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AUTHOR Frohmberg, Katherine A.; Moffett, William A.
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ABSTRACT

In order to study the effects of introducing an automated circulation system at Oberlin College, Ohio, data were collected from September 1978 until June 1982 on book availability, usage of library facilities, attitudes of library users toward the library, and the efficiency of circulation activities. Data collection methods included circulation system monitoring and the administration of 10 sets of surveys. It was found that: (1) efficiencies in production caused by automation resulted in increased quality of service to patrons; (2) this new level of service decreased after a period of time (probably due to the Hawthorne effect) but still remained much higher than the level of service under the manual circulation system; (3) patron response to changes produced by automation varied over time, beginning with unfavorable attitudes during the period of transition from the manual to the online system, moving to more favorable attitudes after the transition period, and returning to original attitude values as patrons cycled out of the student body; and (4) patrons did not make increased use of the automated system even though it was easier to use. This report describes the Oberlin automated circulation system and research methodology and findings. A 34-item bibliography and sample data collection instruments are provided. (Author/ESR)

RESEARCH ON THE IMPACT OF A COMPUTERIZED CIRCULATION SYSTEM ON THE PERFORMANCE OF A LARGE COLLEGE LIBRARY

FINAL REPORT

Report on National Science Foundation Grant No. IST 78-10821
for the period September 15, 1978--June 1, 1982

January 1983

Prepared by

Katherine A. Frohmberg
William A. Moffett

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Oberlin, Ohio

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Since September 1978, Oberlin College has been [illegible]ing certain performance variables which were expected to change as a result of the introduction of an automated circulation system. Four years of data collection have shown that efficiencies in production caused by automation have resulted in increased quality of service to patrons. Probably because of the Hawthorne effect, this new level of service has decreased somewhat but is still much higher than its original value. A series of attitude surveys showed that patrons respond to changes produced by automation but that these returned to original values as patrons cycled out of the student body. Patrons did not make increased use of the system even though it is easier to use.

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Preface and Acknowledgements

Oberlin College, with the assistance of the National Science Foundation, has been using the introduction of an automated circulation system in 1968 as an occasion to study certain measures of library performance.

Interest in developing reliable methods of evaluation has been growing in library management since the early 1960's. Increasingly, library researchers have been applying techniques used in operations research, systems analysis, mathematical modelling, and statistical methods of quantitative analysis, often with useful results. But while it has been recognized that circulation of library materials to patrons is a basic library function--and hence an aspect of performance that is worthy of study--the impact of the circulation function on patron satisfaction has not been well understood and has rarely been measured. The precise nature of the impact of automation is particularly unclear in the absence of objective measures which would make it possible to quantify levels of performance before, during, and after the installation of automated systems. For that matter, careful documentation of the process and effects of the installation of such systems, even in the form of non-scientific, first-hand narratives, has generally not been carried out.

In introducing its own automated circulation system, Oberlin College had a unique opportunity for a quantitative study. Through objective measurement of the use of its library facilities, the attitudes of its users, and the availability of its library materials to patrons before, during, and after the introduction of its new system, Oberlin might not only document the consequences of automation in its own library, but develop techniques of measuring performance which would be applicable to other libraries.

This is the last comprehensive report on that attempt. It discusses the analysis of four full years of surveys conducted at Oberlin's main library, the first of two testing sites. Surveys at the second site, the music library, were discussed in a separate report submitted in December 1982 (Trotenberg, 1982). The previous report on the main library, dated 1981, analyzed two years of data. This report analyzes the full four years of the project. As our results are substantially different from those presented in the 2 year report, the interim report is completely superseded.

Chapter 1 of this report introduces the Oberlin project in terms of its immediate environment as well as in relation to other projects of its general type. Chapter 2 briefly describes the automated system and some of the management reports it produces. Chapter 3 discusses the project hypotheses. Chapter 4 describes the various data-gathering methods--the surveys and the continual monitoring of the circulation system itself--and some of the findings. Chapter 5

describes the mathematical techniques by which reliable inferences may be made. Although it employs some mathematics, we feel a reader even by the mathematically naive reader will give a sense of how reliable analysis in the social sciences is performed. Chapters 6 and 7 describe the results of the objective and attitude surveys as well as system state measurements of the videodisk system. Finally, Chapter 8 offers some ideas on the interpretation of the results.

The contributors of this report are especially indebted to Paul Tenler, President of Personal Inc., for his design of the survey instruments and thorough analysis of survey data, as well as the keen interest and care he has taken in this project from the start. There are in addition a number of people in Oberlin for whose contributions we are grateful. Herbert F. Johnson, former College Librarian, wrote the original grant proposal and has followed our progress as a member of the advisory committee; his colleague, Harold A. Olsen, former Associate Librarian, conducted some of the essential pre-automation surveys. Virginia L. Martin, originally a principal investigator, was responsible for preparing much of the material that went into our 1979 report. Robert A. Almony, Jr. was NSF project manager from September 1978 through November 1979. Donna Lippincott was automated circulation project officer from September 1977 to January 1979. Mary Jane Demopoulos was NSF secretary and data collection supervisor from February 1979 through September 1980. Mark N. Salomon who was former director of the Oberlin College Computing Center, and Terri Nelson who was former catalog librarian, were also instrumental in the project.

We are grateful for outstanding assistance from [illegible] Sweeney, [illegible] Director of the Music Library, who served as automated circulation project manager June 1977 through August 1978; George Mercer, Director of the Catholic College Computing Center, and his colleagues, Steve Wojcikiewicz, Alan Schaefer, and William Dabney; and Pearl Fix, data collection supervisor since September 1978. Participant thanks should go to Valerie McGowan, NCF secretary since September 1978.

Throughout the project we have profited from the constructive participation of our National Advisory Board composed of Mildred Hawkins, Dean of the School of Library and Information Studies, University of California, Berkeley; Robert W. Burns, Jr., assistant director of libraries for research, Colorado State University Library; Nathan E. Falkner, formerly senior vice president, King Research, Inc.; Herbert F. Jelinek, now director of libraries at Emory University; and Marcia Tuttle, now on the faculty of the San Jose State University Library School. This group has met from time to time over the life of the project and has provided valuable guidance, especially in assessing the theoretical implications of our study and their bearing on other research projects in the field.

Finally, we are obliged to the National Science Foundation not only for funding, but also for the thoughtful attention given to the progress of our project, especially by Richard Lee, project monitor, and his successor, Sarah Rhodes.

CHAPTER I

INTRODUCTION

Oberlin, in the words of a recent comparative guide to American colleges and universities, is "one of the nation's most esteemed coeducational, liberal arts colleges". It is unique among its peers because in addition to a superior academic program it boasts a music conservatory that is one of the most eminent to be found in a college setting. Admission to the College of Arts and Sciences (2200 students) is among the most selective in the country, and highly selective for the conservatory of music (500 students). High academic standards have led to an international reputation for the extraordinary number of Oberlin graduates who have made significant contributions to professional, artistic, and public life. Oberlin's heritage is also unique. It was, for example, the first coeducational institution of higher learning in the United States (1837), and it was the first to admit Blacks on a regular basis (1835).

Because of an extraordinarily aggressive collection building program begun over a century ago by its eminent librarian, Azariah Root, Oberlin came to have one of the largest college libraries in the nation, and is today one of the most complex academic libraries in an undergraduate setting. Its 850,000 volume collection is housed in the

large main library, a science library, a [illegible] library, and four branch libraries. The staff includes [illegible] professional and [illegible] support personnel.

The history of the Oberlin College Library is one of continual growth and renewal. From the [illegible], the focus has been on expanding and modernizing facilities: a new science library opened in [illegible], a new music library in [illegible], a new main library in [illegible], and a new art library in [illegible]. Completion of the building program, and especially the new main library, has led to fundamental changes in operations. The Dewey catalog was frozen in [illegible], and despite a more complicated stack arrangement, cataloging by the Library of Congress classification system was begun without a large-scale reclassification of the material from Dewey to LC. This further complicated a manual circulation system which had evolved in response to the needs of the outmoded Carnegie library. A drastic overhaul was clearly needed when the old building was exchanged in [illegible] for new quarters in the Seeley G. Mudd Learning Center. (Chapter 2 briefly describes the traditional card system and attempts to simplify it.)

