COMPUTER SERVICES FOR BUSINESS SCHOOLS:
A PROCEDURE FOR ANALYSIS AND APPLICATION TO THE SLOAN SCHOOL OF MANAGEMENT

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Submitted to the Alfred P. Sloan School of Management on May 10, 1974 in partial fulfillment of the requirements for the degree of Master of Science.

This thesis seeks to develop an understanding of the problem of selecting computer services and facilities for a school of business and management. A general framework for the decision area is described. The intent is to model the decision process as an aid to administrators faced with this class of decisions.

The process of computer facilities and services selection is seen to have three components: Evaluation of Needs, Examination of Technological Developments, and Development of Resources. These three components interact to affect the final decision.

A survey of business schools was undertaken to learn how these components interact in a variety of situations. The survey highlighted specific issues central to the decision process: the setting of educational priorities, determination of modes of computer use, and resource allocation and charging policies.

Synthesizing the results of the survey with earlier normative concepts gained from the literature yields a three-level hierarchical model of the decision process. The three components discussed earlier are placed in a specific relation to each other. Each is an on-going process that periodically is linked to the others to yield a decision.

The model is applied to the Sloan School of Management as a case study analysis. Part of the evaluation process includes a survey of student attitudes about the current computer facilities. Finding the current facilities somewhat less than satisfactory, a recommendation is made to develop a mini-computer-based timesharing system which will also permit remote job entry to the Institute's central batch processing facility.

Recommendations for further application of the model and development of normative theory conclude the thesis.

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CHAPTER 1

Introduction

1.1 Statement of Problem

The primary questions this thesis was designed to answer are:

1) What computer facilities and services should a business school provide for the use of its faculty and students?
2) How should decisions on this subject be made?
3) What is available to meet the needs?

The motivation for answering these particular questions at this time stems from several considerations. The variety of computer hardware and software available is proliferating at a rate that has already surpassed the ability of many educators to keep current. New applications of these tools to business and management education are rapidly being developed. Secondly, the computer is increasingly in demand as a computational tool for use in both faculty and student research. Most recently, a third form of interest in computers has surfaced: computer systems and their business and management applications have themselves become subjects of detailed study at many schools.

The need to have available or to have access to some computer facilities is now easily perceived. It is no sooner perceived, though, than questions arise of "how much?" "what type?" and "from where?". Our intention is to present some answers to these questions.

The type of answer we propose to give is not a solution. Rather, we shall present an approach to solving these problems; a series of models for making the relevant decisions. We shall map out the decision area, giving models which are useful in considering the computer facilities selection and evaluation decision. We hope our "answer" will be seen as a guide for the decision makers at a business school or school of management who have chosen to address themselves to these problems. It is intended as a procedure that they can use to arrive at a solution to their particular facilities and services problems.

The need for attention to the questions outlined above is very much felt at the Sloan School of Management. Much of the motivation for embarking on this study came from a hope expressed by several members of the faculty and administration that the results could be brought directly to bear on Sloan's problems. We have therefore attempted to do just that, and the results are discussed in the form of a "case study" as a later chapter in this thesis.

Our role in this regard may be characterized as "unofficial consultants." We hope our recommendations will lead to modifications at the Sloan School facility. There is one further reason, however, for undertaking to apply our results to the Sloan School problem. This has to do with "calibrating" our models and our decision procedures by matching them against a real situation. Political and other factors that do not tend to be reflected in answers to questionnaires are nonetheless important considerations. The best way to learn about these, we felt, was to delve into a real version of the problem.

The goal of our efforts has thus been to produce a policy-oriented and usable guide to problem-solving for the business school computer facility problem area. We proceed now to describe in more detail the context, or background, for this problem area.

1.2 The Decision Context

The problem statement that preceded this section hinted at several distinct uses to which computers might be put at a business school. The purpose of this section is to examine these uses in more detail and characterize them in ways that will be useful later in the discussion. After outlining these uses of computer resources, we will consider some of the "technological" information bearing on our subject area. Specifically, a brief discussion will be presented of the types of resources available to serve these uses and the ways in which resources may be combined to fulfill particular types of needs. Lastly, we will draw some comparisons and some distinctions between our chosen problem area and other relevant problem areas that have already been the object of some study. All this is by way of giving the reader a general overview of the terrain to be traversed in the remainder of the thesis.

1.2.1 Uses of Computer Resources. Three types of computer usage at business schools were previously distinguished. Each of these now bears closer examination. The first might be called "instructional." Included herein are all methods whereby a computer is used as an educational tool to assist the student in learning some specific subject area. The simplest of these arrangements is what is commonly understood by the term "teaching machines." A mechanized version of Programmed Instruction, it consists chiefly of programs designed to present portions of curriculum material and to administer questions to test the student's grasp of the material. Further presentation of material is keyed to the student's progress. Typically, student-computer interaction is via a typewriter-like computer terminal. "Canned programs" are sets of computer programs designed to allow the student to explore operations in a particular subject area (e.g., accounting or inventory control) in a less rigidly structured way than programmed instruction. Canned programs enable the student's participation in the learning process to be a more active one. The term "Computer Assisted Instruction" (CAI) is sometimes used to refer to both types of instructional programs, but more frequently refers only to the former.

Further along on a hypothetical spectrum of instructional uses of computers are computerized cases. These involve use of the computer to present both the substance and the environment for solution of a case study example. In some sense the most advanced instructional use of computers is in simulation or "management games." These are specially designed to simulate situations illustrating various areas of management concern and requiring the participants to make decisions which then determine the further progress of the game. Typically these games include elements of competition, uncertainty of information, simultaneous effect of various factors, and time limitations.

We can characterize the instructional uses of computers as chiefly interactive in mode and thus typically requiring terminal devices that facilitate such interaction, as well as the ability to support many users on-line simultaneously. From the software viewpoint, these uses tend to require substantial development work (beyond the basic systems software) and can turn out to be less flexible than desired unless knowledgable persons are on hand to implement modifications.

The benefits of such developmental work, once performed, can usually be exported, allowing many schools to use packages developed for a particular situation. Such sharing often takes the form of bartering, and when documentation is good, can be of much benefit to all parties involved.

The second use distinguished above is as a computational tool for faculty and student research. Here is invoked the computer's longstanding ability as data processor. Most applications in this area can be cast into one of two types. First is ordinary "number-crunching"; using the computer to perform computational tasks that simply would not be possible any other way. Second is use of the computer for modelling and simulation. The most common areas using computer resources for these purposes are Finance, Econometrics, Statistics, and Industrial Dynamics. For these purposes, computer usage is often in batch mode (non-interactive) and substantial computational power is frequently required. A variety of programming languages and problem-oriented languages for ease of problem expression characterize a good environment for such usage. The emphasis recently has been on specialized packages designed to simplify the expression of a class of problems (i.e., statistical manipulations) without sacrificing power and flexibility.

The third use of computer resources is for the study of computer applications for their own sake (not purely for their own sake, of course, but rather for the purpose of learning about business and management applications). Herein included are courses in computer programming, computer architecture, management information systems, decision support systems, and systems software design. While it is not absolutely necessary to use computers in order to study the analysis, design, and implementation processes involved in developing business computer applications (or non-business management applications, for that matter), availability of computer resources with which to conduct project work enhances these studies. Courses in computer programming and software design naturally tend to make quite heavy use of computer resources. Beneficial to such uses are some interactive capacity, sound batch processing capability, and even a system or portion thereof allowing hands-on operation.

1.2.2 Technological Background. We have, unavoidably, made references to various terminology and concepts of computer hardware and software, which now perhaps deserve some explanation. The reader familiar with all the details of computer programming and equipment may find this portion somewhat simple-minded.

Computer hardware can be broken down into many fine categories, but we will simply divide it into "mainframes" and peripheral equipment. Mainframes vary in size, speed, set of programming instructions, and basic architecture.

Minicomputers, with cycle times of about one microsecond and a few thousand words of main memory, are at one end of the spectrum. Large general-purpose "maxis" with cycle times of a few nanoseconds and a few million words of main memory are at the other end. The mainframe architecture can be more or less suited to timesharing (simultaneous support of several users on-line) versus batch processing. It can be more or less suited to character versus number processing. It can be dedicated to hands-on use, or shared between several users in a multiprogramming environment (this simply means that several programs are being attended to concurrently). These characterizations are not dichotomies; there is much middle ground. Although they may be seen as technical details with which administrators need not be concerned, they will play an important part in the selection process as it is developed.

Computer peripheral equipment consists of devices for input and output, and devices for secondary storage. These secondary storage devices (such as disks and magnetic tapes) will be of lesser importance in our later discussions than the input/output devices which are the means by which the users communicate with the computer. Communication is of paramount importance in education. The primary input/output devices of interest to us are card readers, printers, and terminal devices. The terminal devices (either graphical display or hard-copy typewriter terminals) are the essence of interactive use of computer systems, and new types of terminals with new bells and whistles have been developed specifically for educational applications.[1]

The above types of hardware may be combined in a number of ways to yield system configurations advantageous to differing modes of use. Perhaps the most straightforward is simple batch processing. Users jobs are fed into the system one after another, the necessary computing is performed, and the results printed out. This is the standard mode of operation of large central computer facilities. An embellishment often added consists of a unit combining a card reader, a printer, and the necessary communications electronics that may be located at a site remote from the central computer. Such a device, known as a remote job entry (RJE) terminal, allows somewhat decentralized use of the computer (as its name implies). A minicomputer may also be located at such a remote site acting as a "front end" to the larger central computer and performing certain tasks before passing on the jobs to the central facility. Access to a central computer from remote locations has obvious relevance to the problem of selecting facilities for a user community (a business school) that is part of a larger whole.

In a system configured to support timesharing, the

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1. Peter M. Carey and John Tate, "Computer-Aided Learning - Student Terminals - Some Recent Canadian Innovations," Proceedings of the Canadian Symposium on Instructional Technology, 1972.

terminal devices may be located centrally and be connected directly to the computer (hard-wired), or they may be located remotely and access the computer via dial-up telephone lines. This capability provides flexibility in the use of instructional systems, which as we have mentioned depend on substantial interactive capability.

It should certainly be mentioned that batch processing and timesharing are by no means mutually exclusive. Both modes of use may coexist on a single computer and operate simultaneously. Naturally, smaller computers would have difficulty handling such mixed usage, and are typically dedicated to one type of usage or the other. Larger and more powerful computers can readily support both.

As we have suggested, successful instructional use of the computer relies on good timesharing facilities. What constitutes "good facilities" can vary widely depending on the exact needs, though. This point will receive further elaboration in later chapters. For research use and for computer systems study, strong batch processing capability can be used to absorb the bulk of the "number-crunching" load, as well as much program development and testing. Time-sharing capability can be very useful for development and test work, because of the interactive nature of those tasks.

The foregoing has been intended as a descriptive, rather than normative, overview of the relevant types of computer resources and their possible uses. The information presented constitutes the basics with which an administrator should be familiar.

1.2.3 Similar Decision Areas. To conclude this chapter, a few words are appropriate about how the decision area being considered here (i.e., facilities selection for business schools) compares to some similar-sounding areas. In particular, selection of corporate data processing facilities is a topic that has received a certain amount of attention. Certainly some of the types of analyses developed for that class of decisions are relevant to our topic.

Typically, however, corporate data processing tasks are periodic in nature, with high data-manipulation and input-output content and low user interaction content. Emphasis is on reporting and data-base management. University computing, by contrast, is less easily forecastable (i.e., more irregular), with high computation (as opposed to mere manipulation) and user interaction content. Thus, the needs of corporate data processing differ in too many ways from the needs of an educational institution to enable this analysis to benefit measurably from the conclusions of corporate data processing studies. The question of selection of facilities for universities as a whole has also received some attention, but again there is reason to believe that these studies do not fully meet the needs of business schools. In particular, a university typically has more control of its own affairs than does a business school. Also, the volume and range of demand are usually of a different order of magnitude for a university, making their facilities selection problems of a distinct nature from those of a business school.

