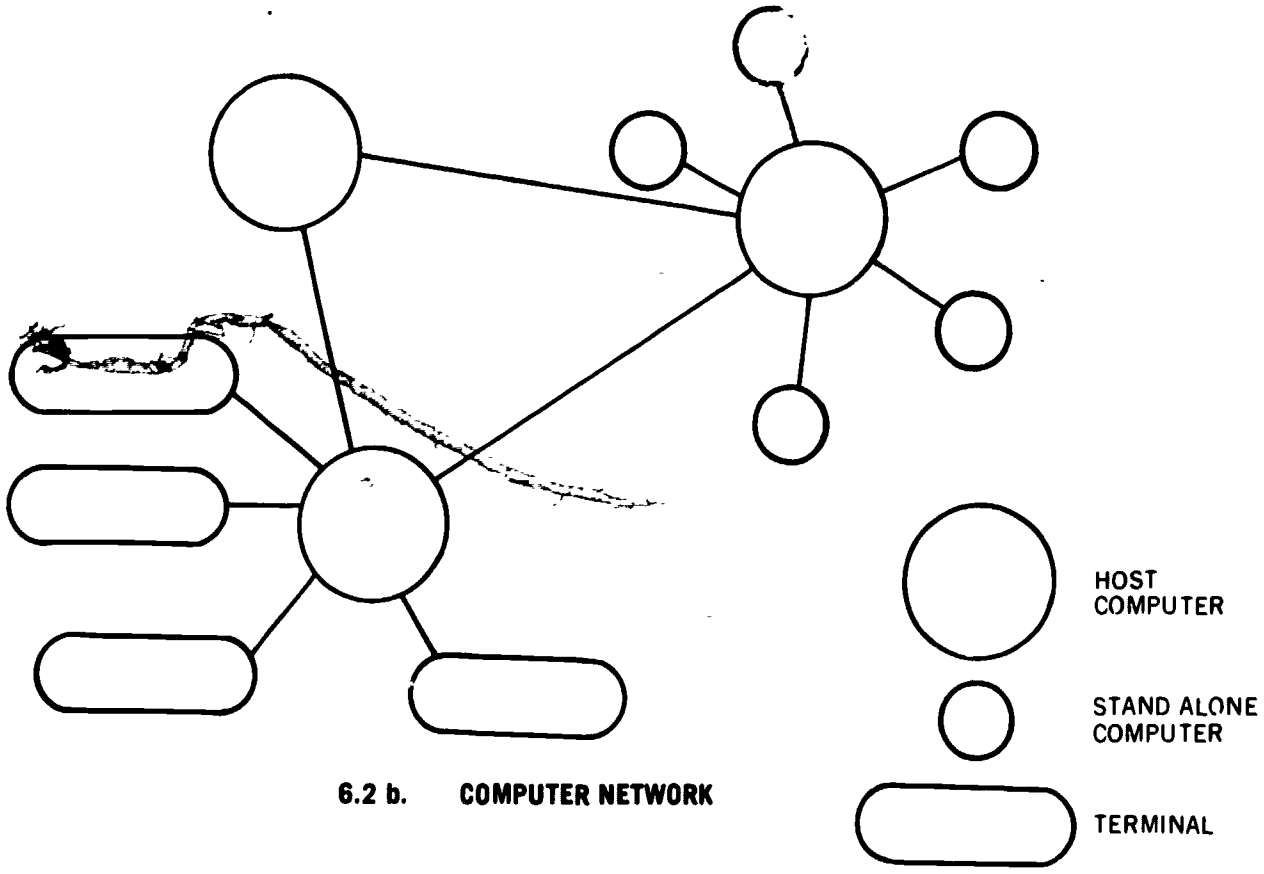
The following factors must be considered in planning a network.

- Data Security
- Interrupt Handling
- User Communication, Assistance
- Control Language Dynamics
- Remote Delays More Frustrating
- Network Control Overhead
- Local Center Income Loss
- Remote Resources Changes
- Operating System Dynamic Data Set Attachment
- Language Processor Differences
- Configuration Changes
- Data Set Differences
- Funding, Rates, Priorities, Service
- User Reluctance
- Organization—Networks Encourage Change
- Communications Cost (Compaction vs Line Speed)
- Host In Control
- Host To Host Interface
- Politics/Tradition
- All Sellers/No Buyers
- Accounting
- Cooperation Mandatory

The lengthy list should leave no doubts that networks require much planning and study before there is hope of there being success.