In [illegible], the college retained Ralph Shoffner of Ringgold Management Systems to study circulation operations on the Oberlin campus and to suggest alternative means of reorganization — including the revision of the manual system and the installation of a computer-based circulation system. It was Shoffner's recommendation, subsequently adopted by the college, that Oberlin transfer and install the operational computer-based circulation system developed by Bucknell

University. Harold Olsen, then Associate Librarian, recommended that Oberlin begin to monitor user satisfaction and frustration so that basic information about the upcoming changes could help guide subsequent library operations. There was a clear need to justify the expense of an automated system. Not only was Oberlin experiencing the same struggle with inflation as other institutions, but the added cost of its unusually complex library system posed an especially heavy financial burden. If the college were to invest an additional $100,000 and more of capital funds in an automated system for its new library, the value of that expenditure simply had to be demonstrated. These two expenditures, along with the belief that a rigorously applied benefit analysis would be a great advantage to the library community at large, constituted the impetus for this study.

Background

Lancaster (1977) indicates that most evaluations of automation center on saved money and decreased staff. Evaluations of circulation systems, however, tend to focus on changes in usage, particularly whether circulation increases or decreases after the installation of an automated system. As Kent (1978) has shown, the ability to manipulate large amounts of machine-readable circulation data has supplied new information on how collections are used. Burns (1978) provides a good discussion of use studies as a performance measure.

There have been a few studies which have attempted to integrate several types of performance measurement into library operations.

Kaske (1973), for example, tried to measure library effectiveness by focusing on patron attitudes about the quantity and quality of materials and assistance supplied; the status of the collection (what is misshelved or stolen), and use of the collection. In general, however, the Oberlin approach has been unique in the breadth of its concern.

The Oberlin study has centered on such questions as:

- Does an automated system make materials more available to users?
- Does usage of the building change, and would there be a change in the use of certain services?
- What effect would the system have on patron attitude and satisfaction?
- How would costs and staffing be affected?
- How would these changes evolve over the long range?

A project designed to answer these questions should focus on several measures of the library's functions: availability, building use, visits to the library, number of checkouts, required time to charge a book, patron attitudes and more. It was felt that a broadly-based study such as this would provide a more complete picture of the effects of automation than a study concentrating on a single measure.

Availability

Considerable attention was focused on the problem of book availability in the 70's. There was good reason for this: fewer dollars available for book purchases meant libraries had to discover new means of making the best use of decreasing resources.

Early efforts to define the concept of book availability tended to focus on attempts which fail to find the book. Urquhart (1971) asked patrons to insert a slip at the place on the shelf where the book they wanted should have been. Library workers collected the slips and analyzed the causes of failure. Total availability could not be computed, however, because no record was kept of the number of successful searches.

Gore (1975) and Buckland (1975) also documented their efforts to increase availability. Gore used increased interlibrary lending in the Minneapolis-St. Paul area as a method of increasing availability. Buckland employed such methods as reducing time spent in the bindery and placing heavily used books on a shorter loan period. By measuring availability before and after the introduction of automation, our study tests whether automation increases availability.

The techniques used for measuring availability are described in Chapter 4. They were developed by Paul Kantor of Tantalus, Inc. and are described in detail by him (Kantor, 1976 and 1981). These techniques have also been applied by Saracevic et al. (1977) at Case

Western Reserve University and by Whitlatch and Kieffer (1978) at San Jose State University.

Goehlert (1978) pointed out that many patron needs do not require immediate satisfaction, that frequently the patron is able to wait some period of time for a book. Goehlert was able to show that after 50 days, 93% of the books sought could be made available to his clientele. In a related study, Murfin (1980) describes the problem of availability of periodicals. The concept of a span of time over which a book may be found is relevant to broader considerations of availability.

User Satisfaction/Frustration

Buckland (1975) has stated that there has been a "neglible amount of analysis of the dynamics of user response to changes in standards of service". Clearly, one important aspect of justifying library automation to administrators is to demonstrate the attitude of the users toward such a change. Moseley (1977) for example, suggests that a long-term examination of availability and satisfaction at Colorado State University would show some (positive or negative) changes as a result of their newly installed automated circulation system.

There were a number of aspects of user satisfaction and frustration that the Oberlin research team wished to explore. Most attitude questionnaires are administered once and are not compared to or comparable with results from other institutions or other patron

groups. By administering the same questionnaire over the life of the project, data points before, during, and after the installation of the system could be compared with each other providing a longitudinal look at changes in attitude.

Another aspect of the satisfaction/frustration question we wished to examine was the concept of unexpressed demand. Had our patrons been so conditioned by the inefficiencies of a manual circulation system that they were not checking out all the books they would like? Would an automated circulation system release sufficient staff that they could begin to respond to this unsatisfied demand and contribute to an increased use of the system?

Building Use

The main library at Oberlin College is in a spacious building with seating for 1/3 of the student population. Preliminary studies of building use were done in 1975 and 1976 by P. Kantor and H. Olson, confirming that the library was heavily used, but primarily as a study hall and a social center. These studies showed that students spent an average of ten hours per week at the library. By monitoring building use for the life of the project, we could discover subsequent trends in building usage.

System State.

In addition to the special-purpose measurements described above, measurements of the circulation system itself were required. The number of visits to the library and the number of books checked out measure certain types of use. The hours the system is unavailable due to malfunctions and the speed of response when it is available are also measures of the success of the system.

The Surveys.

In September 1978 Oberlin received funding from the National Science Foundation for this project. Oberlin contracted with Paul Kantor of Tantalus, Inc. for the design of the survey instruments, analysis of data, and a final technical report. As indicated above, the project was predicated on a series of before-and-after measurements of patron attitudes and of objective and qualitative variables. The study was to be conducted in the main library and conservatory of music library.

The art and science branch libraries were not included in this project. The two libraries chosen are the largest of the Oberlin system and were held to be most likely to experience change as a result of the new circulation system. The main library was experiencing great difficulty with the inefficiencies of its manual card system, and the music library had so little space that patrons could not find places to sit.

Although this project was originally designed to run two years, it soon became clear that the changes introduced by automation had effects which would take several years to develop fully. Consequently an extension was granted by NSI which allowed us to gather another two years, resulting in a project that lasted one student generation--four full years.

The data-gathering instruments are described in detail in Chapter 5. They measure:

- book availability
- usage of the library
- patron attitude
- state of the circulation system

CHAPTER 2

DESCRIPTION OF AUTOMATED CIRCULATION SYSTEM

System History

The manual circulation system in use at Oberlin College until 1975 was a traditional card system. Two pocket cards were signed by the patron with name, ID, and campus mailbox number. One card was filed by the date the book was due and the other by the call number. (Oberlin has a semester loan period.) In addition to the call number and date due files, there were many supplementary files for materials in special status, (bindery, missing, etc.). In 1974 the Assistant Director of the Library, H. Olsen, identified some 26 separate files in the Circulation Department. The next year, in order to simplify the system, the double pocket card system was dropped and a single pocket card system was implemented, also organized by date due. As a result of this change, several files might still need to be searched to discover the status of a particular book.

To determine whether the manual system could be salvaged or, indeed, whether an automated circulation system would solve the perceived problems, Herbert F. Johnson commissioned Ringgold Management Systems to study the circulation problems at Oberlin College. In October 1976, Mr. Shoffner, vice-president of Ringgold, recommended that Oberlin College purchase the circulation system installed at Bucknell University in Lewisburg, Pennsylvania. The significant factor involved in this recommendation was its implementation on the same computer used at Oberlin College, a Xerox Sigma 9.

At the same time there were important features of the Bucknell system which would have to be modified for Oberlin's needs. For example, the

Bucknell circulation system was based on punched cards. The programs were written in Fortran and used the database manager known as DMS, which was developed by Xerox. Further, the Bucknell libraries had converted their 250,000 volume shelf list to machine-readable form and had it available on-line. Therefore, every book entered into the system had an automatic verification of the existence of the call number-- an important means of eliminating errors. Finally, Bucknell's system did not handle branch libraries and had limited reserve book room capabilities.

These modifications were begun by Mr. Shaffner of Ringgold Management Systems. Early in the system's development the Oberlin College Computer Center modified the program for barcoded labels; enabled the system to accomodate branch libraries; and designed and programmed a microcomputer interface. In subsequent years, the Computing Center would considerably improve and enhance the system by a number of other modifications--a vital contribution to the success of its implementation.

Since Oberlin had 850,000 volumes in its collection in 1976 it was not thought feasible to create an on-line shelflist. Therefore, the system was designed to be a transaction system, not an inventory system. In other words, once the charge/discharge cycle was complete, the information would be deleted from the data base. Moreover, with a transaction system, the complete machine-readable record must be physically on the book, so that author/title and call number bar labels had to be produced and affixed to each book. The awkwardness and expense of this last requirement was later eliminated by implementing an archiving capability which allowed the dropping of author and title labels on the book. Books barcoded since March 1980 have only call number labels.