This study is intended to fill a perceived gap, therefore, and to serve as a guide to administrators in this decision area.

CHAPTER 2

Process Models for the Facilities and Services Decision

The purpose of our research was to develop a normative model of the procedures used by business school administrators in choosing computer facilities. A literature search was conducted to assist in developing process models for this decision area.

The conventional literature search (books, periodicals, indices, etc.) produced little in the way of useful references. Therefore, a search on the topic was performed using a computerized data base.[1] The ERIC data base consists of a collection of references and abstracts of periodicals, articles, and proceedings pertinent to the field of education. The automated literature search revealed that much of the information within the field of computers and business schools is concerned with one minor aspect or another of a multifaceted system (e.g., utilization of management games at a business school); none of the sources dealt with the problem of how to select computer facilities for a business school, although some of the authors did address the large

1. The ERIC (Educational Resources Information Center) system is maintained by the Northeast Academic Science Information Center. On-line searches are conducted by information specialists in consultation with the users.

scale problem of choosing university computer facilities.[2]

Most helpful as sources of information were studies performed at several business schools about their own computer usage and made available to us. They revealed varying philosophies and attitudes about computer usage and the results of implementing these philosophies.

The substance of this chapter synthesizes the information gleaned from the literature to develop a framework for the facilities development process. The framework relates the component process models to each other to create a unified whole.

2.1 A Framework for the Facilities Development Process

We present here a framework for considering the factors and forces that constitute the facilities development process. The framework incorporates many of the traditional views expressed in the literature, as well as some more radical ones. Chapter 3 will present research undertaken in an attempt to verify aspects of this proposed framework.

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2. N.T. Bell and R.D. Moon, "Teacher Controlled Computer Assisted Instruction," Michigan State University, 1969, and R. Code, "An Administrator's Guide to Computers," College Management, Oct., 1972, and R.E. Levien and S.M. Barro, "Framework for Decision," in The Emerging Technology, R.E. Levien, ed., (New York: McGraw-Hill, 1972), and R.E. Levien and C. Mosmann, "Institutions," in The Emerging Technology, R.E. Levien, ed., (New York: McGraw Hill, 1972).

Three primary components of the process may be identified. First is identification of needs. This comprises resolving certain policy issues, summarizing the needs for computer services of the various user groups, translating these needs into computer requirements, and costing out the requirements. This key process component is an internal one (i.e., under the administrator's control), but is affected by the other process components which are chiefly external. (See Figure 1).

The second component is technological evolution in the computer industry. This macro-process is an on-going part of the external environment from the administrator's point of view. It is relevant to his problem precisely because it is a process of change in the environment. Technological evolution is today perhaps the dominating factor in the cost structure of computer resources. Certainly it is a process the administrator will want to take account of. As most computer facilities remain somewhat stable for periods of time while the technology continues to change, proper positioning can be important. In other words, at the time a major decision is made, a good understanding of the technological developments to be expected in the near future can prevent later regrets.

The third component is resource development and allocation. Computer facilities and services can only be provided at some cost. Ways of affecting the effective cost to the school, of providing funds to meet the cost, and of allocating the cost to the eventual bearers are all comprised within this component.

The three components interact to determine the facilities and services to be provided. They interact not independently, but rather affect each other with varying intensity. The circumferential arrows indicate the effects of each component on the others, while the central arrows signify their mutual action in determining the outcome of facilities decisions. Following sections explore the details of this process framework.

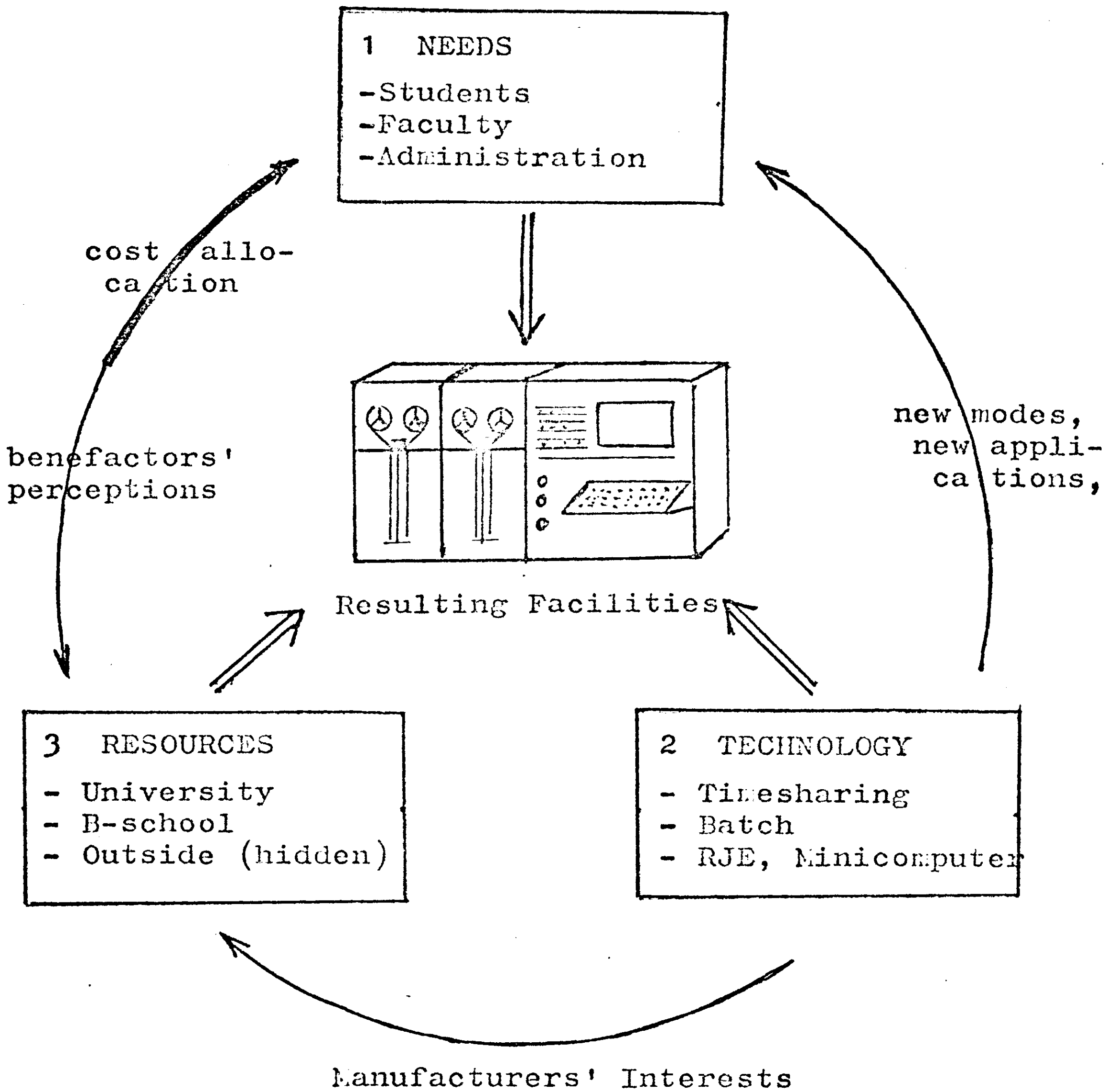

Figure 1. Framework for the Facilities Development Process

2.2 Identification of Needs

Before any new system can be developed, some criteria of effectiveness must be established so that the proposal can be judged as to the likelihood of success. In the case of business school computing facilities, the primary function is to provide a service to the user community. So the first question to be answered in developing proposed facilities is what are the needs of the business school for computing equipment and services. The process of answering that question will now be described.

First, the administrator must recognize the three types of usage of computing facilities, namely, administration, research, and instruction;[3] and then must identify the separate and overlapping needs of these groups. In terms of cost justification of a computer, very often the administrative uses are the most obvious benefits for a university. But in this instance, we are addressing the computing facilities to be chosen by a business school primarily for research and instructional use. In many cases, the business school's accounting system is a part of the university's accounting system and it would not be reasonable for the business school to undertake its own bookkeeping and data

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3. R.E. Levien, "Instructional Uses of the Computer in Higher Education," in The Emerging Technology, R.E. Levien, ed., (New York: McGraw Hill, 1972).

processing. Therefore, the primary needs which we will address are those of the faculty and students.

Before a realistic estimate of demand for computer usage can be established, the administrator must recognize the fact that in the years 1966-1972, U.S. business schools have drastically expanded their use of computers in teaching and research. To assist administrators in predicting demand, Stanford researchers have suggested and supported a cumulative process model of the development of computing in a business school. (See Figure 2).[4]

> "In the first stage, the computer is used by a few faculty members and Ph.D. students for research. Pressure from the external environment, changing faculty composition and interests, and student interest combines with the impetus provided by research to lead to a demand for a required computer course in the curriculum...The exposure of students to a required computer course then facilitates the utilization of computerized cases, exercises and projects in other areas of the curriculum. This widespread use of the machine builds student reliance on the computer in general and leads to the fourth and final stage in which the machine is treated as a general problem solving tool."[5]

Because of the variety of demands for computing at various stages of development within this model, the administrator must attempt to estimate not only the needs of the

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4. H.C. Lucas, Jr., et. al., "An Analysis of Computing Use at the Stanford Graduate School of Business," Technical Report No. 17, Graduate School of Business, Stanford University, Nov., 1972.

5. Ibid., p.2.

present users but also the needs in the future horizon over which the facilities will be used.

The basic decisions involved in choosing a computer facility are:

a) mode of access (batch vs. timesharing)

b) source of service (central vs. localized)

c) equipment (hardware and software), and

d) funding.

All of the issues in some respect are a function of the demand pattern of the user community.[6]

The arguments in favor of timesharing have been addressed extensively by both Dartmouth College and Stanford's Graduate School of Business. At Dartmouth, the Amos Tuck School found little utilization of its batch processing system a few years ago although it was available with free access to students. Even though all students were required to take one computing course, little use was made of the computer outside the class. However, with the introduction of a timesharing system, "the initiative in new computer applications at the Tuck School came largely from the students and not from the faculty."[7] In other words, with a system

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6. R.E. Levien and C. Mosmann, "Computer Services on Campus," in The Emerging Technology, R.E. Levien, ed., (New York: McGraw Hill, 1972).

7. J.P. Williamson, "The Time-Sharing Computer in the Business School Curriculum," Dartmouth Conference Proceedings, Dartmouth College.