6.2 a TIME—SHARING SYSTEM



6.2 b. COMPUTER NETWORK

EXHIBIT 6.2 a, b ILLUSTRATION OF A TIME SHARING SYSTEM AND A COMPUTER NETWORK

INTER-INSTITUTIONAL COOPERATION

Existing Networks

Appendix 6.1 contains a brief description of four computer networks as of April, 1972. For a more detailed examination of existing networks the reader is referred to "A Study of Regional Computer Networks" by Weingarten, Nielsen, Whiteley and Weeg, The University of Iowa, 1973.

Issues Involved in Cooperation and Sharing

A number of factors influence the need for and the type of inter-institutional cooperative actions that should be pursued within Ohio. The needs for computing services within higher education in Ohio are growing and will continue into the future. These expanding needs influence the choices for cooperation and the choices in turn are affected by both financial and technological factors.

Future Computer Services Needs

The following factors must be considered in accessing future needs:

- Computer based instruction is not making its full impact at any institution yet — if and when it does, computing needs will increase significantly — facts inhibiting use of computers in instruction have been identified on a national basis — recommendations regarding encouragement of development of material and inter-institutional cooperative effort in development and sharing of material will stimulate growth.
- As continuing education and vocational educational programs expand rapidly the computer will be called upon even more to assist the educational process.
- ADP costs are a significant part of the computer service budget at most institutions, yet the number of unserviced areas where computing can contribute to cost saving (e.g., dining hall, bookstore) is significant.
- Many needs of management for computer-aided decision making which are not now being fulfilled — will grow as management becomes more aware of the capability of computing tools (e.g., CAMPUS, RRPM1.6).
- Financial decisions will also necessitate the utilization of computers in difficult decision making (PPBS, program cost recording and reporting).

In summary, the future computer services needs will continue to increase at the public university level and more so at the college levels where enrollments are growing.

Financial Implication

Financial implications include:

- Costs for computer services are growing very fast — in total and on a per student basis.
- Budgets are tight at all public institutions — long-term trends for higher education finances are not bright.
- Tight state budgets for higher education will require alternatives to using capital funds to expand individual computing facilities as two-year public college enrollments grow.

Technological Implication

Technological implications include:

- Advances in computer technology (operating systems, communications, faster and larger CPU's) point toward the advantages of shared use. Limited local service to some users is not incompatible with sharing.
- It is no longer a question of whether sharing of computing resources will work technically—Question is one of degree of sharing that is cost effective.

Guidelines for Cooperative Computing

Guidelines for Cooperative Sharing of Computer Resources:

- Cooperation can be achieved through a spirit among the institutions or through a directive from the Legislature. There must be a recognition that success of cooperation depends upon the commitment of not only computer service personnel and users at each campus but **more importantly** on the **top management** at each institution.

Goals for Cooperative Effort

- Provide for the computing and systems needs of higher education, in a reasonably cost-effective manner.
- Determine which administrative systems are best developed jointly and direct effort of joint development of such systems.

Alternatives for Cooperation

Many alternate forms have been pursued by institutions and systems of higher education nationwide for cooperation in and sharing of computer services. Many of these cooperative ventures have been primarily for providing or acquiring computing power with secondary results being in some cases sharing of data, software and applications programs.

The alternatives pursued have included:

1. By each campus independently providing for its own needs via on-campus computing facilities.
2. By voluntary cooperative efforts between institutions on an informal basis.
3. By regional center(s) under boards of directors appointed by participating institutions and financially backed by the institutions and/or the state (NOUCC, SWORCC).
4. By a commercial (for profit) computer service bureau (e.g., CHI, ALPHA corporations).
5. By a not-for-profit, educational corporation established by the institutions or the state and controlled by a board of directors.
6. By an independent state level higher education board (e.g., Board of Regents).
7. By an executive level state agency (e.g., Department of Finance, newly created department)
8. Combinations of the above alternatives in what has been called a hierarchical approach to cooperation in computing.

Discussion of Alternatives

The fact that alternative 1 represents the past and not the future is typified by the words of Charles Mosmann, the educational computing consultant who co-authored a much quoted book entitled **Computers on Campus** in 1967. He said in 1972, "If we wrote the book today, a small but significant change would have to be made in the title: It would have to be called **Computing on Campus**." He goes on to state that the chief question administration must face today is, "what is the most effective way of providing computer services?" It is no longer assumed that this involves only establishing a campus computer center.

Voluntary Cooperative Arrangements

A voluntary cooperative arrangement (Alternative 2) as used herein means that few rights or responsibilities have been surrendered by the institutions, and each is free to dissolve the arrangement quite easily. Voluntary arrangements are sufficient for infrequent cooperative efforts such as computer hardware back-up. However, the tough managerial decisions regarding priorities and cost sharing inhibit voluntary agreement ventures from being viable.