There were significant retrospective barcoding efforts while the system was being modified and installed. Between Summer 1979 and the end of 1980, about 20,000 volumes were barcoded in the Art Library, 120,000 volumes in the Main Library, and 22,000 monographs and 50,000 scores in the Conservatory of Music Library. As of this writing 85% of the books circulating in the Main Library are barcoded.

Before March 1980, when author/title labels had to be produced and affixed to the book, barcoding costs stood at about 50¢ per volume. After March 1980, any book in the Library of Congress classification scheme costs about 19¢ per book to label. Books in the Dewey Decimal classification are more difficult to label and, since March 1980, costs average about 27¢ per book.

In November 1978 the system was installed and began operation. For the full academic year of 1978-79 the manual pocket card systems were kept as a backup to the automated circulation system. By late Summer 1979 when the system was sufficiently stable and it was felt enough materials were barcoded, the manual backup was dropped. Since then, with further refinement, the system has proved to be admirably suited for the circulation needs of the Oberlin College Libraries.

System Description

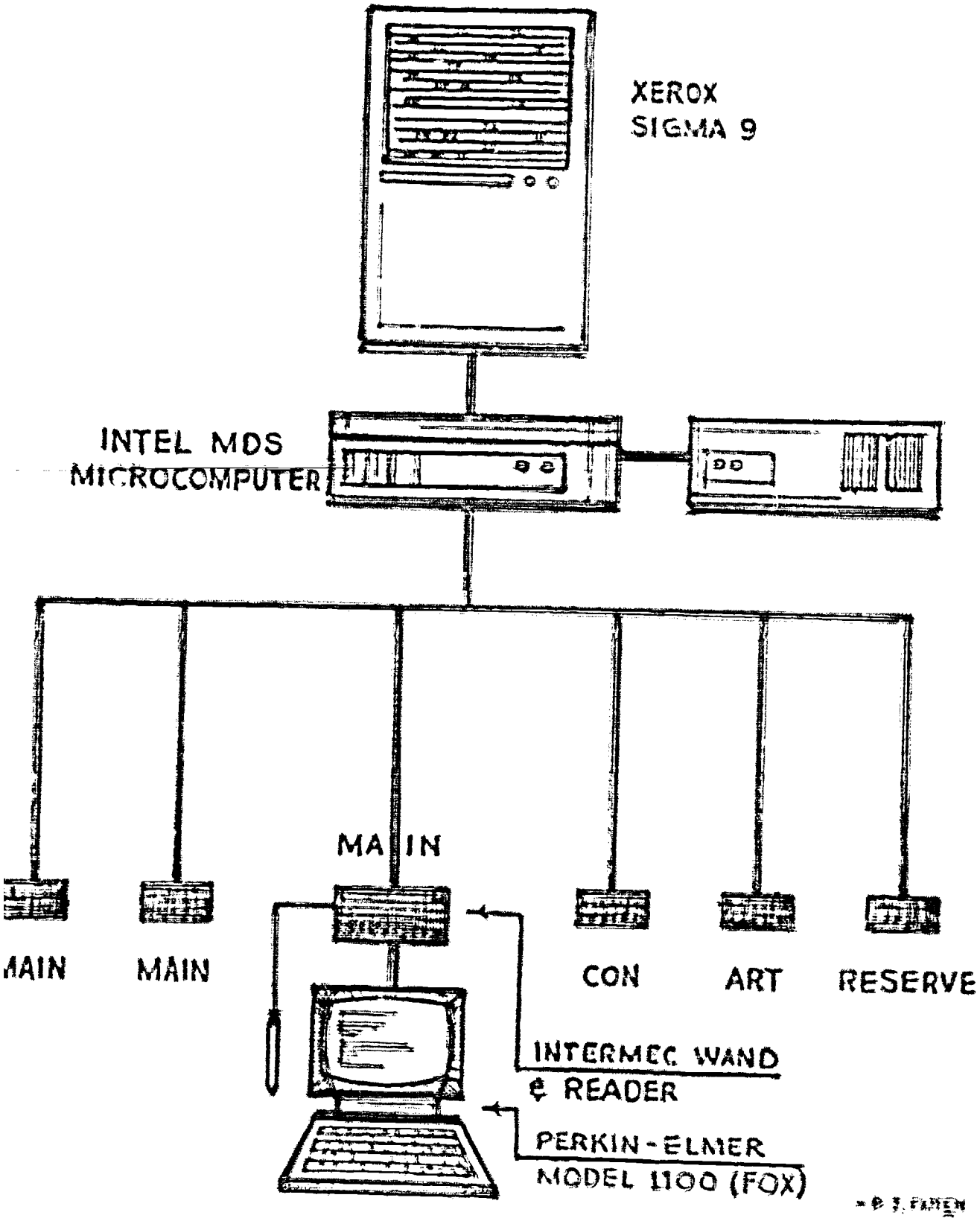
The machine-readable inputs to the circulation system are variable length, alphanumeric, Intermec Code 39 barcode labels. One or two labels contain the base call number for the title and an extension which distinguishes different physical manifestations of the same title (e.g. copy or volume). These labels are placed on both the inside and outside back cover of the book. The outer labels permit staff to discharge books without opening them. The labels are overlaid with mylar tape to protect them from wear.

Figure 2.1 shows the configuration of the system. The Xerox Sigma 9 uses the CP-V operating system, has 128 K words of core memory and uses 6 disc drives of 80 megabyte capacity each. The circulation system is allocated 8,000 granules (approximately 16 million characters) of on-line storage.

The Intel MDS microcomputer uses a 64,000 byte core memory, ISIS II operating system, and 2 floppy diskettes of ½ megabyte capacity each for logging of transactions when the Sigma is unavailable. The Perkin-Elmer model 1100 terminals contain a cathode ray tube display plus a full keyboard. Intermec model 1232 wands and readers are used to convert the barcode labels into a digital signal.

Figure 2.1

— SYSTEM CONFIGURATION —



As mentioned before, the on-line circulation database itself resides on the Xerox Sigma 9. In addition, the Sigma houses patron validity files, statistical report programs, error checking, etc. The microcomputer, however, also plays a significant role in operation of the system:

- The micro identifies terminal and branch location in order that an operator need not enter branch location codes.
- It automatically assigns the loan period for the majority of borrower categories.
- It formats transactions to the Sigma by computing check digits and concatenating barcode labels.
- It does some prompting of the system operators.
- The micro acts as a multiplexer in that it manages six terminals on one line.
- The micro allows logging of transactions when the Sigma mainframe is not available.
- The micro times various functions for statistical purposes.

There are two types of commands available on the microcomputer, "%" function and "F" functions, so characterized because of prefix symbols. *Percent functions*, an alphabetic code prefixed by %, change the status of the microcomputer; they do not affect the database resident on the Sigma. For example, %SEND is used to transmit messages to other terminals and %DWNLD begins the procedure for sending logged transactions to the Sigma for updating the database.

"F" functions (two alphabetic characters, the first of which is always F) cover the most common tasks required of an on-line circulation system (Figure 2.2). They are *charge* and *discharge, query by call number, transfer, delete,* and *place a hold.* In addition, books may also be allocated to reserve with an "F" function. For "F" functions, books are simply wanded into the database and the micro performs the various functions outlined above: computing check digits, concatenating labels, etc.

There are other functions, of course, which must be accommodated in a circulation system; maintenance of the patron file, to cite a single example,

Figure 2.2

"F" FUNCTIONS

FS	SHORT CHARGE
FL	LONG CHARGE (REQUIRES AUTHOR/TITLE)
FD	DISCHARGE
FV	QUERY BY CALL NUMBER
FA	LONG RESERVE ALLOCATE (REQUIRES AUTHOR/TITLE)
FB	SHORT RESERVE ALLOCATE
FT	TRANSFER TO ANOTHER BRANCH
FW	WITHDRAW OR DELETE
FH	PLACE A HOLD

functions which are not frequently performed, or which require access to confidential information, are accomplished by using yet another mode on the microcomputer, *transparent*. In transparent mode, the operator is communicating directly with the main circulation system program, which is resident on the Xerox Sigma 9. In transparent mode, such very important functions as *maintenance of the hold file, searching by author/title, and quick on patrons* may be done, as well as *discounts* on delinquent patrons.

The interaction between the computer and the operator is considerably more conversational in transparent mode than in regular mode. The micro computer is not operating on such transactions at all. As a result, such data as status and location of books must be entered manually by the operator, something that is not required in regular mode. Furthermore, labels may not be worded in transparent because check digits and label identifiers are not removed. (Figures 2.3 and 2.4 illustrate examples of charging books in regular and in transparent mode. As can be seen from Figure 2.4, transparent charging requires input of location, loan periods, etc.)