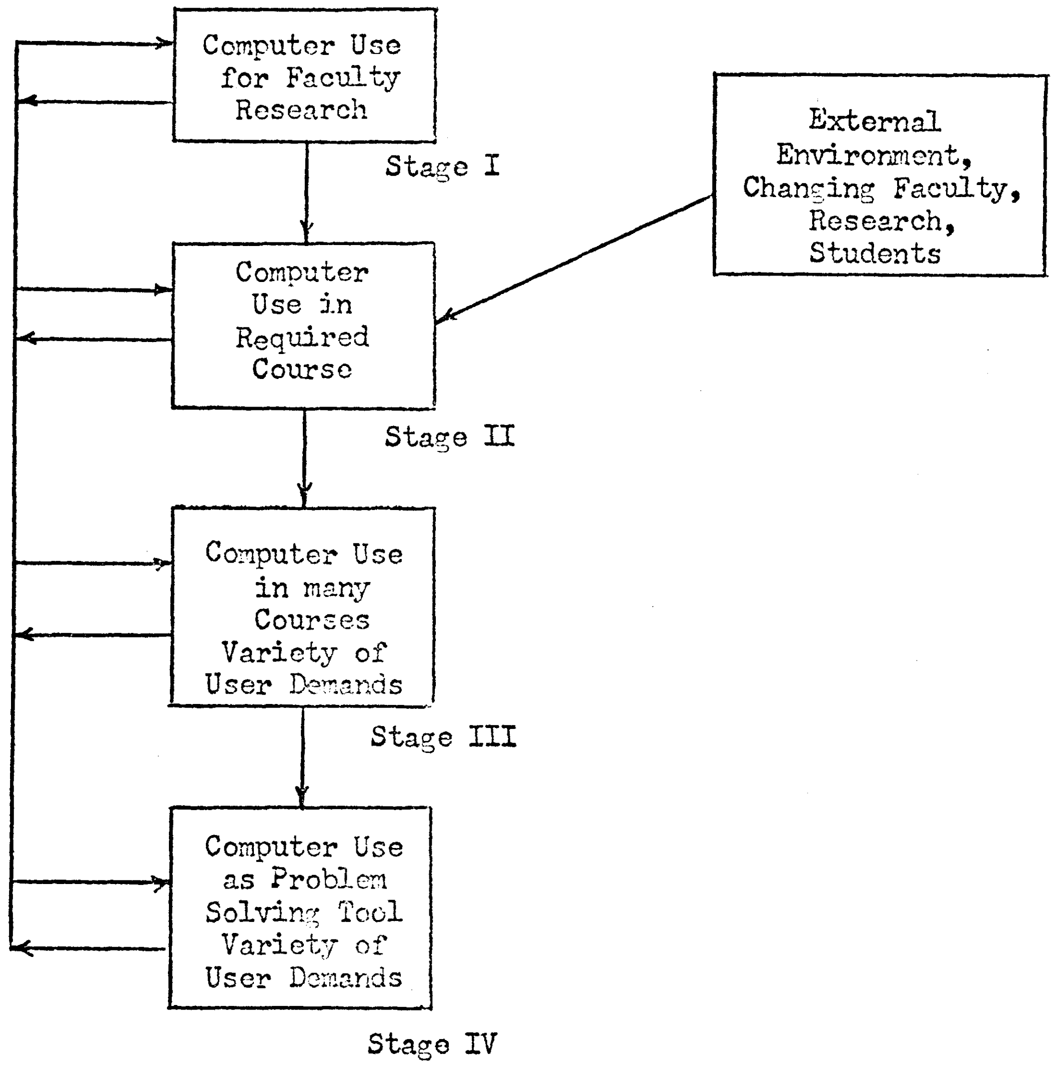

Figure 2: A Cumulative Process Model of Computer Use in a Business School

taken from "An Analysis of Computing Use at The Stanford Graduate School of Business", by H. C. Lucas, et.al., Technical Report No. 17, Stanford University, 1972, p. 2.

that was convenient for students to use, Dartmouth made a rapid progression through the process model.

At Stanford, a number of advantages of a dedicated timesharing system in a business school environment have been recognized. "It encouraged the development of new teaching and research uses directly through its availability and directly by freeing resources on a larger, general-purpose system."[8] At both of the universities cited above, the administrators have made timesharing a free-access service to the students and faculty; and prompted by this action, the users have become accustomed to treating the computer as a problem-solving tool.

Although a few very strong arguments have been made in favor of timesharing services, many of the business schools are still dependent on the university computing facilities, which are predominantly batch processing facilities. But the issue at question here is what mode of access is preferred for a business school computing facility. Batch processing equipment is often utilized for large research projects and MIS (Management Information Systems) development. However, the number of users at the business school community who utilize such programs is often small

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8. H.C. Lucas, Jr., et. al., "An Analysis of Computing Use at The Stanford Graduate School of Business," Technical Report No. 17, Graduate School of Business, Stanford University, Nov., 1972.

compared to the size of the population.[9] Given this fact, it seems that a business school should provide timesharing facilities to the large number of users whose needs are satisfied by such a system, and rely on the university batch processing system for its large scale computing needs. There are many machines available which could be utilized for time-sharing during the day and evening, and be used to satisfy some of the batch processing demand at night.

2.3 Technological Evolution

Although the available technology is essentially an outside influence upon the decision making process of choosing computer facilities, there are a number of general aspects of the technology which strongly influence the decision.

The process of hardware/software selection is basically an extension of the needs development mode. In general terms, the steps consist of:

a) identifying the instructional requirements
b) translating these requirements into computer system requirements, and then
c) translating the computer system requirements

9. A.W. Luehrmann and J.M. Nevison, "Computer Use Under a Free-Access Policy," Kiewit Computation Center, Dartmouth College.

into system costs.[10] (See Figure 3)
But beside these considerations, there are two current trends in technological development which affect the decision of choosing technology, and will therefore be discussed.

In the first place, hardware costs are rapidly decreasing, while software costs are rising. With 90% certainty, the cost per computer operation taking 1965 costs as a base, will drop by a factor of 200 by 1985.[11] In the future, therefore, software costs will tend to be the restraining factor in developing computing facilities. Similarly, minicomputers will likely become more important as a source of computing power due to the fact that they are easy to program and they do not require a large staff of system programmers.[12]

Secondly, the rapid advance of computer technology heightens the risk of obsolescence of computer equipment. The administrator must be aware of current developments so that he can choose the facilities that have the longest

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10. S.M. Barro and R.E. Levien, "Economics," in The Emerging Technology, R.E. Levien, ed., (New York: McGraw-Hill, 1972).

11. Ibid.

12. R.E. Levien and F.W. Blackwell, "Technology," in The Emerging Technology, R.E. Levien, ed., (New York: McGraw-Hill, 1972).

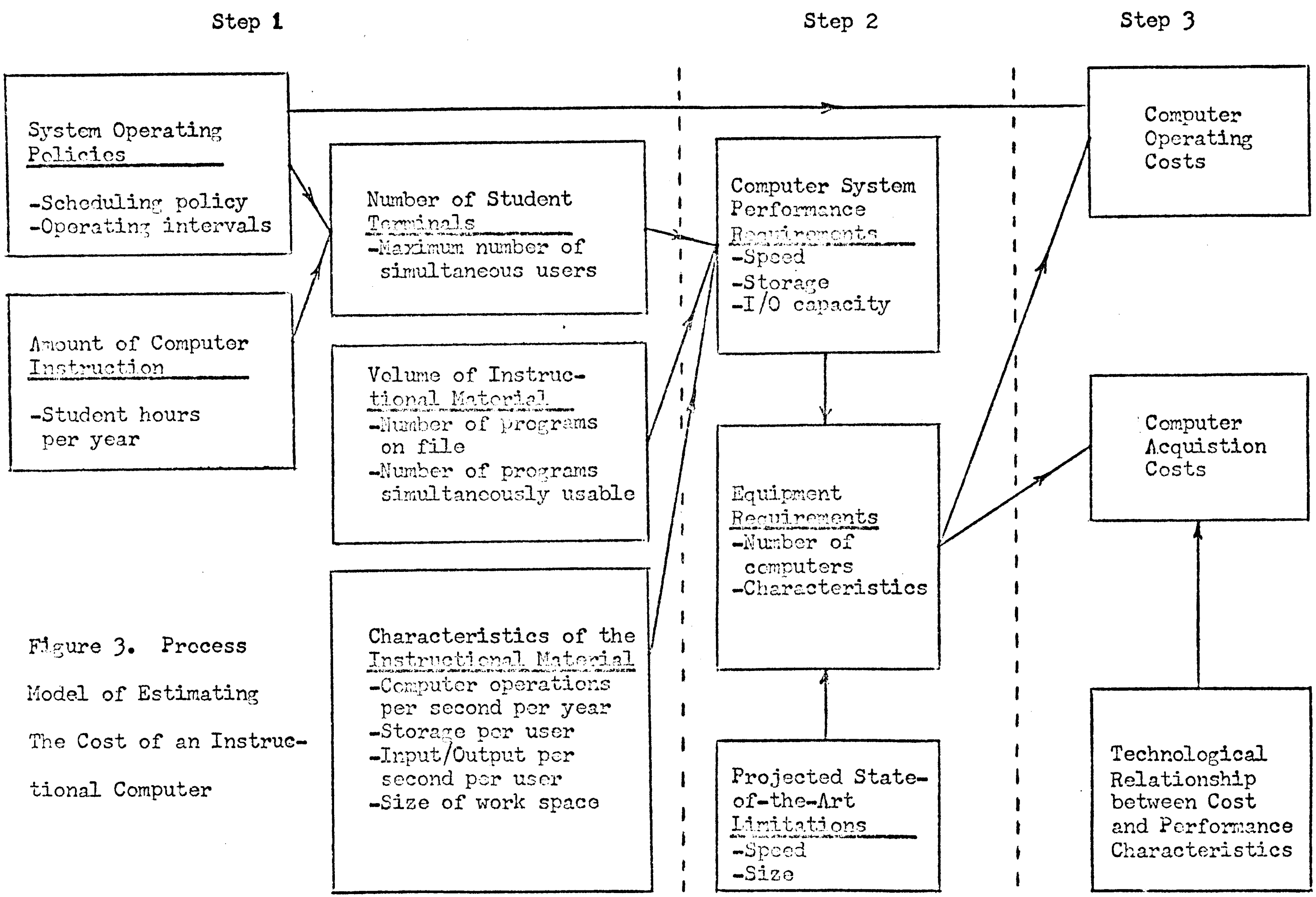

Figure 3. Process Model of Estimating The Cost of an Instructional Computer

anticipated lifespan.

2.4 Development of Resources

Having discussed the needs of the business school community, and the available technology to satisfy those needs, the next concerns are the questions of how the new facilities will be funded and who will bear the operating costs of these facilities. The answer to who will bear the costs is, in part, dependent upon how the facilities are funded, therefore we will address first the issue of resources available to pay for the facilities.

The most obvious source of funds for computing facilities is the university, especially if the business school facilities are part of a university computing system. In many instances, even if the business school has its own computing facilities, the university funds are being used to pay for the facilities. Because of this procedure, the business school is not free to go outside the university to purchase computing equipment unless it develops the resources on its own to fund such purchases. This type of system is necessary if the university desires to insure the success of a centralized computer facility. The reasons in favor of a centralized system are obvious, namely, the improved efficiency and wider variety of packages and languages available through centralization. On the other hand, with a decentralized system, the business school (or any department within the university) can exercise control over the computer facilities, including the selection of services particularly well-suited to its own needs.[13]

If the business school chooses to fund and manage its own computer facilities, there are resources other than the university available to fund the equipment. Within its own community, faculty sponsored research pays for its own share of computing usage and is therefore a source of revenue for the system. A less obvious, but still significant, resource is the business school students. Although they are not a source of revenue, per se, the students can assist in the software development for the system. Often this program development occurs as a result of student coursework related to computers, or as students perceive a need to use the computer in their other coursework. In the light of rapidly increasing software costs, student and faculty research can substantially reduce the expenses for outside consultants to develop software.

Another means of reducing the expenses associated with computing facilities is assistance from industry, whether it be in the form of educational discounts on computing equipment or donations. A sometimes-overlooked resource

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13. R. Code, "An Administrator's Guide to Computers," College Management, Oct., 1972.

outside of the university is industry. In the past there have been a number of instances where a computer manufacturer donated equipment to a university in exchange for software development. This was a worthwhile endeavor because the manufacturer would have to devote much time and money to collect the technical specialists that are readily available at the university.

Each of the resources cited above should be investigated when the business school is evaluating new computer facilities. Once the funding has been accomplished, the question arises as to how the resources will be allocated to the school's community, and who will bear the operating costs. If the computing facilities are part of a university system, then it is obvious that a university committee allocates computer services to the departments. But the business school has to allocate resources and costs to its community (whether it received them from the university or an outside resource) in the case where the business school has facilities independent of the university system.

There is a wide range of methods of allocating computer resources to the community. Administrators at Dartmouth have distinguished the two endpoints of this scale.