Formal Regional Centers

Formal regional centers (Alternative 3) are operated under the authority and financial liability of participating parties, either institutions or a state agency. In the Warren King report of 1969, it was recommended that the state be divided into three (3) higher education regions and regional computer centers formed under the direction of the Board of Regents. The centers would provide computer services to the public colleges and universities within their jurisdiction. The recommendation was not implemented for a number of reasons. Among them was that the Ohio Revised Code did not provide for this type of authority within the Board of Regents duties and responsibilities and a change in the statute was not deemed advisable.

Existing Regional Centers

As an alternative to the OBOR regional centers recommendation, two institutionally controlled regional centers have been established in Ohio since 1969. The Northwest Ohio University Computer Center (NOUCC) was formed by a joining resolution of the Boards of Trustees of Bowling Green State University and the University of Toledo. The Southwestern Ohio Regional Computer Center (SWORCC) was formed via a memorandum of understanding and a three-year contract signed by the presidents of the University of Cincinnati and Miami University.

NOUCC was financially supported by a local industry (Owens-Illinois provided 6 acres and $250,000 toward construction of the facility) and the state of Ohio ($2,000,000 for equipment and facility costs). If the agreement of the universities is dissolved by mutual consent due to assumption of the maintenance and operation of the Center by the State of Ohio, the member institutions will be reimbursed their capital investments upon such terms and conditions as may be mutually agreed upon by the State of Ohio and the member institutions.

It is intended that both Centers provide computing power to the participating universities as well as any other college or university that chooses to join as a customer or as an equal partner.

Commercial Firms

There is a long tradition in higher education to internally or cooperatively (with other educational institutions) provide for necessary services on campus. Commercial firms (Alternative 4) have been utilized infrequently.

In the area of computer services, this tradition is changing. The high investment necessary for computing (initial and continuing hardware costs, facilities and staff costs) has prompted some schools, primarily small institutions, to obtain economical service from an available commercial firm. The motivation is the same as would be for joining a regional or statewide (cooperative) center. The commercial services are also attractive since they offer a variety of services, are motivated to reduce costs, and can become an excellent mechanism for distributing instructional material (instruction by computer). Instructional material collection and promotion, which are significant problem areas, would be pushed by the firms since the associated computing will increase revenue for the firms.

A variation of the commercial firm is a profit making corporation spin-off from a university. A case in point exists within Ohio. The CHI Corporation was set up as a profit corporation by Case-Western Reserve University to provide computing services to its campus. CHI now provides service to a number of other educational and industrial customers.

Battelle Memorial Institute is another Ohio non-educational organization providing computer services (remote batch, interactive) to a number of private colleges within the state.

The public institutions should consider the commercial service firms as potential suppliers of computing especially in the interactive and instruction-by-computer areas. Many of the major cities in Ohio have local call, dial-up service and some of the commercial rates are quite competitive for certain services.

State Agency

A state level agency, either a department of the executive branch (e.g., Dept. of Finance) (Alternative 7) or an independent board (e.g., Board of Regents)(Alternative 6), has been implemented in some states and is being recommended in others. As examples, the California State University and College computer network connects 19 campuses and is under the direction of the Office of the Chancellor; Warren King consultants in 1969 recommended that three regional computer centers be established in Ohio, funded and administered by the Regents and accommodating all state education institutions.

Advantages

The advantages of a state agency approach are:

1. Statewide equality of computer access is more easily obtainable.
2. State agency may have or may be given line authority to encourage cooperation between unwilling institutions.
3. There may be a need for a mechanism whereby inter-institutional differences of viewpoints can be arbitrated. In the absence of such adjudication, differences of opinion between the two institutions become potential sources of disruption for the inter-institutional venture.
4. This need for an external adjudicator in the governing body of the

network does not conflict with the desirability of hiring an independent director who can be charged with establishing agreements between institutions as the basis for the network. It is only subsequently (when these agreements are questioned) that an arbitrator is needed in order to interpret and, if needed, to enforce the agreements. The director who is in the employ of the institutions cannot serve this role.

5. Experience also indicates that smaller institutions require the type of guarantees, reassurances, encouragement and pressure that can only be provided by the Board of Regents before the small institutions become active participants in cooperative ventures with much larger institutions.

Drawbacks

The drawbacks of a state level approach are:

1. Reduction in institutional autonomy.
2. If the state agency is not involved in higher education, the unique aspects of college and university computing needs may not be recognized.
3. Difficulties that private institutions may feel under a state agency.