The last major mode of the microcomputer is called *offline*. The micro times every transaction it sends to the Sigma and if no response is received after 5 minutes, the microcomputer severs communication with the Sigma and logs the transaction on the floppy diskettes. Until the operator tries to bring the system on-line, the micro will log transactions on the diskettes. This is very valuable when the Sigma crashes and when response is very slow. When the Sigma subsequently does become available, transactions are unwound to the on-line database and any problems with patron validity, volumes already active, etc. are written on paper output by an independent console typewriter.

```
***TERM = "TRANSPARENT"

*C
--ENTER PATRON ID-->
^%S
?747474747
--ENTER LOCATION CODE--
?1
--ENTER VOLUME--
^%S
?843.7D89E.19262%V1
--ENTER PERIOD--
^%S
?8

       VOL: 843.7D89E.19262
                 V1
        ID: 747474747
       DUE: 16 DEC 80 2400
^%S

#SYSTEM READY:
?
*
```

VOLUME CHARGE IN TRANSPARENT

Figure 2.3

```
* FL TRANSACTION TYPE LABEL, OK
* 747474747 PATRON LABEL, OK
* CHQ1781,P2T54%COP29/ CALL NUMBER LABEL, OK
* ATTGER WOMEN IN TH AUTHOR LABEL, OK
*

TRANSACTION TIMEOUT (ORG14-M6)
FOR A COMPLETE TRANSACTION THE FOLLOWING IS NEEDED:
-TITLE LABEL
YOUR TRANSACTION IS STILL INTACT, PLEASE CONTINUE

*TE KIBBUTZ/
* TRANSACTION (00178) RECEIVED ... OK

STBY:
** VOLUME ALREADY ACTIVE
** NO ACTION POSSIBLE

#SYSTEM READY:
```

VOLUME CHARGE IN REGULAR MODE

Figure 2.4

System Organization

The circulation program resident on the Sigma 9 uses a CODASYL style database manager. The programs purchased from Bucknell were implemented using DMS but were upgraded at Oberlin to EDMS, Xerox's latest release of the database manager.

Figure 2.5 displays the various groups and fields around which the database is organized. EDMS defines relationships between the groups listed which then determine the structure of the on-line links (pointers).

There are no variable length records on this system. For circulation purposes, an abbreviated author/title record has been adequate. However, the character limit of 28 for call number and 12 for extension has proven to be inadequate. Musical scores classed in the Dewey system have very long call numbers and some portion of the Conservatory score collection (less than 1%) had call numbers or extensions too long to enter. At some point we will be redefining the database to accommodate these longer call numbers.

The microcomputer has been programmed with a high-level language known as PLM-80. The circulation program operates in a 'repeat forever' loop, cycling through each terminal in turn and processing messages through use of interrupts. Thus the micro is able to simulate time sharing.

Management Reports

Statistics and Management reports for the circulation system are generated through two means: the on-line database itself and the journal record. The journal is used to provide a chronological record of system activity so that it may be restored at any point in the day from a fatal error in the database. The database is copied to tape every night and the journal is used to bring the system up-to-date at any point during the day.

There are some 26 types of journal records. Figure 2.6 is an example for a simple charge. Journal records range from charges and discharges to records for patron updates and holds which have been cancelled by Reserve. In this particular journal record, everything required to simulate the charge at the time it occurred must be recorded. Thus, the record must include:

Column	Name
1	Identifies transaction as a charge
3	Location (Main, Art or Conservatory)
4	Unwound or on-line transaction
5	Circulation type (Reserve or Regular)
6-15	Date and time
16-43	Call Number
44-55	Extension
56-64	Patron's ID number
65	Loan period (2 weeks, 4 weeks, semester, etc.)
66	Patron status (undergraduate, staff, town, etc.)
67	Charge type (wand with author/title, wand without author/title, keyed)

The journal record is the means by which most research into library collection analysis and circulation of library collections is accomplished (Kent, 1978). Similarly, Oberlin uses the journal record to produce the following reports:

A. Daily statistics. This series of reports is generated from the journal record and from the on-line database. Components include:

- Recall and overdue notices
- Tallies of various types of transactions
- Charges by patron types
- Charges by loan period
- Keyed vs. wanded charges (a measure of what proportion is in machine-readable form)
- Charges by call number schema

The statistics reports are prepared for each branch library plus a summary report for the system as a whole.

B. Recall Response Report. This report allows us to measure the delay between the sending of a recall notice and the return of the book for each class of patrons. It has allowed us to observe changing response to the recall service as it has been introduced. It will allow us to measure the effectiveness of changes in recall response as we vary wording of notices, timing of notices, etc.

C. Item Activity Report. This report is a variation of the "purchase alert" report available on many commercial circulation systems. A Library