> "At one extreme, exemplified in varying degrees by most universities, computer use is treated as a marketable good, and allocation is by fee-for-service, on a pay-as-you-go basis...At the opposite extreme, represented here at Dartmouth College and at a few other universities, computing is regarded as a good that is priceless,

in the technical sense that economists use the word -- a good whose subjective worth is extremely difficult for an individual consumer to estimate in advance. Library use is an excellent example of another priceless commodity."[14]

Implementing the "library model" of computer usage, Dartmouth has shown the economic feasibility on a university scale over the past 9 years. In terms of availability of computer time to all members of the community at any time, Dartmouth has proven the success of its free-access policy. At Stanford's Graduate School of Business, "A dedicated timesharing system which is treated as a free good...has had a major impact on the environment of the school."[15] Stanford's administrators felt the elimination of charging should increase demand by both faculty and students and subsequently expand computer usage at the school.[16]

Although administrators at Dartmouth, Stanford's Graduate School of Business, and Harvard Business School have been convinced of the merits of free-access computer usage and have adopted such a policy, many other universities

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14. A.W. Luehrmann and J.M. Nevison, "Computer Use Under a Free-Access Policy," Kiewit Computation Center, Dartmouth College.

15. H.C. Lucas, Jr., et. al., "Integrating the Computer into a Business School Curriculum," Stanford University, Oct., 1973, p.l.

16. Ibid.

still retain the policy of charging on a fee-for-service basis. The free access policy does assume a system composed of a large number of users with small tasks to be performed; if this is not the case at a university then the policy may not be feasible. But in an age where knowledge of the computer is expected of all students in college, the provision of computer facilities on campus should be taken for granted by the university, just as library services are unquestionably provided. For those schools who choose to maintain a charging for service system, the allocation of computer services probably is similar to allocation of any other university resource; a list of priorities is established in terms of user needs, and services are distributed to fulfill those needs. The priority system is normally a function of which users can pay for the services (as in sponsored research) and which users require computer services for the instructional purposes. Although often the budgets are prepared on an annual basis, adjustments can be made during the course of the year in response to demand.

2.5 Component Interactions

The three component processes discussed above each exercise effects on the others. These can only be exploited if they are recognized, therefore this section is intended to explore them.

The process of technological evolution exercises an undeniable effect on the expressed needs of the user community. This is true simply because in the case of many technological innovations, the new innovations create their own demand. There is pressure to acquire the newest and the latest in both hardware and software, both for reasons of prestige and curiosity. More basically though, particular advances in hardware and software can have major impact on the computer's usefulness in the educational setting. The most obvious example is the development of timesharing. There can be little question that this product of the process of technological evolution has today a major role in university computer usage. Minicomputers are a more current example. By way of the new modes of use and new applications which they make possible, minicomputers are already having an effect on the perceived needs of both faculty and students.

Evolving technology can also translate into a resource. Manufacturers will often lavish substantial attention on the first few users to take delivery of a new system. This might be an ideal way to make a fixed amount of dollars go further.

Lastly, there are interactions between needs and resources. Although resources are primarily external to the process of formulating computer requirements, there are effects in both directions between these two components. The effect of needs on resources may perhaps best be captured in the following paraphrase of a comment by one faculty member: "The cost of a proposed system is not as important as it may at first seem. The more a system's cost, the greater the generosity of our benefactors will have to be." To the extent that benefactors perceive need, resources may increase with need. A decidedly stronger effect exists in the reverse direction. Depending on how the school's costs are allocated to the end user, expressed demand for computer services will vary. Typically, the more remote the allocation of costs, the greater the expressed demand, <u>cet</u>. <u>par</u>. Demand will be greater where the computer is a free resource, obviously. One can imagine the shrinkage in demand if individual faculty and students were charged for their usage. Intermediate allocation schemes also have their measurable effect. In Figure 1, the effect of allocation on needs was shown with a heavier line to distinguish it from the weaker effect in the opposite direction.

It remains now to understand how the three components interact in the decision process to yield a decision on computer facilities. The model we propose for this interaction is shown in Figure 4. Each of the primary component processes retains its identity and its nature as an ongoing process. The three are linked together by sequential flows when a decision is to be made.

The "needs" component is dominant. It leads into an examination of current and expected future technology. Comparisons suggest modifications. The modifications are studied to assure that they will serve the desired purpose. Cost and resource issues are then brought into play to meet the requirements of the proposed facility modification. If all goes well, the improvement is implemented.

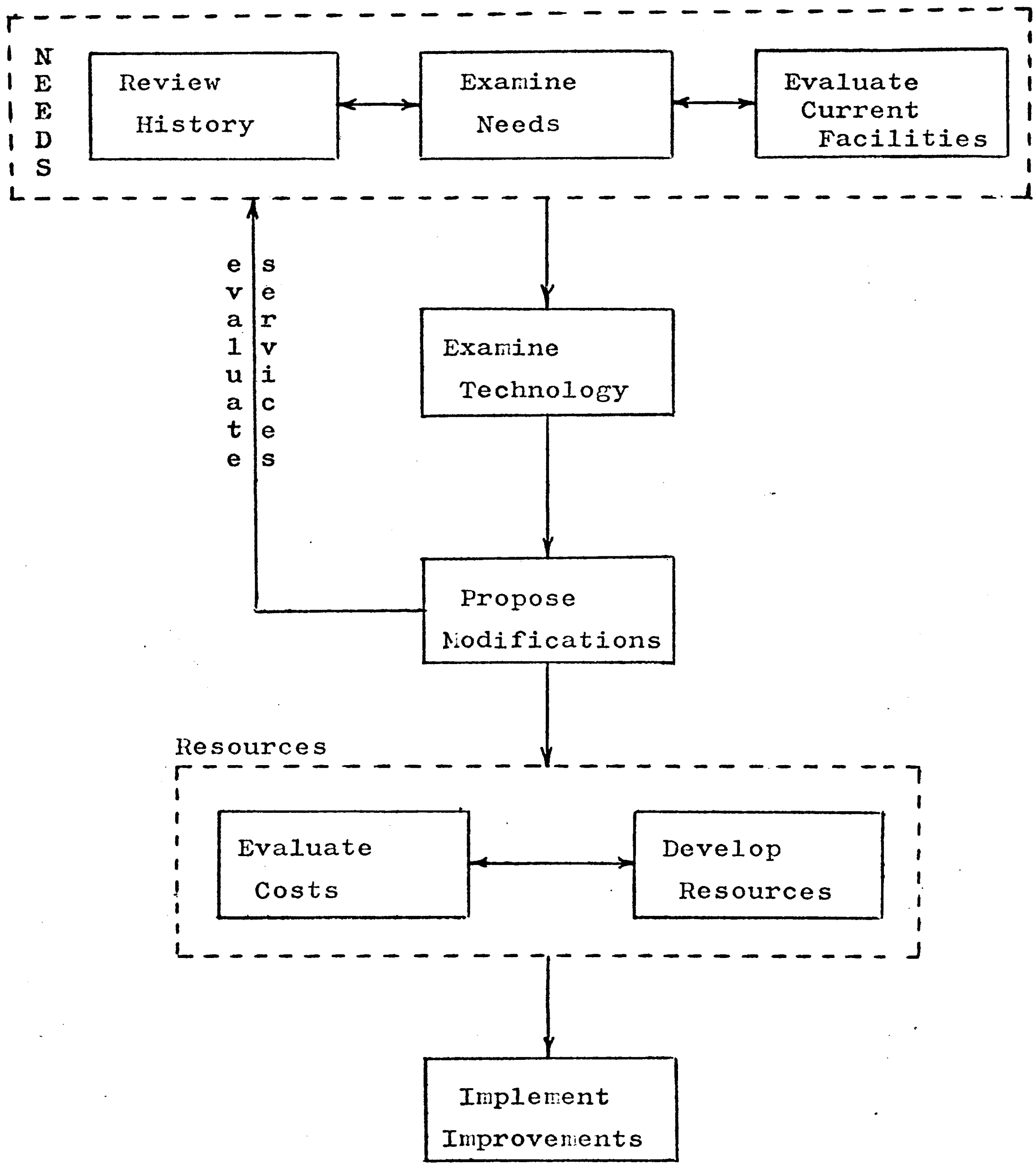

Figure 4. Components Linked in Decision Process

CHAPTER 3

Field Investigation

3.1 Development of Survey

To compare our normative framework with the real world it was desirable to obtain data detailing the nature of current facilities at a variety of schools, and also information concerning the process of selection of these facilities.

Basically, the relevant issues within the question of selecting computer facilities could be categorized into five areas: mode of access to the system, source of service, equipment utilized, management of the system and funding of the facilities. These criteria were addressed in part or as composite factors in many of the articles pertaining to computer facilities.

In terms of specific services which a business school should try to offer, a few articles made particularly noteworthy comments.[1] On a general level, a distinction has been made concerning teaching with the computer and about the computer. Both of these objectives play a signi-

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1. P.V. Thomas, "The Role of the Minicomputer in CAI," roceedings of the Canadian Symposium on Instructional Technology, 1972, and G.B. Strother, "Educational Applications of Management Games," Wisconsin University.

ficant part in the training of business students because as a subject, the computer is a vital factor in commerce, science, and technology, and at the same time it is a tool for both researchers and administrators.

Some recent interests in the area of teaching with the computer are the use of computer algorithms in teaching accounting and the use of management games at the undergraduate level as an integrator of previously learned material. The computer algorithm for accounting is an appropriate teaching method because most accounting techniques involve a sequential process of solution and most internal auditing systems are computerized.[2] Management games not only draw from the students' background in finance, marketing, and production, but the games also utilize in a real-life situation statistics and probability theory.[3]

Drawing from these concepts as discussed in the literature and from our own previous experiences, some issues relevant to computer selection at a business school were de-

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2. W.F. Bentz, "Computer Assisted Algorithm Learning in Accounting," Proceedings of the 1972 Conference on Computers in Undergraduate Curricula, Georgia Institute of Technology, Atlanta, 1972.

3. T.L. Guthrie, "The Business Core Integration at Indiana University," Proceedings of the 1972 Conference on Computers in Undergraduate Curricula, Georgia Institute of Technology, Atlanta, 1972.

veloped. Next, a list of questions was devised to obtain the information from other schools concerning these issues. The questions could be broken down into five areas: historical development of the current system, quantitative measures of the business school itself, utilization of computer facilities at the school, required computer usage on the part of students, and the university environment. In the final mailing questionnaire these same areas were addressed.

Realizing the misunderstandings which can occur due to respondent misinterpretation in answering a questionnaire, it was necessary to test the questions on two potential recipients; we chose Professor Chris Nugent, Assistant Computing Director at Harvard, and Mr. George Dixon, Research Associate at the Sloan School of Management. Besides assisting in the restructuring of certain questions, Professor Nugent provided an extensive amount of information on the development of Harvard Business School's computing facilities. After the Harvard visit, a new questionnaire was developed with the consultation of Mr. Dixon, who has overseen the Sloan computer facility for several years and is very familiar with typical information requested by other researchers.

Although it was hoped that the final questionnaire would provide all the desired information concerning the current facilities at various business schools, it was lacking in any information regarding the decision process involved when developing the facilities. Therefore, a flow-chart depicting the author's conceptualization of the necessary procedures to follow in choosing computer facilities was constructed. The recipients of the questionnaire were then requested to connect the procedural boxes as they saw fit in describing the decision process.

Having developed a mailing questionnaire, a list of schools to be contacted was drawn up. Schools were chosen that were considered prominent, innovative or noteworthy out of the list of business schools accredited by the A.A.C.S.B. Of the 20 universities contacted by mail, responses were received from fifteen of them. This sample size was still considered large enough to make some basic conclusions concerning computer facilities and business schools.

Just as two types of information were sought in the questionnaire, so do the results fall into different categories of answers. The first type deals with data on current facilities, services and business school enrollment; the second type reveals the various decision process models as seen by the computer center administrators at the business schools who answered the questionnaires. Readers interested in the detailed responses to the questionnaires may see Appendix I.

3.2 Results

The results of our questions concerning historical development of the current facilities are that most of the business schools have been and are dependent upon the university for their computing services. (See Table 1)

The business schools generally utilize such a system for two reasons:

a) the improved efficiency through centralization of computer facilities on campus, and

b) lack of separate funding for business school computing services (or as one respondent described the central system, "It's the only game in town.").