Factors such as the above argue that the state should be at least involved in the inter-institutional sharing ventures. A balance must be maintained, however, with the autonomy of the institutions. A possible approach that has been tried in other states involves the formation of a not-for-profit educational corporation. The benefits to be derived and the guidelines for formation of such an arrangement are discussed below. In addition, the agreements for the need for top level institutional administration involvement are also stated.

Not-for-Profit Public Corporation

A number of not-for-profit corporations (Alternative 5) have been set up by universities, TUCC (North Carolina), Merit (Michigan) or by state agencies (New Jersey, Illinois) in order to provide computing service to the educational institutions.

The not-for-profit or public interest corporation offers:

1. As a corporation it has legal status to acquire assets and conduct business.
2. Users exert control via representation on the Board of Directors.
3. Independent status necessary for stability and long term operations is provided since corporation is not controlled by or responsible to one institution.

Benefits

The benefits of a not-for-profit corporation include:

- preserve institutional antonomy
- provide user control over allocation of resources
- provide for cost-effective utilization of computers
- provide the long-term stability necessary through independent and legal status

Guidelines

The guidelines to be followed in forming the not-for-profit corporation include:

- Having the board of directors represent the highest level institutional policy makers plus users in instruction, research, administration and public service areas.
- Having technical experts as advisors to board of directors, and not as members of board—the technical staff hired by the board should make the technical recommendations and decisions-technical board members tend to concentrate on best system rather than board policy decisions.
- Satisfying the definite need for superior **managerial talent** to allocate the available resources and serve the needs of the varied users in a productive manner.
- Having legal status achieved through incorporation or through statute — this provides for long-term stability and ability to acquire and hold assets.

Reasons for Top Administration Involvement In Decisions

Reasons for requiring top management to make final decisions regarding computer use include:

- Many decisions and potential problem areas in computer sharing are not technical in nature — (technical feasibility is acknowledged) issues are financial, political and the commitment of upper management-effect of variations in equipment can be easily overshadowed by unresolved managerial problems.
- Costs are high and rising rapidly while institutional resources are growing at a slower rate
- There are inter-departmental and inter-disciplinary aspects of problem that require top level resolution
- Computer use in instruction remains a threat to many faculty — only top management at the institution can establish the necessary atmosphere regarding the computer-that the faculty be allowed to create with the computer rather than be replaced with it.

Possible Structure for Not-For-Profit Corporation

In order to balance the needs of the various users and the interests of the state a not-for-profit public educational corporation can be established, control of which would be invested in a board of directors representing the top administrators of the aforementioned parties. A possible makeup of a five member board of directors would include:

1 Public University President
1 Community College President
1 Technical College President
1 Private College President
1 Board of Regents Chancellor or Vice Chancellor

Overview

Procedure for Cooperation and Recommendations

Having discussed the histories of cooperation within Ohio and the nation, the issues involved in cooperative efforts and the various alternatives forms that cooperation has taken in the past, the procedures for inter-institutional

cooperation that the Task Force feels will achieve the most success will be discussed.

In Ohio, the task force believes that the best approach to inter-institutional cooperation is one that builds on the proven ability of the Ohio Board of Regents to operate in a coordinative mode. In addition, the task force believes that the best approach to cooperation is to undertake a continuing effort based on the demonstrated functional needs for and proven abilities in computing evidenced in institutions of postsecondary education in Ohio. The broad functional areas for computing as discussed above are:

1. Teaching Languages and Concepts
2. Problem Solving
3. Production Processing

Within each of these areas there are significant opportunities for cooperation with respect to hardware, software and data. Furthermore, operating in a functional context permits the evaluation of the cost effectiveness of a particular alternative or set of alternative opportunities.

Recommendations

The Task Force makes the following recommendations:

1. **In the area of access to computing—**
   - A. **The Task Force encourages the institutions and the Ohio Board of Regents in pursuing sharing of computing resources as the resulting regional centers, shared networks or other cooperative efforts will offer the institutions additional avenues of securing services for their computing needs.**
   - B. **The computer services needs of the two-year colleges must be given equal consideration and that the two-year institutions be involved in any inter-institutional planning for regional centers and/or statewide networks. To this end it is recommended that the two-year colleges form a committee that will represent the colleges in any formal discussions regarding the needs of the two-year colleges and will act as spokesmen in any planning efforts.**
   - C. **The regional computer centers presently operating and planned for the future should make provisions for two-year college representation on the governance of the organization.**
   - D. **The regional centers presently operating and planned should concentrate part of their efforts in the areas of providing for interactive processing, computer-assisted-instruction and computer-based instruction.**
2. **In the area of administrative data processing — as discussed in Chapter III a committee be formed on administrative data processing and charged with the tasks listed therein regarding uniformity of procedures and application systems doelopment.**
3. **In the area of instructional applications of computing the following recommendation is made:**
   Organize a committee of two-year college personnel directly involved with using computers as tools in instructional support and services. The committee should be managed by a working group composed of interested members of the committee and chaired by a member

of the staff of the Board of Regents or his designee. The committee should accomplish the following:

A. Develop a two-year college inventory of instructional support and services which involves the use of a computer.
B. Exchange with all colleges the experiences gained by each college in using the computer as a teaching aid.
C. Publish a newsletter for sharing those ideas that are thought to be most useful to faculty who wish to use computers in their courses.
D. Develop a library of CAI, CMI, CBI and problem solving applications and documentation.
E. Plan a periodic workshop wherein computer-oriented teaching ideas can be exchanged and developed.
F. Identify and disseminate cost-effective techniques for providing adequate computer use at minimal cost. These will include cost comparisons of different computer utilities, terminals, applications and use techniques.

Role of Board of Regents Staff

The Task Force recommends the following roles for the Board of Regents staff in the computer services area:

1. Each time the Regents Master Plan is created, a computer services component of the plan should be included. The computer services component will be used by computer services planners and administrators in the same manner as institutional administrators use the Master Plan.
2. Board of Regents staff should serve as central point of contact regarding hardware coming to or leaving the public campuses. This will allow for maximum utilization of accruals among institutions.
3. The Board of Regents plan and conduct a one and one half day computer services seminar for all university and college presidents and chief executive officers. The purpose of the seminar will be to acquaint the officers of the institutions with the present status and trends in computing, the capabilities, limitations and potential of computers in solving problems within the institution and to answer specific questions they may have regarding computers. The goal of the seminar is to increase the awareness of the officers in terms of how the computer can assist them to direct the institutional resources on an administrative and instructional level. The seminar will involve business leaders, computer manufacturer representatives, private consultants, college and university computer services specialists and Board of Regents staff. There will be no marketing presentation of equipment since this can be obtained on a local level. Topics for discussion will be solicited from the participants prior to the seminar.
4. Board of Regents staff pursue the feasibility of statewide acquisition of computer-based management decision-making tools such as CAMPUS, RRPM 1.6. etc.
5. The Ohio Board of Regents staff provide the expertise and assistance to the two-year colleges in the areas of interpreting, maintaining and using computer-based management and planning tools such as those available from WICHE/NCHEMS.

APPENDIX

APPENDIX 2.1 TECHNIQUES FOR FORECASTING

Forecasting Techniques

Good forecasting procedures are clearly essential in all aspects of planning since the prediction and estimation of occurrences of future events provides a basic input into the planning process. The comparison of alternatives requires that the most likely future consequences be determined. The significance of forecasting in the planning process has resulted in researchers developing an exceptionally wide variety of techniques to assist the forecasting effort.

Forecasting techniques can be subdivided into two basic categories, each including a number of techniques.

I. Judgmental forecast techniques
   a. Judgmental forecasts
   b. "Delphi" method
   c. Scenario method

II. Model-based Forecasts
   a. Analytical models
   b. Simulation models
   c. Intrinsic models (Curve Fitting, Time Series)
   d. Extrinsic models (Regression, Econometric, Input/Output)

Ia. Judgmental Forecasts

In this most fundamental and perhaps the most frequently used technique, future values of a variable are predicted by directly specifying their level. Although this technique is sometimes criticized as being unscientific, it is probably true that an experienced forecaster takes into account far more information and processes this information more consistently than many "model-based" techniques. A danger seems to exist when inexperienced persons make forecasts, and when individual forecasts are merged into "consensus" forecasts. In these situations the lack of formality in both forecasting assumptions and analysis quite often result in inadequate projections at any point in time and in consistent projections through time. Those responsible for computer service planning should insure that the assumptions used by those involved are uniform, well understood and in agreement with the assumption being employed by upper management.

Ib. "Delphi" Method

The technique has been used to forecast future technological events by a method of iterations. Basically, experts respond (anonymously) to a well-defined forecasting question. The responses are then statistically summarized, returned to the experts, and revised forecasts are prepared. The procedure ends when a consensus or total lack of consensus is achieved. The merit of the procedure lies in its ability to maximize the advantages of group dynamics in forecasting, while minimizing the problems caused by dominant personalities and silent experts.