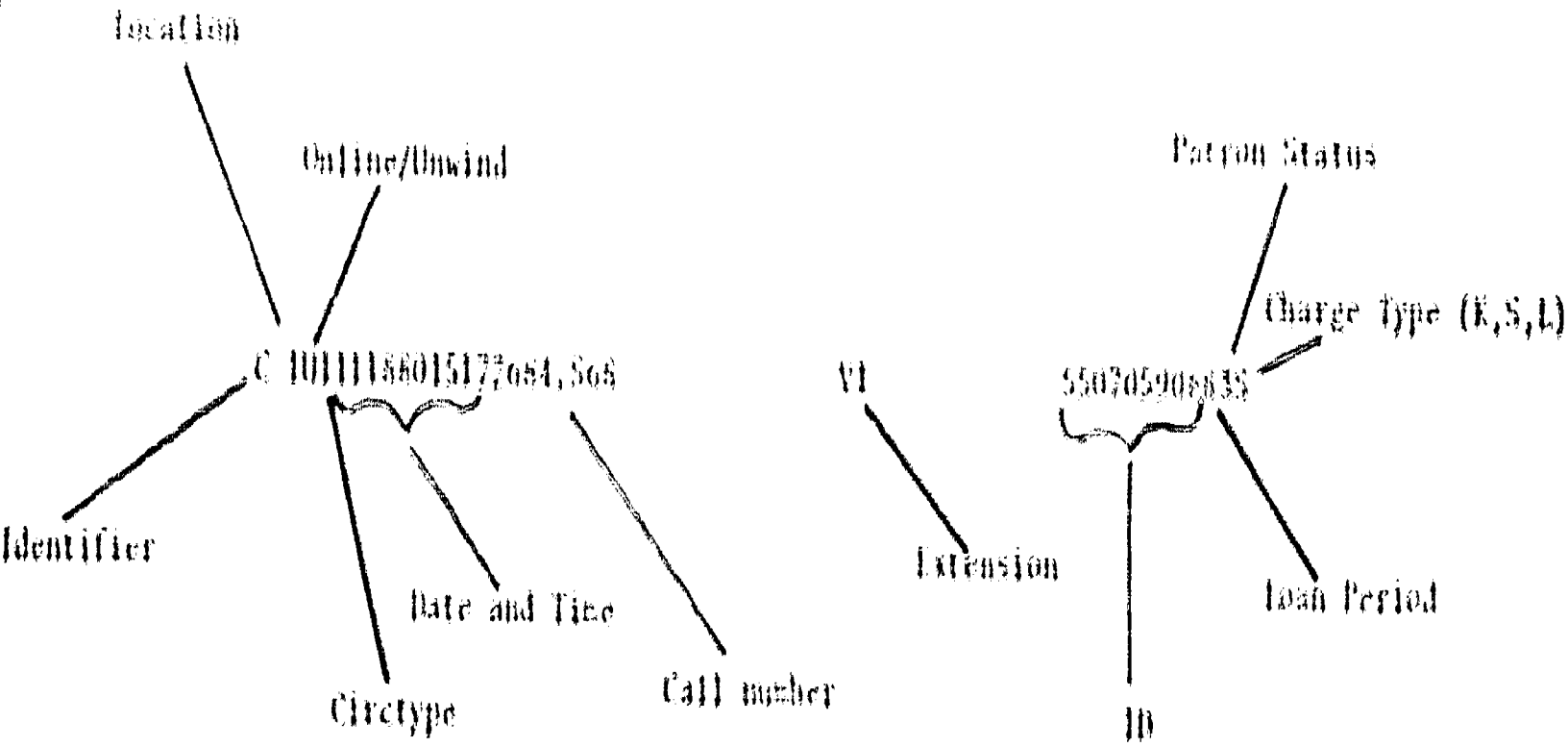
Figure 2.5

Oberlin College
Library Circulation Database Fields

Group	Field	Description	Field Type
PATRON			
	ID	9 Digit Patron ID Number	Binary
	PRINNAME	Patron name	24 Char
	INDATE	YY/MM/DD patron entered system	Binary
	STATUS	Patron type (student, staff, etc.)	1 Char
	ADDRESS	Patron mailing address	40 Char
ATINDEX			
	KEYATX	3 Char of Author, 3 Char of Title	6 Char
	HITCNT	Number of times this group occurs	Binary
VINCIRC			
	CALL NO	Volume Call Number (LC or Dewey)	28 Char
	AUTHOR	Volume's Author	40 Char
	TITLE	Volume's Title	56 Char
CALLEXT			
	LCNOEXT	Call Number Extension for books	12 Char
	LINKCURR	ID of patron to whom book is charged	Binary
	OUTDATE	YY/MM/DD book was charged to LINKCURR	Binary
	DUEDATE	YY/MM/DD book is due	Binary
	PERIOD	Loan period is due	Binary
	HOLD	5 Patron IDs of people requesting book	Binary
	OWNER	Branch number of book's home	Binary
	LOCATION	Branch from which book currently circulates	Binary
	CIRCTYPE	Circulation Category	Binary
	COURSE	Course for which Reserve book is used	Binary

Figure 2.6

JOURNAL RECORD CREATED FOR CIRC:



defined combination of charges, holds and queries is used to scan all circulations for a semester. Books which match that criteria are output on the report. The combination of holds, queries, and charges may be varied from run to run and allows us to determine a threshold level of book activity for various subject areas.

Chapter 3

Project Hypotheses

There are many factors other than increased efficiency and decreased costs which should be considered when contemplating an automated process in a library or other office environment. A service such as a library cannot be made to function according to the same standards as a manufacturing facility. Whereas it is clearly desirable for automation to process more units in less time, production vs costs is not the whole picture. The psychological effect of a system on staff and patrons is one important issue. Another can be the changes in work flow and allocation of staff duties resulting from the implementation of such a system. In libraries, other important considerations include the manner in which the building is used and ease with which students can find materials.

The effect of automation on patron behavior and attitude is a particularly interesting topic. Besides the obvious presence of terminals, to what changes wrought by the system do patrons react most? Do patrons check out more books when an automated circulation system is installed? Do they care that they spend less time at the circulation desk in the mechanical process of checking out books? Are there needs which have not been expressed by users which might be more

successfully served by an automated circulation system? Are they frustrated by delays at checkout or by inability to find books where they belong? A qualitative analysis of these issues was seen as useful for the library profession as a whole and for the Moffitt College administration in justifying the installation of such a system.

Moffitt had a unique opportunity to study the effects described above when plans were made to implement an automated circulation system. The basis for the study was a series of before and after measurements of certain variables, including such traditional measures as number of checkouts and system response time, but also including book availability measures, studies of building use, and an attitude questionnaire. The analysis of these variables would result in a generalized measure known as 'system performance'.

The following hypotheses were formulated.

#1 Qualitative Hypothesis.

As the circulation system's performance improves, the quality of service improves and the quantity remains the same. Attitudes may improve.

III. Homeostatic Hypotheses.

As the circulation system improves patron attitude improves. As attitudes improve the quantity of service increases. The cumulative effect is that quality first increases and eventually returns to its original level. Attitude at this point is unknown.

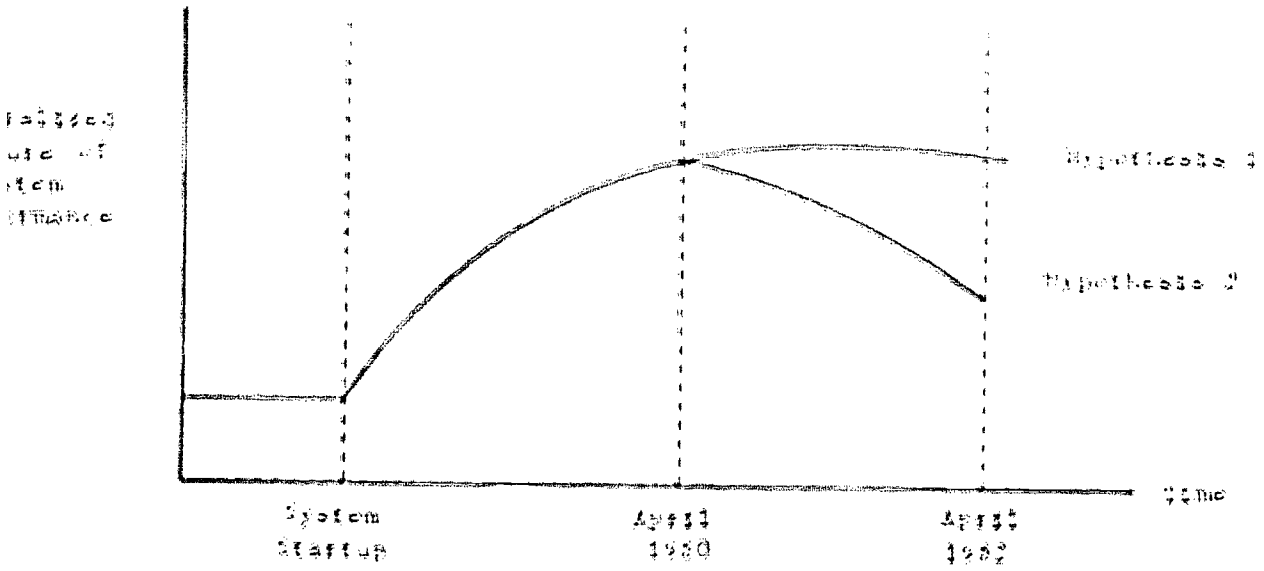
These hypotheses are illustrated in figure 3.1. Hypothesis 1 asserts that system performance will start at some non-automated level, a level which presumably existed for some time as a result of a manual system. The circulation system causes increases in the quality of service which does not result in increased quantity. In other words, efficiencies introduced by automation have the simple effect of increasing performance which then rises to your new level, but patrons do not change their behavior by using the system more.

The second hypothesis treats the library environment as a dynamic one, regulated by changes in patron perceptions. As in the first hypothesis, system performance exists at some non-automated level and rises as a result of the circulation system. However, in hypothesis 2, patrons notice the changes in the system and, as a result, modify their use of the system. Specifically, students place so many more demands on the system that its performance falls. Eventually system performance returns to its pre-automated level but at a higher quantity of service being rendered. Attitude may or may not retain its improved level.

It was considered very important that we study the variables over a sufficiently long period of time in order to establish the presence or absence of such a feedback cycle. If the digital project was designed for full field type, and as is seen in figure 3.4, this was not adequate time to determine whether system performance would level off or fall. The follow-up models planned by NSF have provided the additional data to show that hypotheses 4 is proved true in the math and conservatory disparities.

Figure 2.1

Project Hypotheses



Chapter 4

Instruments for Data Collection

Data for this study were gathered through formal monitoring of the circulation system itself and through two sets of surveys administered during the four project years. Two of the surveys were objective and one was attitudinal.

The attitude and objective surveys are designed to overlap in the variables they measured. For example, students' perceptions of book availability is later compared with objectively measured availability. If there were significant differences between perception of conditions and objectively measured conditions, they would be more completely further investigated.

The Calendar of Surveys

Four periods in the academic year were targeted, two fall semester and two spring semester. Typical weeks were chosen, one before and one after each semester break but not too close to those breaks. For example, a "typical" week chosen for the late spring study is the last week in April. During the first weekend in May, a festival known as Mayfest is held, at which time the library is usually deserted.

The late spring survey is held to be ignored because of methods for study patterns associated with the earlier part of the semester, where the accomplishment of teacher and the intensity of task associated with it is exceptionally.

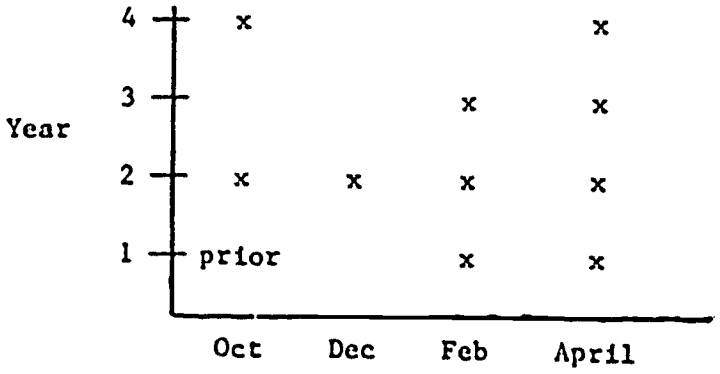
The surveys are made over the four years during the same week of the semester in order that cycles in the academic calendar are not mistaken for real changes in usage or attitude. Therefore, comparisons should be made among datasets of years 1, 2, 3, and 4 instead of comparing results in April of the following.