Of the sixteen schools responding to the survey, (fifteen surveyed by mail, plus the Sloan School), three have entirely separate facilities for the business school, six have a remote job entry terminal to the central system, and the seven others have some terminals on location at the business school, but primarily utilize the central facilities.

Table 2 shows the percent of the schools surveyed having timesharing and batch facilities available. Figures are shown for schools having their own facilities (four of the sixteen) and for the university facilities.

Table 1. Example Business School Computer Configurations

Business School	University Computing Facilities	Business School Facilities
Boston Univ.	IBM 370/145 (Virtual)	On-line terminals
Carnegie-Mellon	IBM 360/67, UNIVAC 1108 EXEC 2 PDP-11 I/O to 360	PDP-8
Columbia	IBM 360/65	T/S term. (7)
Cornell	IBM 360/75, 360/91	T/S term. (20)
Harvard	IBM 370/165	DEC-10
Indiana Univ.	CDC 6600	Honeywell 200, I/O to 6600
New York Univ.	IBM 370/145, UNIVAC 1108	IBM 1130, RJE to 370
Purdue	CDC 6500-6400	High Speed Data Link to 6500
Sloan	IBM 370/165	RJE to 370 Prime 500
Stanford	IBM 360/67	HP2000F 20
Tuck	Honeywell 635	T/S term. (20)
UCLA	IBM 360/91	T/S term. (20)
Univ. of Ill.	IBM 360/75	PDP-11 RJE to 360
Univ. of Mass.	CDC 3600	T/S term.
Univ. of Mich.	IBM 360/67	T/S term. (4)
Wharton	IBM 370/168	DEC-10

	In-house	University
% just T/S	25.0	12.5
% just Batch	0.0	18.7
% with Both	0.0	68.7
TOTALS	25.%	100 %

Table 2. Types of Service by Facility Location

A significant trend to be noted is that fourteen of the schools now do some (if not all) of their computing using a timesharing system, and even more importantly, all four of the independent facilities utilize timesharing exclusively.

The reasons mentioned in favor of timesharing services were that it was economical and easy to use, that it encouraged students to experiment with quantitative techniques in their coursework, and that the interactive capability is highly valued as a decision-making aid.

Probably one of the most direct influences upon computer facilities utilized by the business schools is the university's central administration, as reflected by the fact that more than half of the schools surveyed do not have a separate budget for computing services at the business school. This procedure not only reduces the flexibility of services provided at the business school, it also reduces the control which the business school's administration can exert over the computing services. As the range of computer facilities increases in the market, it is felt that this factor will become an even less tolerable constraint upon the business school's computing services.

As far as usage of the facilities is concerned, the average usage was 73% of the students, with a range of 25% to 100%. At most of the schools all students were expected to take at least one class which utilized the computer, or to show equivalent proficiency in programming and/or utilization capability during their enrollment. However, this requirement exists usually only for entering students; subsequently, in a two-year program only half of the students at any time are required to use the computer. Therefore, if one evaluated usage on a per student basis throughout their enrollment, at most of the business schools, the usage would be close to 100%.

The services available at the business schools are very consistent, with the exception of consultation services. About 60% of the schools maintained full-time consulting staff for the business school community. In general the computing services include: a few computer assisted case studies, a computerized management game, various utility packages and a number of programming languages, especially Fortran, Cobol, PL/1 and Basic. The breakdown concerning computer utilization by various segments of the business school community is not available, basically because it is felt that the respondents did not have access to the information.

The students' general level of familiarity with the computer varies widely both within and among business schools and both before and after the students complete their degree. If one rates the students on a scale of 1-4, with 1 indicating lack of familiarity and 4 expertise, then the average entering capability was rated at 1.76, almost slight proficiency. The computer utilization at the business school seems to have a significant effect upon their performance because their understanding of the computer at graduation was rated at 2.6 on the average, almost a whole level of familiarity greater than at the beginning of their studies. However, due to the subjectivity of the rating system, the students' progress at business schools concerning the computer might be overrated.

The second type of result which the survey produced is the respondents' perception of the decision-making process in choosing computer facilities. It is difficult to summarize the variety of flow diagrams which were devised by the respondent schools to depict their conception of the process, but some general statements can be made. First, the most significant point is that either explicitly in the charts, or implicitly in their explanations, the respondents recognized the iterative process necessary in balancing trade-offs within the proposed system. Second, all of the respondents recognized the necessity of examining the needs of the business school community before any other analysis is undertaken. Although this should be a highly obvious step in the analysis, in the case of a centralized system the needs of the business school community are assumed to be identical to the needs of the university at large. From the complaints voiced in the responses, however, it appears that some of the specific needs of the business school are not being met by the current system. Subsequently, this becomes one argument in favor of a separate computer facility for the school.

In conclusion, the survey provided some background information concerning current configurations of computer facilities at business schools. From it, we were able to determine some of the motivations behind choosing facilities at the schools, and the types of services which business schools have decided to offer their students.

CHAPTER 4

A Procedure for Analysis

4.1 Implications of the Research -- A Hierarchical Model

We return now to the substance of Chapter 2, and interpret it in the light of the knowledge gained from the research described in Chapter 3. Chapter 2 presented a framework for the facilities decision problem which broke the process down into three components, and dealt with the nature of these components and their interactions. Is this a reasonable or useful view? Does the real world evidence support the basic structure of this framework? We believe positive answers to these questions may be inferred from our survey results. Our respondents, all practitioners of the process according to their own views of it, invariably grouped their explanatory responses in ways suggestive of the three components of our framework. Given the same process modules used in Chapter 2, Figure 4, many of the respondents drew process diagrams similar to Figure 4 in important ways. These diagrams typically showed iteration or interaction between modules in the "needs" group, with subsequent flow through the technology, proposal, resource and implementation modules.

The primary implication we derive from these results is a reconfirmation of the dominance and integral nature of the process of needs analysis. The major impetus for improvement of the facilities and services a business school maintains should come from self-examination, not from looking at the outside world. Differently stated, it is better to examine first what you need, and then see what the world has to offer to fill those needs. As rational as this advice may seem, there is considerable temptation to do the opposite when computer technology is concerned. A not uncommon reaction when a glittering new product of the advancing technology appears is: "That looks fascinating; let's get one (or several)."

The top-level process in our decision-making model, then, is self-analysis, what we have called "needs" analysis. Ideally, there is an on-going process of retrospective review, evaluation of current status, and forecasting of future needs. The purpose of the review and evaluation is to determine whether the desired benefits of computer usage are indeed being received. As is often observed, the benefits of computer use in an educational setting are difficult to quantify. A Stanford report observes: "Most of these benefits must be treated as intangible due to the absence of indicators of the benefits of the educational process itself. Intangible benefits are indicated by usage patterns, the impact of computers on the curriculum, and user attitudes toward computer resources."[1]

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1. H.C. Lucas, Jr., et. al., "Integrating the Computer into a Business School Curriculum," Stanford University, Oct., 1973.

These suggested avenues for evaluation and review seem most appropriate.

The top-level process as envisioned above operates continuously. By this we mean there is a regular cycle of evaluation, forecasting and review. The next level is what we have called "examination of technology." The word "technology" is used loosely here to include any developments that may be of significance to the application of computers in business and management education. Thus we include not only hardware and software technology but also educational technology.

There are two conditions under which the top level process can activate this next level in our hierarchical decision making model. The first condition under which this level is activated is when the evaluation, forecasting, and review cycle signals that at the present or in the near future the facilities and services provided are or will become less than satisfactory to meet the needs and demands of the user community. Such an exception condition should trigger a search for ways to bring facilities up to the level of what is desired. The first step in such a search, logically, would be to learn about possible alternatives by looking at what the world has to offer. The further steps would involve feasibility and resource questions.

The second case in which this level is activated is not occasioned by any particular result of the evaluation and review process, but rather by a periodic need to gain new perspectives and to guard against complacency. For this purpose it is often particularly helpful to look at what other institutions are doing. Comparing recent technological developments with the school's current facilities should suggest possible ways to improve. Proposed modifications should be subjected to the same forecasting and evaluation procedure as the current facilities, in an attempt to project their probable impact. Considerable study may be necessary to isolate proposed modifications which will achieve the desired improvements.

When modifications to the existing facilities are finally developed which will likely have the desired impact, the third level of the hierarchy is invoked. Resources must be developed to implement the desired improvement. This process was described in detail in Chapter 2. The main point to be made about this process here is the place we have ascribed to it in the hierarchy. We regard the resource development level as primarily a facilitator process within the overall decision-making model. A number of respondents to our survey appeared to treat the resources development process as a restrictive element, which acts to constrain alternatives. Often, these same schools found themselves in an unsatisfactory situation with no perceived recourse. They tended to view the resources issue as primarily a financial one, and felt constrained to operate within the confines of university policy.

A broader view of the resources development process as set forth in Chapter 2 would enable these schools to operate in a less constrained way. In particular, there are some resources which are "hidden" at first glance, but which can provide substantial support to the facilities development process. One such "hidden resource" is university computing funds, which the business school may be able to convert to real money for the purchase of outside computing services. To do so, however, would require that the scheme be more favorable from the university's viewpoint as well as the business school's. Additional financial support may also be available from alumni of the school, especially for the development of a better computing system. The last "hidden resource" exists in the form of non-financial support, but in a sense can still help to defray some of the costs of the system development effort. We have reference to the fact that the business school community usually has a reasonable supply of experienced student programmers whose skills can be utilized for software development purposes. Many pedagogical programs at M.I.T. have been developed by students as theses or project work.

The importance of some of the resource issues leads us to reexamine the linkages of our hierarchical decision-making model. We have so far maintained (in keeping with the original format of the model presented in Chapter 2, Figure

4) that the Needs component periodically activates the Technology component, and if facilities modifications are proposed, these then activate the Resources component. A few schools, however, recognizing the broad scope of the resource development process, occasionally activate this process directly when the top-level evaluation and review cycle signals a need for action. By modifying some of the policy decisions which form a critical part of the Resource component, they can "tune" the current facilities to better serve the perceived needs. Sometimes, this is all that need be done to set things right again. Possible examples are restructuring the procedures by which students and faculty are allowed access to the computer, or changing the available mix between timesharing and batch processing.

These observations persuade us to alter our original model slightly by the inclusion of a "tuning" link between the Needs and the Resources components. This is shown in Figure 5. The basic hierarchical structure of the decision-making model is maintained. That is, iteration occurs primarily within major components, rather than between them. This implies a certain conservation of effort in the problem-solving process. The linkages between process components are dynamic ones, renewed each time the decision sequence is invoked.