Generally, the "Delphi" method utility also lies in its use of a large sample of experts. This may not be the case generally within a computer services unit. A mini-Delphi method

may be used within an institution or, possibly of more benefit, computer services directors could employ the technique on an inter-institutional basis to answer common forecasting problems such as — the duration of IBM maintenance of 360 computers, the most likely timing and significance of future equipment announcements, the growth rates of CAI on campus, the effects and timeliness of significantly lower cost of core storage.

Ic. **Scenario**

The procedures are initiated by postulating a formal set of assumptions (a scenario) about the future environment. Logical arguments are then utilized to develop various specific consequences of these assumptions and these consequences form the basis for the forecast.

II. **Model Building Forecasts**

The majority of model building forecast techniques involve a description of the situation in mathematical terms such that the outcomes of various change can be quickly and economically established via mathematical computation. The computer is used in most model building forecasts if there is some complexity and this has led to the development of a number of simulation languages (GPSS, SIMSCRIPT, PLANTRAN) as well as application programs available on computer libraries.

The simulation languages allow the fast development of the mathematical model of the process, and this in turn allows quick response to "What if" types of questions.

These application programs provide detail quantitative information regarding a number of areas of concern to computer services management.

cashflow analysis	buy-least projection
depreciation expense	growth projections
PERT	linear regression
Monte Carlo simulation	

The use of these canned programs is usually cost effective since no development time need be spent — all that is required is the submission of the appropirate data and (what is sometimes overlooked) an understanding of the underlying assumptions in the model.

APPENDIX 4.1 HARDWARE AND SOFTWARE MONITORS

Performance Monitoring

Before the advent of multiprogramming within third generation computers, it was a relatively easy task to determine how efficiently each piece of computing equipment was being used The concurrent execution of multiple programs makes this determination more difficult. Performance monitors, however, are available that have the capability and have been used successfully at computer installations to gather data regarding the actual status, (i.e., busy or wait) of critical components (i.e., Central Processing Unit (CPU), channels, peripheral devices) of the computing equipment. In some cases users have found that they can both downgrade their configuration and at the same time increase their throughput.

The performance monitor records events such as CPU busy, channel X busy, CPU in wait state, etc. The data gathering portion is followed by another phase wherein an analysis is performed on the recorded events and a report is generated. The report provides information on utilization at a level that is not available with job accounting packages.

Types of Monitors

Performance monitors are available as hardware monitors or software monitors.

Hardware Monitors

Hardware monitors consist of high impedance probes that are physically inserted into the computer circuits. The probes' other ends are connected to counters generally through some logical circuitry. By sensing electrical signals within the computer, the monitor can count events during a time period or determine a time period between successive events. In addition to the probes, counters and logical circuitry for event or time interval counting, analysis programs are provided to analyze the raw data and for preparing the performance reports. Hardware monitors have the following characteristics:

Advantages of Hardware Monitors

- They do not increase computer overhead
- They are applicable to many makes and models of computers
- They can make direct measurements on peripheral devices

Disadvantages of Hardware Monitors:

- learning to use hardware monitor requires substantial amounts of time
- chance of error in placing probes on wrong point

Software Monitors

Software monitors perform the data recording function via a routine that is resident in main memory during the measurement process. One technique involves the use of interrupts of the processing during which the software quickly samples the status of designated components and, in effect, asks if the CPU is busy, if the printer is busy, etc. As with the hardware monitors, analysis and reporting routines are provided for preparing the measurement reports.

Software monitors have the following characteristics:

Advantages of Software Monitors:

- They are generally easier to learn to use than hardware monitors
- They are more versatile in that they can collect as much or as little data as is required, based upon the results obtained

Disadvantages of Software Monitors:

- They can only be used with a specific hardware/operating system configuration
- They use memory space, CPU cycles and channel time

Use of either hardware or software monitors results in the following problem areas:

- need for monitor specialist
- decision regarding data to collect and measurements to take
- decision regarding interpreting results

APPENDIX

Experience with Monitors

Third generation computing experiences with monitors began about 1967-1969 when independent companies were forced to develop and market monitors. In higher education, Brigham Young University (BYU) located in Provo, Utah became interested in monitors in 1970. They acquired and employed rather successfully a portable hardware monitor for their on-campus computer monitoring. As their experience grew with hardware and software monitors, they consulted for other organizations and began to offer two-day seminars on performance monitoring.