Due to various difficulties on the project, four surveys were not accomplished each year (see survey schedule, figure 4). Funding for the project was received too late in the first year for an early data survey, but late fall, early spring and late spring surveys were successfully conducted. As a result, the late fall survey of 1972 is the only measure of the network system. A full complement of four surveys were administered in the second year. At the end of this period, it was clear that the response of the automated system was leveling off and the variables were not responding as quickly as in the first two years. We felt we could not justify the cost of surveys four times per year. Therefore one survey was done during year three and two during year four.

Figure 4.1

SURVEY CALENDAR - MAIN LIBRARY

	Survey #	Objective Surveys (availability and activity)	Attitude Survey
	1	October 1978	November 1978
Year 1	2	February 1979	March 1979
	3	May 1979	May 1979
	4	September 1979	September 1979
Year 2	5	November 1979	December 1979
	6	February 1980	February 1980
	7	April 1980	May 1980
Year 3	8	April 1981	May 1981
Year 4	9	October 1981	November 1981
	10	April 1982	May 1982



Availability

Data on availability were gathered with a survey administered through the four years of the project. A data collection sheet (Figure 4.2) was given to the students approaching the card catalog after it had been determined that they were looking for a specific item (not searching by subject). The students were asked to use the worksheet as a scratch page and to note call numbers and the author/title of items they were seeking. If for any reason they did not find the item, they were requested to check the box and drop off the worksheet as they left the library. Survey workers then followed a fixed procedure to ascertain why students were unable to locate a particular item.

There are five basic hurdles which must be cleared if patrons are to be successful in getting books they want:

- Does the library own the book sought?
- If yes, can the patron find it in the card catalog?
- If yes, then is it not already charged out to another person?
- If yes, is it properly shelved or not in the process of being shelved, discharged, etc.?
- If so, can the patron find it on the shelf?

In computing an overall success rate, each availability factor must be multiplied with the next. Figure 4.3 illustrates this process using data from the April 1980 survey.

Figure 4.2

BOOK AVAILABILITY STUDY: HUDD LIBRARY

Our library is involved in a long-term study of the impact of library automation on service and attitudes. Part of the project involves tracking down any specific books which you cannot find. Please help us by using this form as "scratch paper" and leaving it at the door when your visit is over. For any book you cannot find, place an "X" in the "Can't find" column. Thank you for your help.

AUTHOR and TITLE	CALL NO.	Can't find	For library use only					
			phone patron staff	not in catalog	wrong call no	on the shelf	circulating	other
			phone patron staff	not in catalog	wrong call no	on the shelf	circulating	other
			phone patron staff	not in catalog	wrong call no	on the shelf	circulating	other
			phone patron staff	not in catalog	wrong call no	on the shelf	circulating	other
			phone patron staff	not in catalog	wrong call no	on the shelf	circulating	other
			phone patron staff	not in catalog	wrong call no	on the shelf	circulating	other
			phone patron staff	not in catalog	wrong call no	on the shelf	circulating	other
			phone patron staff	not in catalog	wrong call no	on the shelf	circulating	other
			phone patron staff	not in catalog	wrong call no	on the shelf	circulating	other

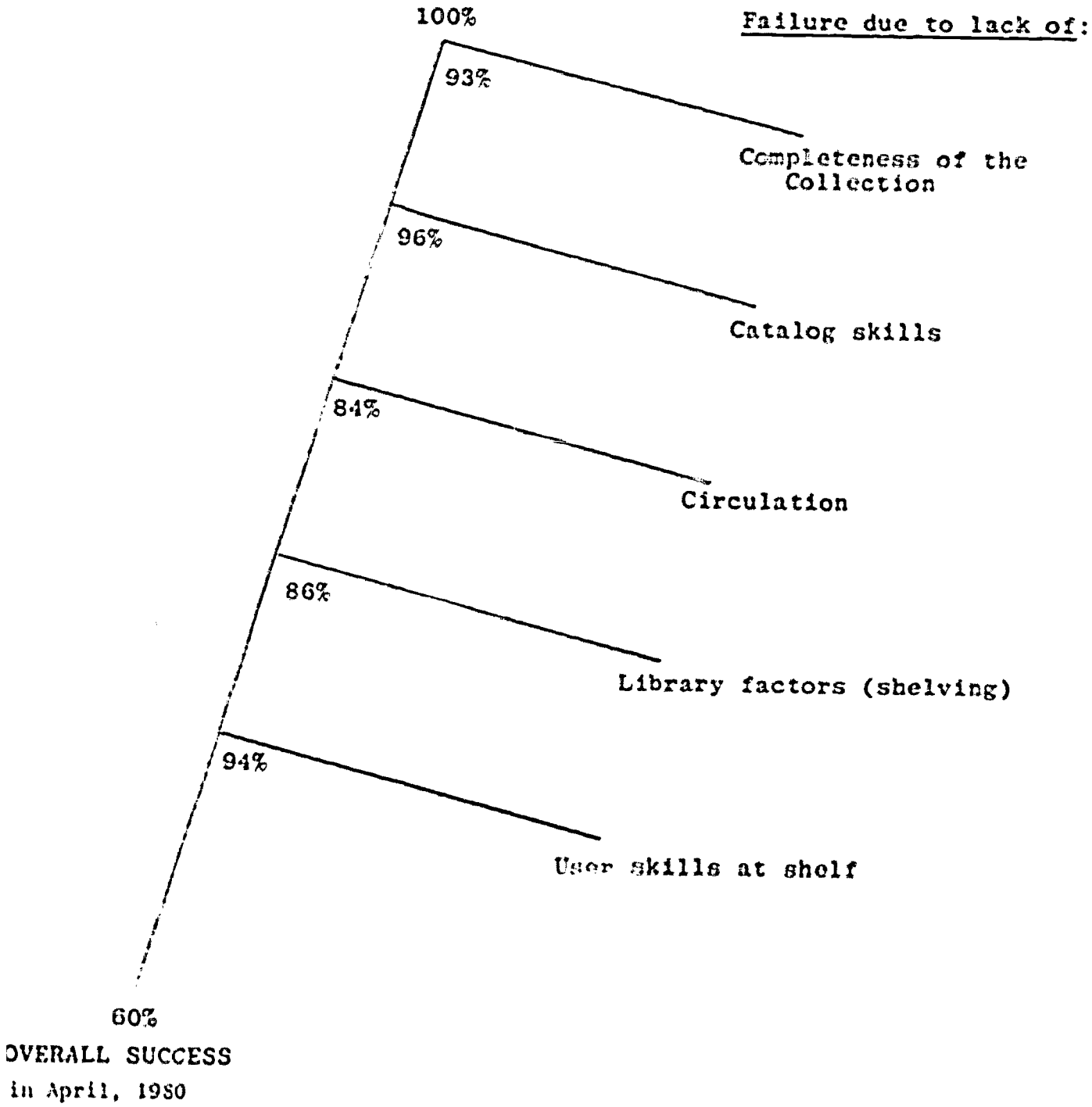
PLEASE INDICATE STATUS: Faculty ☐ Student ☐ Staff ☐ Other ☐

Oberlin Libraries Impact Assessment Study
GREEN Data Form (Document Availability Analysis)

Availability Worksheet

Figure 4.3

Factors in Computing Book Availability



The patron approaches the catalog with a particular author/title in mind. In April, 1981, there was a 7% chance the library did not own the book. There was a 4% chance s/he was unable to locate the citation in the card catalog even though it was there (96% chance they could locate the book). These two factors must be multiplied together so that after these stages, the patron's chance of success has already been reduced to 89% (93% x 96%). In April, there was a 16% chance that the book was already checked out to another user, thus reducing the probability of success to 75% (93% x 96% x 84%). There was a 14% chance the book was improperly shelved or in the process of being shelved and a 6% chance the patron could not find it on the shelf. These 2 factors are again multiplied with the other factors (93% x 96% x 84% x 86% x 94%), giving a total probability of success of 60%. Figure 4.3 illustrates the decreasing chance of success as a patron searches for a book. In April, 1980, the patron had a 60% chance of following all 5 steps to successful conclusion.