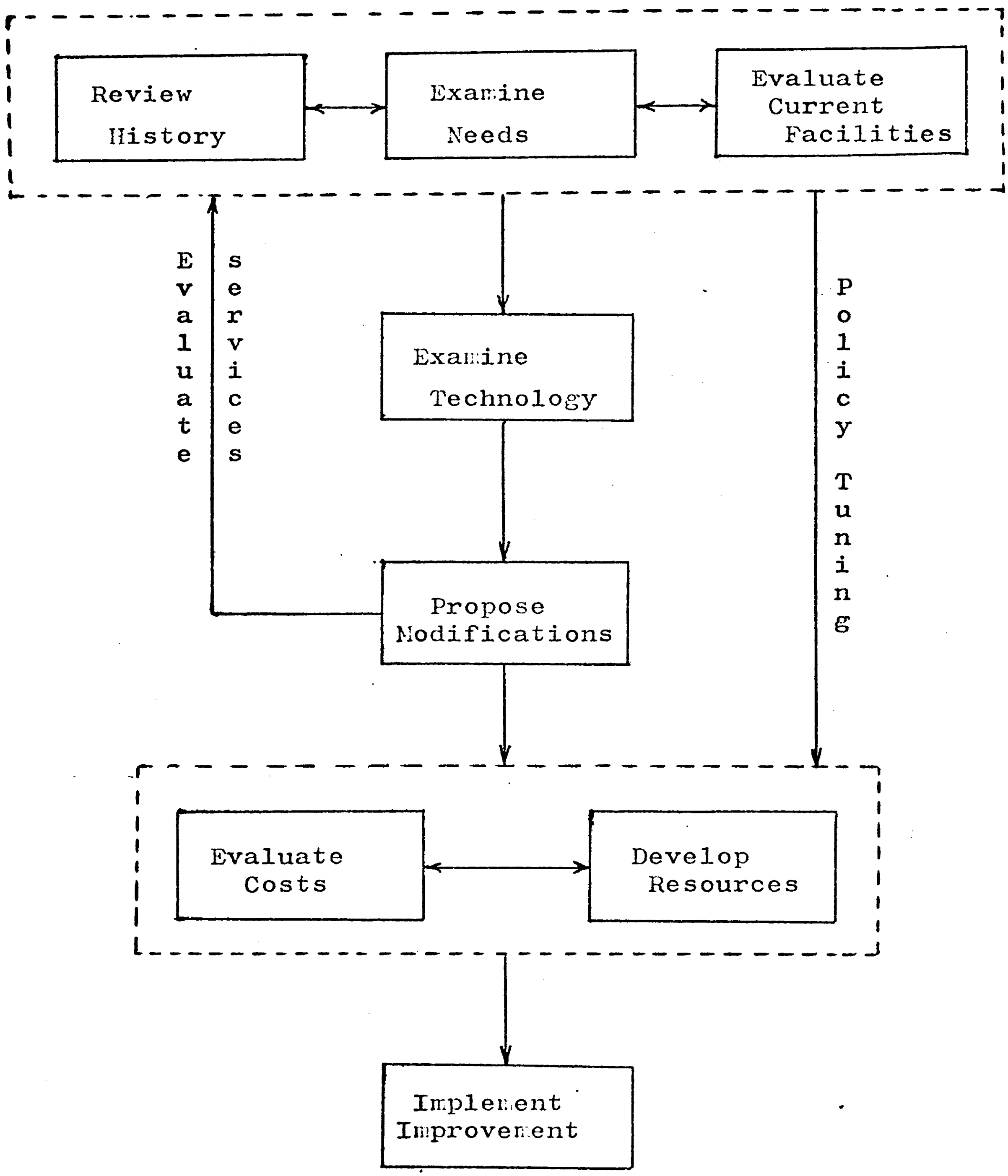

Figure 5. Modified Process Model

4.2 Key Sensitivity Points of the Model

The purpose of this section is to focus on some key issues which represent the sensitivity points of our decision-making model. These are the areas which exert relatively high leverage on the outcome of the decision-making process.

Perhaps most significant of these key issues is the whole set of charging and access policy issues. Our earlier discussions indicated the importance attached to these matters at specific schools (see Chapter 2). The questions of whether to implement a "free-access" policy for students and faculty, and how to limit abuse without losing the benefits should be addressed squarely as soon as possible.

The Dartmouth study shows:[2]

---"that the main effect of a free-access policy is that nearly all members of the community use the computer,

---"that, nevertheless, a small fraction of these people account for a very large fraction of the total usage,

---"that if one accepts as an inevitable cost the need to supply computer service to these "big users," then the added cost of a free access policy for everyone appears to be no more than a twenty to forty percent increase in aggregate demand, while the added benefit is a tenfold to twenty fold increase in the size of the total user community compared to the 'big user' community,

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2. Arthur W. Luehrman and John M. Nevison, "Computer Use Under a Free-Access Policy," Kiewit Computation Center, Dartmouth University, December 1973, p.3.

---"finally, that a free-access policy does not mean that externally supported projects cannot be charged for computer use, nor that there is no accounting for use."

The point is that by adopting a free-access policy the school opens the computer services to a much larger group of users, without a large increase in cost. This concept inherently assumes that the system is able to accomodate a large number of users in small quantities at the same time, which is tantamount to a timesharing system.

Another important aspect of the "free access" issue is the fact mentioned above that outside users do not have to be charged on the same basis as in-house users. Also, a free-access policy does imply no budgets, but does not imply no accounting of costs. Records are still maintained on the cost of the system.

The second matter is chiefly one of setting certain educational priorities. Each institution may view the computer service somewhat differently depending on what they expect to teach students. Specifically, we would like to distinguish three basic attitudes toward the computer at a business school. There are some who view it as a general problem solving tool, others see it as a tool primarily utilized for specific functions, but with some possibility of expanded usage, and the third group sees it as a black box in which you input data to yield some different output.

Depending on which of these attitudes is held by the administration, the priorities for business school computers will very. In the first case, all three types of computer services, namely instructional, research and computer science, receive heavy emphasis. In addition, the facilities by necessity must be convenient and easy to use. New applications of the computer in each of these areas is encouraged.

In the second case, research and computer science are heavy users of the system, and instructional purposes are more restricted in nature. It should be pointed out here that the term "instructional" usage refers to teaching non-computer subjects using the computer. Essentially, resource allocation favors the "big user."

The third approach to computer usage emphasizes the instructional and research purposes, while computer science applications are virtually non-existent. Neither faculty nor students are encouraged to develop new software, although new programs are often acquired if they are appropriate for instructional purposes. This type of attitude tends to favor the small users, and subsequently probably keeps computer costs under easier control.

The third issue is in some ways a result of the resolution of the above-mentioned questions, but is of sufficient importance to be examined separately. It concerns the modes of computer access that a business school will provide. This is very often seen as a looming dichotomy between timesharing and batch modes. By drawing both on university facilities and on their own independent facilities, a number of schools have achieved a better mix of these access modes than could have been possible from a single source alone (and by this is not necessarily meant a single computer). The mix of batch and timesharing, and the effort necessary to provide each, should receive careful consideration in establishing or modifying facilities. This issue, as the other two, will have a major impact on the flavor of computing at an institution. The three key sensitivity points are highlighted in a final view of the decision-making model (Figure 6).

4.3 Constraints

We would be remiss if we did not consider possible factors which might weaken the applicability of our decision-making model. Many of these factors are intangibles which fall under the general heading of politics. Political considerations frequently can create obstacles to the type of analytical procedure we have advocated. Computer facilities decisions often impinge on "empire building" at upper levels of the university. Control of purse strings is sometimes overzealously guarded. Certainly the administrator should be cognizant of the political obstacles to his intended course of action. To the extent he can remove or alter these, the decision-making environment is enhanced. To the extent they remain inflexible, he must mold his decisions around them, deviating from our procedure where necessary.

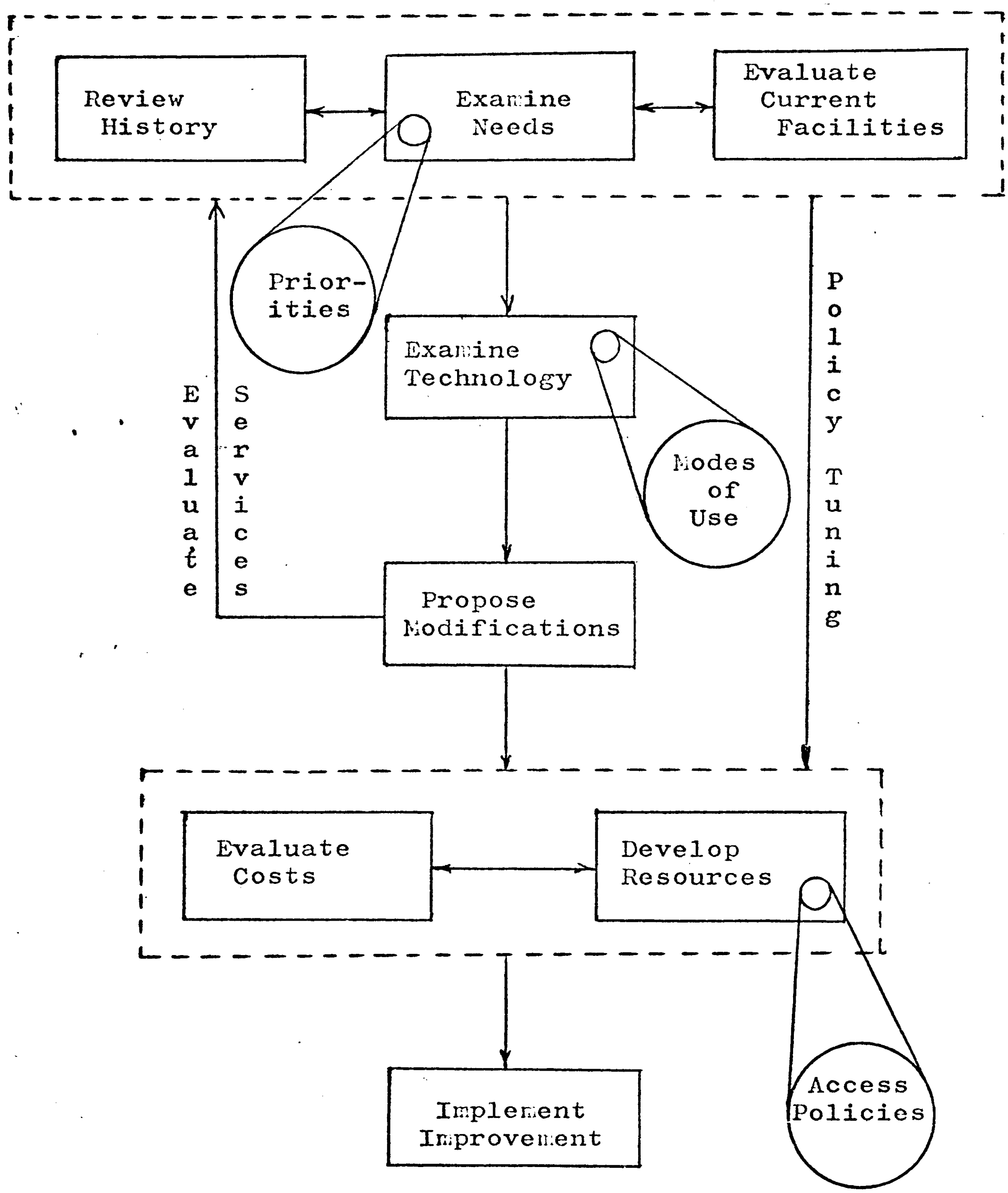

Figure 6. Three Key Sensitivity Points of Model

CHAPTER 5

Case Study: Sloan School of Management

In Chapter 4 we have developed our conceptualization of the procedure for analysis in choosing computer facilities at a business school. But this model is still a general prescription for facilities selection. The focus of this chapter will be to calibrate our models and decision procedures by examining the question of what computer services should be available at the Sloan School.

5.1 Historical Review and Evaluation

As stated in the procedure for analysis, the first area of concern in choosing computer facilities is the three-step process of reviewing historical information, evaluating current facilities and examining the needs of the user community. In this section we will devote our attention to these issues.

The East Campus facility is housed in the basement of the Sloan building and its services are shared by the School of Management, and the Economics and Political Science departments. Although the Sloan School is dependent on the Institute's IBM 370/165 and Honeywell 6180 for computing power, the East Campus facility does include a REMCON unit for remote job entry, six remote terminals which dial into the MULTICS and TSO time sharing services, six keypunches and a number of work-tables for students to use. The remote job entry (RJE) facility is operated from 9-9 on weekdays, while the other facilities remain open all the time.

As far as funding of the facility is concerned, the Institute's Information Processing Center (IPC) pays for the RJE terminal, three of the keypunches, and three of the remote terminals. Sloan together with the Economics and the Political Science departments pay for their own computing time (including job handling), the remaining peripheral equipment and the upkeep of the center. The annual budget for Sloan covers computing time for unsponsored faculty and student research, plus coursework allocations. Of the 158 courses offered in the fiscal year, June, 1972 - June, 1973, 54 were budgeted and used computer time. In that same year, 71 out of 212 thesis students utilized the computer in connection with thesis work. This amounted to about 1/3 of the degree candidates for the year.[1,2]

The next step in the procedure for analysis in choosing computer facilities was to evaluate current facilities. Our evaluation process consisted of developing some idea of the attitudes toward the quality of services provided at the

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1. Profile of Instructional Computing at the Sloan School - Fiscal year 1973.