The director of BYU (Dr. Gary Carlson) has stated that there are three goals for monitoring (a) save money (b) understand the system better (c) indicate trends that will lead to better service and lower costs. His claim is that in all of his and his associates' experience to date, they have always been able to find ways to both reduce the size (and/or cost) of a configuration and at the same time to increase its throughput. Their main attention has been devoted to configuration utilization, because this seems to provide the greatest payoff from monitoring. Benefits are also obtained by improving inefficiently coded programs.

Costs for Performance Monitoring

The costs associated with monitors are the salary of one or more specialist(s) and the cost of the monitor. Purchase costs range from $9,000-$35,000 for today's leading hardware and software monitors. If monitor specialists are employed for approximately one week, the cost, including use of the monitor, would be about $2,000 per installation with multiple installation cost saving arrangements possible. Independent consultants with extensive monitoring experience would be preferable if outside services are desirable, since no equipment bias would exist as might occur with computer manufacturers, peripheral equipment suppliers or monitor suppliers.

APPENDIX 6.1 EXAMPLES OF EXISTING COMPUTER NETWORKS

California State University and Colleges
Distributed Computer Network

California State University and College Network

The distributed network was created in 1969, and under the direction of the Office of the Chancellor, provided computing access to approximately 275,000 students and faculty in California's 19 state colleges. The host computers are two CDC 3300's, regional computers located in the northern and southern part of the state, a CDC 3170 computer for time sharing at San Fernando Valley College and an IBM 360/91 at UCLA for unique software requests or excessive computing power. The four host computers are interconnected and service computers such as IBM 360/40's, IBM 360/20's, CDC 3150, and an NCR Century 200 on the 19 campuses. The network configuration as of April, 1972 is illustrated in Exhibit 6.3

The original design called for 80 percent of the computing to be accomplished locally and 20 percent at the regional centers.

California made a deliberate effort to combine the instructional and administrative workloads in this network. The emphasis was to allow instruction to be handled locally on campus. Each college with more than 5,000 full-time students was given a stand alone computer for instruction.

The percentage of the types of computing being completed locally and centrally are as follows:

	Locally	Regional Centers
Instructional	85%	25%
Research	5%	25%
ADP	10%	50%

In the development of the local campus facilities the first two priorities were:

1. provide computer services to student and allow faculty to expand computed-based courses
2. provide increased capability for faculty to do research.

At the regional centers the priorities which were used as guidelines were:

a. administrative
b. instruction

The systems software, as well as the planning and policy making, were centralized.

TUCC

Triangle University Computer Center (TUCC)

TUCC was formed as a private corporation in 1965 in order to realize economics through computer load sharing. The three owners of TUCC and their associated equipment are:

DUKE UNIVERSITY
- 360/40 as a terminal
- both I/R and ADP being done at TUCC

UNIVERSITY OF NORTH CAROLINA
- 360/75 as a terminal
- I/R — 50% handled locally and 50% at TUCC
- ADP — separate computer on campus
- Public Service — separate computer on campus

NORTH CAROLINA STATE UNIVERSITY
- I/R work done at TUCC
- ADP IBM 360/40

The TUCC does not develop any application programs but rather only provides computing access. The charging algorithm was set up such that as your level of service, compared to the other universities, increased your turnaround time would increase.

The problems associated with TUCC have been:

1. Daily courier service required for tapes, etc
2. TUCC not as sensitive to local needs

The factors that contributed to TUCC's success are:

- Closeness of each university to TUCC (15 miles)
- History of close cooperation among universities
- Legislature made TUCC facility a local call from each university

A change that has taken place since the development of TUCC has been the addition of a HASP-to-HASP capability that allows load leveling between any of the four computers – the TUCC and the three university computers.

Michigan Education Research Information Triad, Inc.

MERIT

The primary goal of this arrangement between Wayne State University (WSU), Michigan State University (MSU), and the University of Michigan (UM) was for the sharing of resources, that is, to obtain service not available locally. The MERIT effort has been assisted by a $400,000 grant from the National Science Foundation (NSF) and a matching grant from the State of Michigan.

The three host computers are two IBM 360/67's and one CDC 6500.

UM 30,000 FTE students

I/R computer IBM 360/67 (duplex) with 70-80 terminals

ADP computer

MSU 35,000 FTE students

I/R computer CDC 6500, CDC 3600

ADP computer (2) 360/40's, (1) 360/30

WSU 22,000 FTE students

I/R computer – } 360/67 (duplex)
ADP computer – }

The major problems associated with MERIT have been the handling of one university charging another for time, especially when one university becomes a center of gravity causing balance of payments problems.

The advantage of MERIT lies in the variety of computers (CDC's), data files (local) and software (IBM's) that are available to each participant.