The results of the availability surveys are given in Figure 4.4. As one can see, 2 factors, catalog skills and user skills at the shelf varied little over the life of the project. However, ownership factors (is the book in the catalog?), circulation factors (is the book not charged out?) and library factors (shelving, prompt sorting, etc.) did vary significantly over the life of the project. They are discussed in further detail in Chapter 6.

Figure 4.4

AVAILABILITY MEASURES: MAIN LIBRARY
(expressed in percentages)

		Nov 78	Feb 79	Apr 79	Sept 79	Nov 79	Feb 80	Apr 80	Apr 81	Oct 81	Apr 82
DO WE OWN THE BOOK?			82.3	90.5	89.2	96.8	96.0	93.2	86.2	88.5	79.7
USER CATALOG SKILLS	USE		96.9	97.9	95.8	97.1	97.6	95.6	89.3	94.7	95.0
IS IT NOT CHARGED OUT TO A USER?	USE		85.7	83.0	92.6	85.5	93.9	83.7	88.3	92.6	90.3
IS IT PROPERLY SHELVED? (LIBRARY FACTORS)	ABLE		75.7	79.5	82.2	84.4	86.5	86.1	96.0	91.3	84.6
USER SKILLS AT THE SHELF	E		92.3	96.1	95.9	94.7	94.0	94.0	95.4	96.8	94.5
OVERALL SUCCESS											
Indicated error is standard error.		47.7 ±2.6%	56.1 ±2.8%	62.3 ±2.5%	64.3 ±2.2%	71.6 ±2.6%	60.4 ±2.4%	62.7 ±2.5	68.6 ±2.3	54.7 ±2.5

Activity Surveys

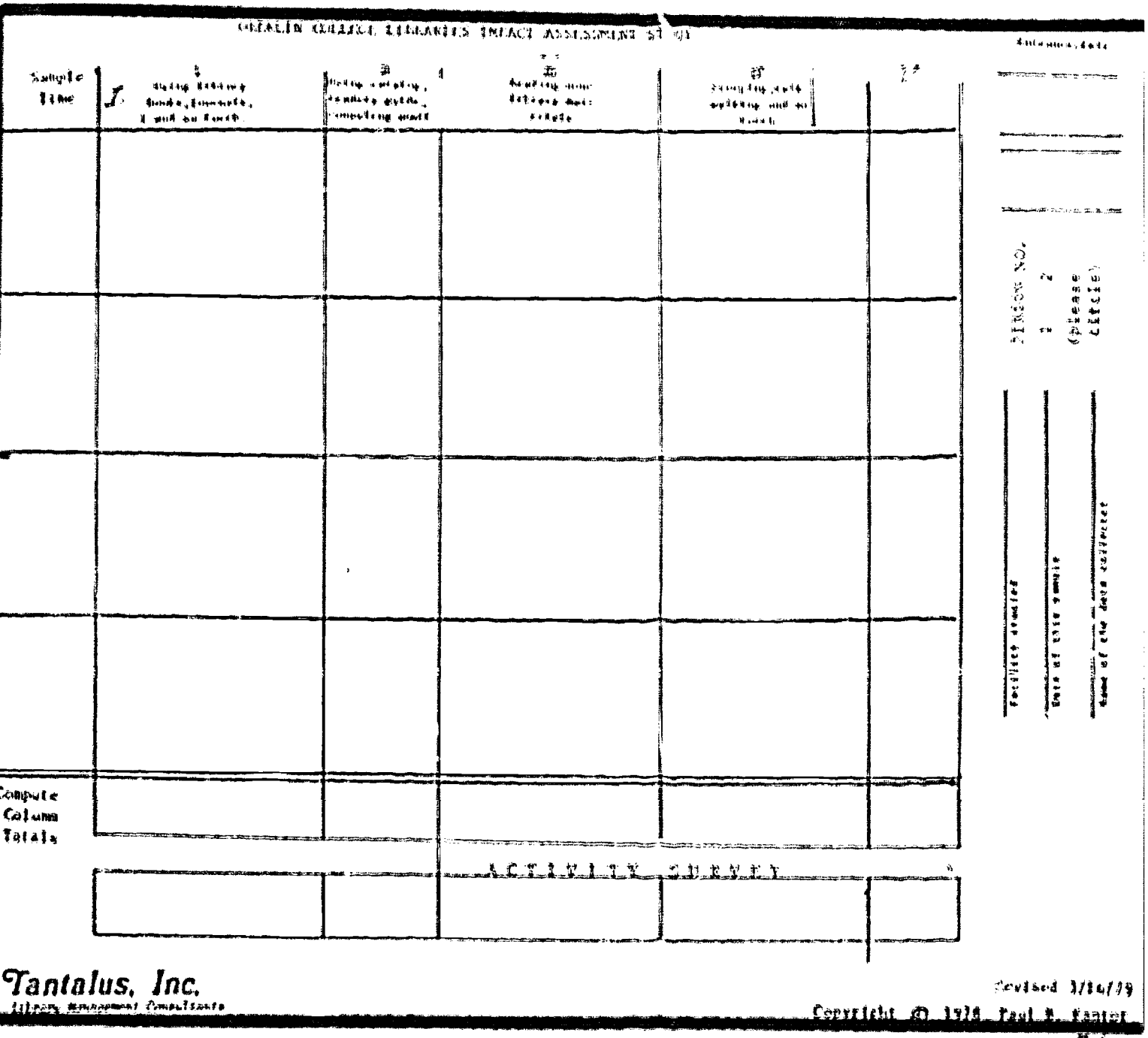
For the Activity Analysis, survey workers walk through the building at specified times, on a specified route, and in a specified manner determine what people are doing, according to the following categories:

- using library books, journals and other materials from the library's collection
- searching for materials through the card catalog, using reference indexes, consulting with staff, etc.
- reading nonlibrary materials (textbooks, class notes, etc.)
- sleeping, talking, socializing, etc.

The worksheet used is shown in Figure 4.5

The interpretation of these surveys will be discussed in detail in Chapter 6. However, the number of user service hours observed in each category are presented in Figure 4.6. As we have mentioned previously, results must be compared by pairs to minimize fluctuations in results due to the academic calendar. Thus, October 1978 must be compared with October 1979, February 1979 with February 1980, etc.

Figure 4.3



Activity Worksheet

Figure 4.6

MAIN LIBRARY ACTIVITY SURVEY RESULTS

Expressed in User Service Hours

	78/79 Year 1	79/80 Year 2	80/81 Year 3	81/82 Year 4
October				
Use	4,100	4,860	***	4,819
Search	650	860	***	946
Study	14,570	12,550	***	13,615
Other	7,270	6,040	***	6,436
TOTAL	27,260	24,290	***	25,816
December				
Use	***	7,283	***	***
Search	***	858	***	***
Study	***	9,473	***	***
Other	***	7,034	***	***
TOTAL	***	24,648	***	***
February				
Use	5,260	5,650	***	***
Search	810	690	***	***
Study	11,600	9,120	***	***
Other	5,900	5,950	***	***
TOTAL	23,600	21,410	***	***
April				
Use	5,160	6,310	4,173	5,383
Search	930	820	611	674
Study	10,130	8,900	11,015	11,134
Other	6,970	6,450	7,363	6,120
TOTAL	23,300	22,500	23,162	23,312

The math library is housed in the Dooley G. Mudd Learning Center, a spacious building designed to provide seating for 1100 of a student body of 2700. It is open for 100 hours per week plus an additional 14 hours of late night study, unusually high for a college library. It was designed to provide a wide range of study environments: private carrels, small study rooms, informal lounges and a variety of inviting comfortable furniture. As a result of the generous amount of uncrowded and comfortable space, the math library invites use as a general study area as well as a place for library research.

Attitude Surveys

The attitude questionnaire was designed by Taktalus, Inc. in conjunction with D. Simpson, a specialist in the design and evaluation of attitude questionnaires. The questionnaire was simplified twice during the course of the project. The final form is shown as Figure 4.7.

The questions fall into five general categories, shown as Figure 4.8.

Figure 4.2

M

RV 8/74

OBERLIN COLLEGE LIBRARY SURVEY

This questionnaire will help us carry out an NSF funded research study of the impact of technology on library services. Your patience and cooperation are appreciated. During our two year study your opinions may be solicited more than once. Your box number is included for computer data analysis. You will not be identified in any way with your answers to these questions.