2. Sloan School of Management -- Enrollment Figures -- Fall, 1972 and Spring, 1973.

East Campus facility. A series of interviews were conducted with administrators, faculty and students at Sloan. The remarks made during the course of the interviews led to the development of a questionnaire to test the validity of the opinions expressed.

In terms of positive remarks in reference to Sloan, several people commended the practice of budgeting computer time for all thesis students. Secondly, Sloan has the capability of providing both batch processing and time-sharing services. The third factor is a rather recent development: a representative from IPC has been assigned to work with the people at Sloan in developing and/or maintaining the current system. This is a significant step because in the past IPC was basically concerned about Sloan only during crisis situations, but now the Institute's Processing Center can partake in short- and long-term planning with the East Campus representatives.

There are a number of potential areas of improvement of the facility which were cited by the members of the Sloan community who were questioned. Some felt that the physical plant itself creates some unnecessary problems. The RJE unit experiences an unreasonable amount of downtime, subsequently computer time is available to the users on a less than full-time basis. In addition, the layout of the workroom is such that the terminal users have little or no work space. This problem could be prevented by a few modifications in the layout.

Both the responses from the schools surveyed and the writings in the literature survey indicate that some general utility packages, such as statistical packages and math routines, should be provided on a continuing basis by the facility. However, at Sloan it appears that there is no conscious effort to maintain and/or document such packages, unless these routines are being used for a class or a research project.

For any computer facility to be effective in its provision of services, a staff of consultants must be available to provide user support. Too often at Sloan the teaching assistants, who constitute the consulting staff, are not readily available at the times when there is a high demand for their assistance.

The comments expressed in the interviews were incorporated into a questionnaire to see if these opinions were representative of the general attitudes toward the quality of facilities at Sloan. For a detailed description of the questionnaire, see Appendix 2. Of the students who responded to our survey, most of the expressed an interest in the quality of services at Sloan: this attitude, we feel, is a favorable endorsement of our endeavor to evaluate the computer services at Sloan.

Table 3 shows that, in general the student population at Sloan regard the current facilities as less than adequate in fulfilling their needs for computer services. The students were asked to rate the quality of each of the six types of services as shown in the table. As can be seen in the table, the average quality rating was below satisfactory in all but one of the categories, implying that the services failed to meet the minimal needs of the students. Although the quality rating data was also analyzed according to reactions by the different categories of the Sloan population (i.e., Sloan fellows, masters candidates, undergraduates, etc.), we were not able to distinguish any basic differences in attitudes toward the quality of service among the different types of students surveyed.

In terms of voicing their dissatisfaction with the quality of services, one fourth of the students said that they had lodged a complaint about the facilities at one time or another with a person responsible for them. Two-thirds of those who had shown enough concern to voice their opinions about the service felt that there had been no response to the complaint. Since the real measure of success of a service function is the user's opinion of the quality of service, it seems that the management of Sloan's facilities should be more sensitive to students remarks about the service.

The next set of questions asked respondents to predict their likely usage if facilities were made more readily

Facilities Components	Quality Rating[1]
Physical Environment	2.49[2]
Consulting services	2.55
Computer services - batch	2.61
Computer services - timesharing	2.90
Equipment - terminals	3.00
Equipment - peripherals	2.79

1. Mean.

2. A four point scale was used: higher numbers are more favorable:
   4 - Excellent
   3 - Satisfactory
   2 - Poor
   1 - Awful
   See Appendix for additional detail.

Table 3. Student Ratings of Computer Services

available. The respondents were questioned as to whether the lack of accurate information on packages had hindered them in the past. Over half of the respondents felt that they had been inconvenienced by this shortcoming. When asked as to whether more information on packaged programs would be useful to them, more than half of the students felt that such information would probably be useful to them.

Table 4 indicates that the students tended to look favorably toward the introduction of more timesharing services at Sloan. However, they did not express as great a desire for increased batch processing services. Batch processing services are already receiving more attention than timesharing services at Sloan, so it is not surprising that their future demand should not increase in line with the increase for timesharing.

Table 5 shows the responses concerning past usage of various computer services at Sloan. It should be noted that statistical packages commanded the highest usage in each of the different categories of students. Of the total sample, 60% of the respondents had used a statistical package at Sloan. The two other services experiencing wide utilization were canned programs and programming languages.

Thus far we have completed two of the three parts of the first level in our procedure for analysis in choosing facilities for the Sloan school, namely: the review of historical information, and evaluation of the current facilities.

Timesharing	Student Responses
Probably use more	43%
Possibly use more	34%
Probably not use more	23%
Batch processing	
Probably use more	23%
Possibly use more	46%
Probably not use more	31%

Table 4. Students Likelihood of Increased Usage

Computer Service	Respondents Usage[1]
Management games	33%
Canned Programs	41%
Math routines	21%
Computerized cases	16%
Statistical Packages	60%
Programming languages	47%

1. Percent of respondents who have used the service at Sloan.

Table 5. Use of Computer Services at Sloan.

What remains now is to examine and define the needs of the user community. It is our goal that the computing system satisfies some of the long-term needs of the management school community and at the same time eliminate some of the current problems in the existing system.

As previously mentioned in Chapter 1, the long-term needs are a function of the three principal types of usage: instructional purposes, research computing and the study of management information systems. The use of computers as an educational tool is probably the newest type of usage; however, it is currently the focus of much attention in the educational field. Stanford researchers, in their process model of computer use, have described the use of the computer as a general problem solving tool as the most advanced stage of development of computing facilities at a school. It is to this level of usage that business schools should try to develop their computer use. But to progress to this level of usage, it is first necessary to incorporate the use of the computer into a wide variety of courses. In this regard, Sloan should attempt to encourage use of the computer in many types of classes, by making the facilities more reliable and easy to use.

Of all the categories of service which were sampled in the survey at Sloan, computerized cases had the least amount of usage (16% of the respondents). With the increased availability of computers in the business world and the increased usage of quantitative methods, it seems that Sloan should try to increase the use of the computer as an aid to decision-making. One obvious means of achieving this end is through the use of computerized case studies because then the business students learn how to use the computer as a problem solving tool at the same time as they learn how to analyze a case.

The second type of demand for computer services is for research usage. For the purposes of modelling and data analysis, the computer has become an integral part of the researcher's tools. At Sloan, the batch processing services available from IPC seem to be adequately meeting the needs of faculty research, except for the unexpected delays because of downtime on the RJE unit. Since research often commands heavy compute-bound jobs requiring substantial computer power, their needs may often be met by the INstitute's computing system or by running these programs in off-hours on a smaller scale facility.

The third and last type of usage of computer facilities at a business school is to study management information systems. This realm of study includes learning about how the computer functions, about the types of functions it is best capable of performing, and how to communicate with the computer via programming languages. To achieve these objectives, it is necessary to expose the students to a wide variety of computer services, such as utilization of different equipment and software development. At Sloan, the management information systems curriculum is well-designed to teach the students about the three types of computer study. However, the problem develops in the implementation of the MIS program. As mentioned earlier in this chapter, many of the services at the East Campus facility are below satisfactory in meeting the students' needs. Because students in the MIS concentration utilize the computer pretty heavily, it is crucial for them to have reliable computer facilities. What Sloan needs in order to effectively implement the MIS program, is a system which is reliable and at the same time offers a wide range of computer services.

Now that we have completed the first step in the procedure for analysis, it will be necessary to investigate available computer technology to see if a better computer system can be provided at Sloan. The current system has been found to be less than satisfactory in many respects and since we have defined the needs of the user community, we have a scale against which to measure proposed new systems.

5.2 Technology: Developing Alternatives

The second step in the decision process model of choosing computer facilities is to investigate the technology which is available to satisfy the needs of the Sloan community. In Chapter 3 we accomplished part of this goal by determining what computer facilities other business schools are using. To some extent we can limit the range of our investigation of technology to the range of configurations currently available at the other business schools, since these pretty much represent the available alternatives.

The first consideration within our study of available technology is what mode of access should the Sloan facility utilize. Currently, batch processing seems to be accorded a higher priority than timesharing. However, throughout this thesis we have pointed out the advantages of interactive capability and the widespread use of timesharing at other business schools. For both of these reasons we feel that Sloan should either improve the current timesharing services by working with IPC and its representatives or Sloan should consider developing their own facilities with timesharing capability.

The latter suggestion is an outgrowth of the survey of other business schools, because four of the business schools surveyed utilize their own computer facilities (exclusively devoted to timesharing) while at the same time using the university facilities for batch processing. Such a configuration seems most appropriate in fulfilling Sloan's needs.

The question now arises: what computer equipment is available to implement the system suggested above? Our answer is that Sloan should look into mini-computers for this purpose. There are a few reasons why we feel a mini-computer would be appropriate for Sloan. A system could be developed whereby the mini-computer could provide timesharing services at Sloan, while at the same time act as an RJE to the Institute's IBM 370/165 for batch processing. Secondly, a mini-computer does not require a large staff of system programmers, and therefore the operating costs are not out of the range of Sloan's resources. Third, Sloan has the workforce available to program a mini-computer with its own user community.

If Sloan is to acquire its own computer, the next step in the decision process is to determine how to finance a new system. This problem will be addressed in the next section of the case study.

5.3 Resources

The last level in the procedure for analysis in choosing computer facilities at Sloan is to determine the costs of a new system and to develop the resources to finance a new computer. Cost determination covers both initial outlays for equipment and programming, and operating expenses on an annual basis. The range of costs for mini-computers goes from about $30,000 to in excess of $250,000. However, there is a chance of reducing this expense through an educational discount from the computer manufacturer. Although exact discount percentages are not available, Sloan should not consider the initial outlay as a fixed constraining factor in analyzing various computers. The operating costs are to some extent a function of which computer is chosen. In this regard it is important the annual expenses for any computer selected be within the annual budget established at Sloan.

The cost of a new computer is a constraint only in so far as the people at Sloan attempt to develop the resources which are available to them in financing the equipment. The most obvious resource available is the Institute's Information Processing Board, which is currently paying for the RJE unit at Sloan. Since the operation at Sloan is a losing proposition from IPC's point of view, the board should be more than willing to assist Sloan in developing a system which is more attuned to Sloan's needs and which is less of a perceived financial drain on the university computing budget.

The second resource which Sloan administrators should remain aware of in determining the means of financing a new system is Sloan's own population. Within the user community at Sloan, there is faculty-sponsored research which is a source of revenue for Sloan, and there are students and faculty available for system development and operation. This type of personnel can reduce expenses (in terms of operating costs) on an annual basis.

In summary, we have pointed out the need for Sloan to improve the reliability of its computer facilities and to develop more timesharing capability. Both of these ends can be achieved through the acquisition of a mini-computer which would be under the control of Sloan's own management. With a computer which is under direct control by Sloan itself, it is likely that the Sloan management will see that it is operating consistently. Secondly, a mini-computer could provide Sloan with the timesharing capability it needs at the present time. The next section of this chapter will address some of the present constraints within which Sloan is confined as it develops a new system.

5.4 Constraints

Although in the ideal case Sloan should be selecting computer facilities which maximize its own benefits, the decision must still be made with the approval of the Institute's Information Processing Board. Because it is likely that Sloan will still also utilize the Institute's computing system for some applications, this is an additional reason why Sloan must coordinate its computer operations with IPC.

The second constraint within which the computer facilities selection must be made is the space limitation, in terms of both layout and area, of the basement of the Sloan building. There is no other location suitable for housing Sloan's computer facilities, therefore Sloan must choose a computer equipment configuration which conforms to this area.

We feel that we have developed some reasonable recommendations in this chapter for Sloan, and that the two constraints are not so binding that some action in this direction cannot be taken to improve the computer facilities at Sloan. At a time when a real understanding of computers and their applications is expected of all business students, it is important that Sloan provide a more effective and reliable computer facility.