New Jersey

New Jersey Educational Computer Center

A public not-for-profit corporation was formed to provide computer related services to the state's public and private colleges. There is a 19 member board representing the user institutions, the Chancellor of Higher Education and the public.

The network uses three large computers that had been installed at Princeton and Rutgers prior to the formation of the corporation. Fifteen public and five private colleges receive services. Both resource sharing and cost savings have been the objectives. The corporation has contracted with a commercial firm for some application program software development. The host computers for the network are:

Princeton University
IBM 360/91
IBM 360/67

Rutgers University
IBM 360/67

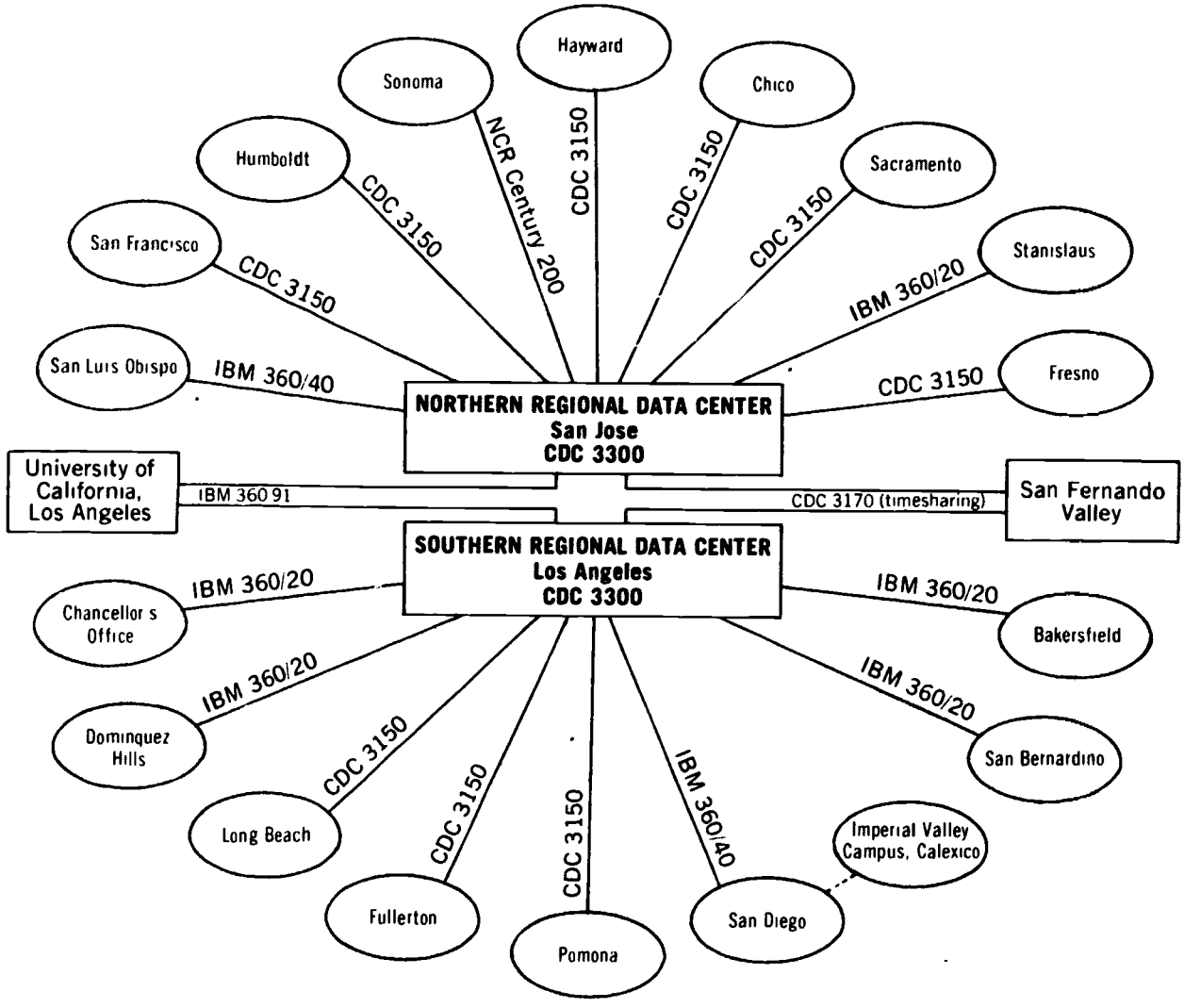


EXHIBIT 6.3 **DISTRIBUTED COMPUTER NETWORK — THE CALIFORNIA STATE UNIVERSITY AND COLLEGES April, 1972**

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