CHAPTER 6

Conclusions

6.1 Summary of the Decision Model Findings

We have found that the process of solving the problem of computer facilities and services selection for business schools can be modelled as a three-level procedure that includes consideration of factors both internal and external to the institution in question. The normative model which we have developed corresponds closely with the current methods used at some of the schools surveyed.

The importance of the process of evaluating needs and evaluating current facilities on a continuing basis is widely recognized. Examination of facilities being used at other schools, and of recent technological advances in both computers and education, is important not only to develop possible solutions to a recognized facilities problem, but also to gain new perspectives with which to further evaluate the school's current situation.

The process of resource development and the issues associated with allocation and access policies are elements of the total procedure whose true significance is sometimes misunderstood. Policy issues should be resolved before detailed questions of machine selection and the like are attacked. If resources are understood more broadly to comprise not just finances but also "people" resources, many constraints are eased, and greater flexibility is possible. The interaction between resource issues and the other process components (needs, technology) is a dynamic part of the decision context, and understanding these interactions allows the administrator to take advantage of them.

Application of the model for decision-making to the Sloan School of Management has resulted in new information about the facility's preceived adequacy. In response to a finding that the facility was generally regarded as less than satisfactory, the remaining levels of the process were invoked to yield a recommendation for certain new facilities and services. Specifically, a minicomputer-based timesharing system permitting remote job entry to the Institute's central batch processing facility was recommended. A policy of "controlled free access" for this system was advocated, noting that controls should be far weaker than those in force with the current facilities.

6.2 Recommendations for Further Research

Our suggestions for further research in this area are divisible into two parts. The first concerns measurement of the adequacy of business school computer facilities. Much work has been done on measuring computer systems performance, but raw performance is not at the heart of the issue. Much more significant is suitability. The means at our disposal today (and traditionally) are measurement of historical use data and measurement of user attitudes. There is always some question as to what significance such measures have. To what should they be related? How can we tell if these measurements are within satisfactory ranges? Can we do anything to directly measure the impact of a computer facility of the school's curriculum? These fundamental questions need answers if maximum benefit is to be gained from the use of computers in business and management education.

The second direction for research that we propose deals directly with the decision model we developed. More "calibration" of the model is necessary -- more comparison with the real world. What are the implications of the model at a detailed administrative level? What resources does the decision procedure itself requipre? How robust is the procedure, how widely applicable? These questions can best be resolved, we feel, by additional case studies at other schools; test applications of the model are necessary to probe its applicability and robustness.

Lastly, we feel our model is a starting point for attempts at better models, differently structured models. When the two lines of research we have suggested have each made some progress, perhaps they will reconverge to unite improved normative theory and improved understanding of the decision process, providing additional insight into a very important business education problem.

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APPENDIX

This appendix contains:

1. "Computer Facilities Survey," used to survey schools of business administration.

2. "Sloan School Computer Facility Questionnarie," used to survey Sloan School students.

COMPUTER FACILITIES SURVEY

A. Historical Development

1. Could you describe your current computer facilities (or the facilities which the business school uses if you do not maintain your own system)? Please describe both hardware and software.

2. How long have these facilities been available? ______

3. What Computer Facilities were available previously?

4. How long ago did the change to the current system occur?
   0-1 yrs.___ 2-3 yrs.___ More than 5 yrs.___
   1-2 yrs.___ 3-5 yrs.___ Never ___

5. Within which time period did the change to the new system occur?
   1-2 months ____ 6 mo.-1yr.____ More than 2 yrs.____
   2-6 months ____ 1-2 yr. ____

6. What were some of the major considerations prompting the change to the current system? Which criteria were the key ones in selecting new equipment or software?

B. Quantitative Measures

Note: If you feel any of these questions infringe on what you consider private data, feel free to disregard the question. However, as much information as you are free to give us would be appreciated.

7. What is the student enrollment in each of the following categories:
   Undergraduate____
   Master's level____
   PhD level ____

8. How many of these students use the facilities per year?

9. What is the total annual budget for the computer facilities? ________ Alternatively, how much is budgeted per student? ________

10. Who is responsible for preparing the budget? ________

11. Who are the decision makers concerning utilization of the allocated funds? ______________________________

C. Usage

12. What percentage of the funds are allocated to each of these uses?
    Administration ____%
    Faculty research ____%
    Student research ____%
    Student course-related research ____%

13. Which of the following services are available? Please check appropriate lines.
    _____Computer-assisted cases
    _____Management games
    Utility packages: _____Math routines
    _____Statistical packages
    _____Other
    _____Programmed Instruction
    Programming Languages: ___Fortran ___Cobol
    ___PL/1 ___Other
    ___Full-Time
    ___Part-Time

D. Academic Requirements

14. What is the general level of familiarity with computers of your entering students?
    _____Lack of familiarity
    _____Slight familiarity
    _____Proficiency
    _____Expertise

15. What is the general level of familiarity with computers of your graduating students?
    _____Lack of Familiarity
    _____Slight familiarity
    _____Proficiency
    _____Expertise

16. Do the requirements concerning familiarity with computers differ for undergraduates and graduate students?

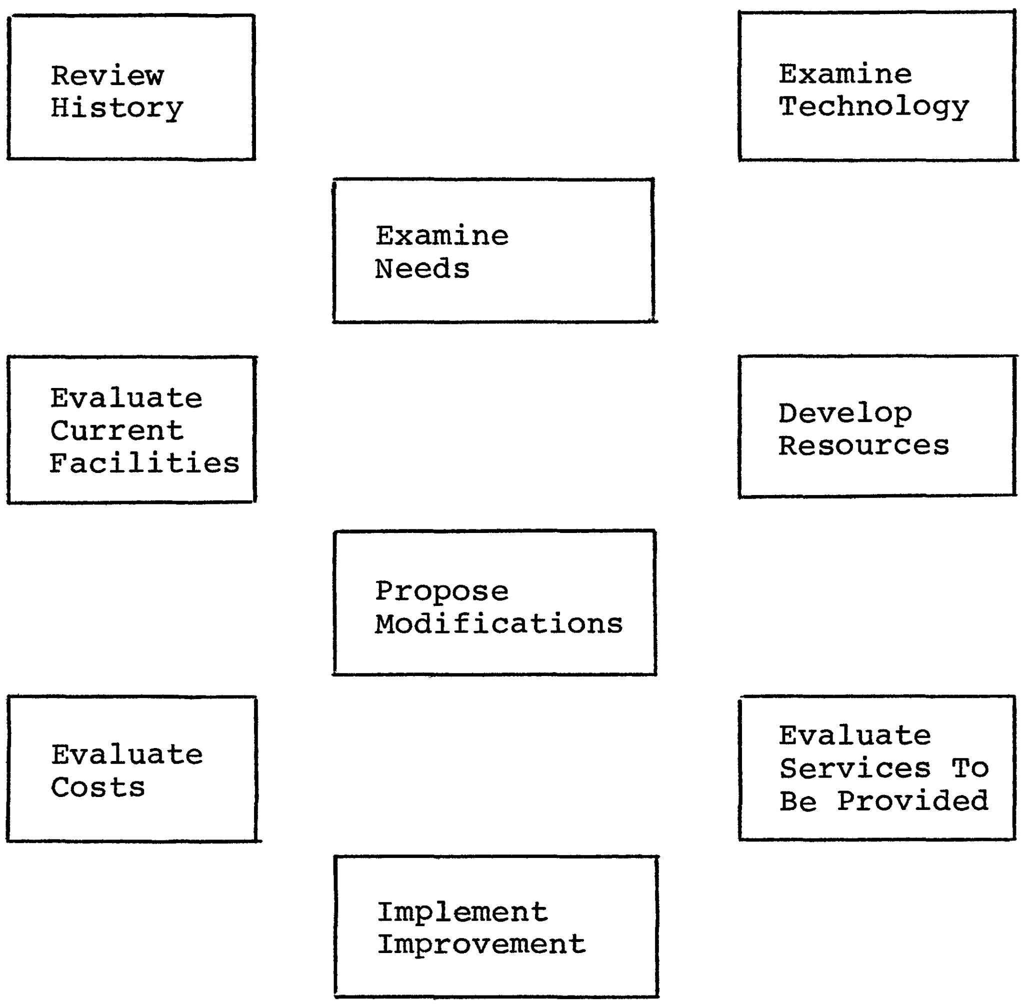
D. Environment

17. How do the business school's computer facilities relate to campus computer resources?
    ____Totally independent (No connection)
    ____"Soft" support (Consulting services, shared programs)
    ____"Hard" support (Hardware back-up, networking, etc.)
    ____Dependence (Remote terminals, centralized system, etc.)

18. Do you purchase computer services from an outside supplier regularly?

____Time-sharing services
____Batch-processing services
____Library data search systems
____Other

Viewing the boxes below as elements of a process you might go through to consider changes to your computer facility, how would you connect these boxes with arrows to show the sequential flow of the process? (Your interconnections needn't form a simple chain; multiple arrows are OK.)



SLOAN SCHOOL COMPUTER FACILITY QUESTIONNAIRE

We would appreciate a few moments of your time to fill out yet another questionnaire. This one is being circulated in a serious attempt to assure that the East Campus computer facilities meet the needs of the Sloan Community. Your co-operation is essential in finding out what those needs are. Thank you for your time.

--Doron Holzer & Loretta Patzelt

1. In which category do you fall: ___Faculty ___Undergrad. ___Master's student ___Ph.D. ___AGP ___Special Student ___Sloan Fellow

2. How many years have you been at Sloan? ____

3. What is your area of concentration? ____________________

4. Do you know where the Sloan computer facility is? ___Yes ___No

5. On average, how frequently do you use the facility: ___Daily ___Weekly ___Monthly ___Less Often ___Never

6. Please rate the following items as to their quality at the Sloan facility, using the following system:
   4-Excellent (particularly suitable, useful, or helpful)
   3-Satisfactory (meets your needs, but minimally)
   2-Poor (fails to satisfy your minimal needs)
   1-Awful (seriously impairs usefulness of facility)

   a) Physical Environment (Tables, chairs, noise, etc.) ___
   b) Consulting services (T.A.'s) ___
   c) Computer services - batch (turnaround, handling) ___
   d) Computer services - timesharing (response, etc.) ___
   e) Equipment - terminals (datasets, paper, etc.) ___
   f) Equipment - peripheral (keypunches, sorter, etc.) ___

7. Have you ever lodged a complaint about any of the above with any person having responsibility for them? ___Y ___N

8. Did you feel there was any responsiveness? ___Yes ___No

9. How would you rate your concern with the quality of the Sloan facility? ___Actively concerned ___Interested ___Indifferent

10. How would you rate your familiarity with computers? ___Little familiarity ___Slight fam. ___Proficiency ___Expertise

11. It has been suggested that information on packages (e.g., L.P. and statistical packages) -- up to date listings of what packages are available, what they do, and how to use them -- is not readily available to the sloan community.
    a) Have you ever been hindered by this shortcoming?
       ___Yes ___No
    b) Would such information be useful to you if more readily available? ___Definitely ___Probably ___Possibly __No

12. If services on a timesharing facility such as Multics or TSO were made more freely available at Sloan, would you make more use of such systems?
    ___Probably ___Possibly ___Probably not

13. If batch processing services were made more freely available at Sloan, would you make more use of such services?
    ___Probably ___Possibly ___Probably not

14. Which of the following have you made use of?
    ___Management Games ___Computerized cases
    ___Canned programs ___Statistical Packages
    ___Math routines ___Programming languages

15. Would you prefer that the Remote Job Entry service be run on an open-shop, hands-on basis (i.e., run your own decks)? ___Yes ___No ___Don't care

16. Your further comments about the facility and the way in which it is operated would be appreciated. Please indicate below any praises, criticisms, suggestions, questions, or ideas. Include any services or facilities that you would like to see provided which are not now available.