Thank you. WM

1. Which of the following best describes your academic major?
   1. Natural Sciences
   2. Social Sciences
   3. Arts and Humanities
   4. Music
   5. Other, _____

2. Place a circle around the name of the library which you usually use:
   1. Art Library
   2. Conservatory Library
   3. Science Library (Kettering)
   4. Main Library (Mudd)

3. For what purposes do you use the Main Library? (Circle all which apply)
   1. To browse through books
   2. To use journals
   3. To read newspapers
   4. To relax or socialize
   5. To borrow books
   6. To use materials on reserve
   7. To read library books
   8. To use other library materials
   9. To study your own materials
   10. Other (Specify) _____

4. In the past three days, how many times have you used the Main Library? _____ [22]

5. About how many hours were you physically present in the Main Library during the past three days? [23,24]

6. The last time you looked for a book in the Main Library, were you able to locate it? *(circle one.)*

YES [26] NO

7. About what percent of the time do you find a book to be unavailable at the Main Library? [27,28]

Almost never — Half the time — Almost always

0 10 20 30 40 50 60 70 80 90 100

(Place a mark on the line at or near the position which best represents your response.)

8. Have you ever used the recall service when the book you wanted was not available? *(Circle one.)*

YES [29] NO

If you have used the recall service, was it satisfactory?

YES [30] NO

9. Which seating area in the library do you prefer to work in? *(circle one.)*

[31]
1. Upholstered chairs or sofas
2. Open large tables
3. Study carrels
4. Globe chairs
5. No preference
6. Other *(specify)* _____

10. If your answer to the preceding question was 1,2,3,4 or 6, is that place usually available when you want it?

YES [34] NO

11. How often is your usual work area too noisy?

1. Usually
2. Sometimes [35]
3. Seldom
4. Never

12. Does the library own most of the books that you need? YES [38] NO

13. To what extent are you satisfied with library services?

[37]
1. Very satisfied
2. Usually satisfied
3. Sometimes satisfied
4. Seldom or never satisfied

14. In your opinion, how do most other students feel about library services?
[47] 1. Very satisfied
2. Usually satisfied
3. Sometimes satisfied
4. Seldom or never satisfied

15. In your opinion, during the past three months have library services
[48] 1. Gotten better
2. Gotten worse
3. Remained about the same.

16. How often have you been frustrated by service delays when checking out library materials? *(Circle one.)*
[50] 1. Seldom or never 3. Often
2. Occasionally 4. Very frequently

17. What are your chances of getting an item that you need at the Main Library? *(Mark the response line to represent your estimate on a scale of 0% to 100%.)* [57,58]

0 10 20 30 40 50 60 70 80 90 100

18. On your last trip to the library, did you search for a particular book?

YES [59] NO

If "YES," did you find it?

YES [60] NO

19. Please indicate the degree to which each of the following statements represents your own opinion or attitude. Use a scale of 1 to 9 in which "1" represents strong disagreement and "9" represents strong agreement.

Response

a. I seldom have problems locating books listed in the card catalog. _____ [61]

b. The atmosphere in the Main Library is not serious enough. _____ [63]

c. The Main Library staff is not usually very helpful. _____ [64]

d. I frequently don't find the books that I want in the Main Library. _____ [67]

e. The Library generally meets my expectations. _____ [70]

20. How often do you consult with a librarian at the reference desk?
[72] 1. Never 3. Weekly
2. Several times a month 4. Daily

21. The reference service at the Main Library is:

[73] GOOD FAIR POOR

22. When you need reference help, is there someone at the desk? *(Circle one.)*
[74] 1. Seldom or never 3. Often
2. Occasionally 4. Almost always

21. The following list of statements represents a variety of opinions about the Main Library in the Mudd Learning Center. Please circle the one which most closely reflects your own opinion; that is, the statement with which you most strongly agree. *(Please circle only one, even if the decision is a tough one.)*

[73,74]

1. Overall, I am pretty satisfied with the library.
2. The library is beneficial to Oberlin college students.
3. The library is just an ordinary institution.
4. The array of services at the library is only mediocre.
5. I would not remain at Oberlin without the resources of t[illegible]
6. People are seldom successful in obtaining what they want [illegible] of the library.
7. The college could get along well without the library.
8. The library is the best part of my education at [illegible]
9. The library generally meets my needs.
10. I would not rely on the library for serious research.
11. I am usually pleased with the services of the library.

24. Are you a: *(Please circle one.)*

[77] 1. Freshman 3. Junior
2. Sophomore 4. Senior 5. Other (specify) _____

25. Are you a conservatory student?

YES NO

[78]

We thank you for your cooperation. If there are any specific comments which you would care to make, please use the space below.

Figure 4.8

ATTITUDE QUESTIONNAIRE

TYPE OF QUESTION	QUESTION NUMBER
Control Variables	1, 2, 24, 25
Specific aspects of library use	3, 4, 5
Perceptions of document availability and crowding (to be compared with objectively measured availability)	6, 7, 8, 9, 10, 11, 12, 17, 1
Attitude Directly measures feelings about the Library	13, 14, 15, 16, 19, 23
Questions unrelated to the project but inserted to answer other library needs	20, 21, 22

Control variables are used to monitor uniformity of coverage and response rate (class status, academic major, etc.) Questions on specific aspects of library use help determine reasons for and extent of use. The third group of questions deals with perceptions of

document availability and building crowdedness which are compared with objectively measured data.

The fourth group of questions directly and indirectly measure attitude. Questions 13, 14, and 15 ask for a direct opinion on satisfaction. Question 16 asks for frustration with delays at the circulation desk.

Questions 19 and 23, however, indirectly measure attitude. Question 19 is a Likert-type question, a type of measure, which requests degree of agreement or disagreement. It was included to test for an attitude factor or bias which would color all the responses given by an individual. It was found that this factor was not stable from survey to survey and has not been used in the final analysis.

Question 23, the Thurstone scale, was the more successful psychometric tool. This method uses eleven questions and calibrates them from least favorable to most favorable through use of a control group. Questionnaire respondents pick the statement which most reflects their feelings and this response is translated into a numerical value determined through the calibration process. The calibration process itself was originally performed upon a group of students (judges) at Case Western Reserve University and Cleveland State University. The usual assumption is that results will be distributed normally about some response. When the first results at Oberlin were analyzed, however, the results were bi-modal. (Results distributed normally about some response may be described graphically as a "bell-shaped

curve," a single peak with results falling on either side to a low tail. A bimodal result, on the other hand, has two peaks, not necessarily equal in size, with a low between the peaks.) When the scale was recalibrated on Oberlin students, the bi-modality vanished and results were more meaningful. It is interesting to note that the statement

"the library is useful to me"

was given a neutral '6' response by non-Oberlin judges and a definitely positive '9' by the Oberlin judges. The Oberlin calibration of responses is shown as Figure 4.9.

The last category of questions (numbers 20-27) are not related to this project. They were introduced by library management to track changes in reference service which were being made at the same time as this project.

The attitude questionnaire was distributed ten times throughout the project according to the survey schedule. It was distributed to an intended random sample of 250 students through the student mail system. Follow up telephone calls and letters were used to provide a response rate of about 100 per survey. The original intent was to have all four classes equally represented and this was successfully carried out the first year. However, between the first and second years, the list from which our sample was drawn was re-ordered, resulting in a sample for the second year of 2/3 seniors and 1/3

Figure 4.9

GENERAL SCALE VARIABLE

STATEMENT	VALUE
The college could get along well without the Main Library.	1.00
I would not rely on the Main Library for serious research.	2.25
People are seldom successful in obtaining what they want out of the Main Library.	3.73
The array of services at the Main Library is only mediocre.	5.75
Main Library is just an ordinary institution.	4.14
The Main Library is the best part of my education at Oberlin.	8.11
I could not remain at Oberlin without the resources of the Main Library.	8.76
The Main Library generally meets my needs.	9.6
Overall, I am pretty satisfied with the Main Library.	9.73
I am usually pleased with the services of the Main Library.	10.00
The Main Library is beneficial to Oberlin College Students.	11.00

juniors. Thus, responses from some students from the first year were unavailable for the second year, but years 3 and 4, all classes are equally represented. Figure 4.10 displays the representation of classes over the four years. In light of the replacement effect discussed in Chapter 3, this under-representation of incoming students in year 2 was fortunate as it makes a cleaner analysis of the transition and response period.

Figure 4.10

Availability of Attitude Data by Year and Class

Year			
1	2	3	4
78/79	79/80	80/81	81/82
Juniors	Seniors	(gone)	(gone)
Soph.	Juniors	Seniors	(gone)
Fresh.	(missing)	Juniors	Seniors
(missing)	(missing)	Soph.	Juniors

Log Data

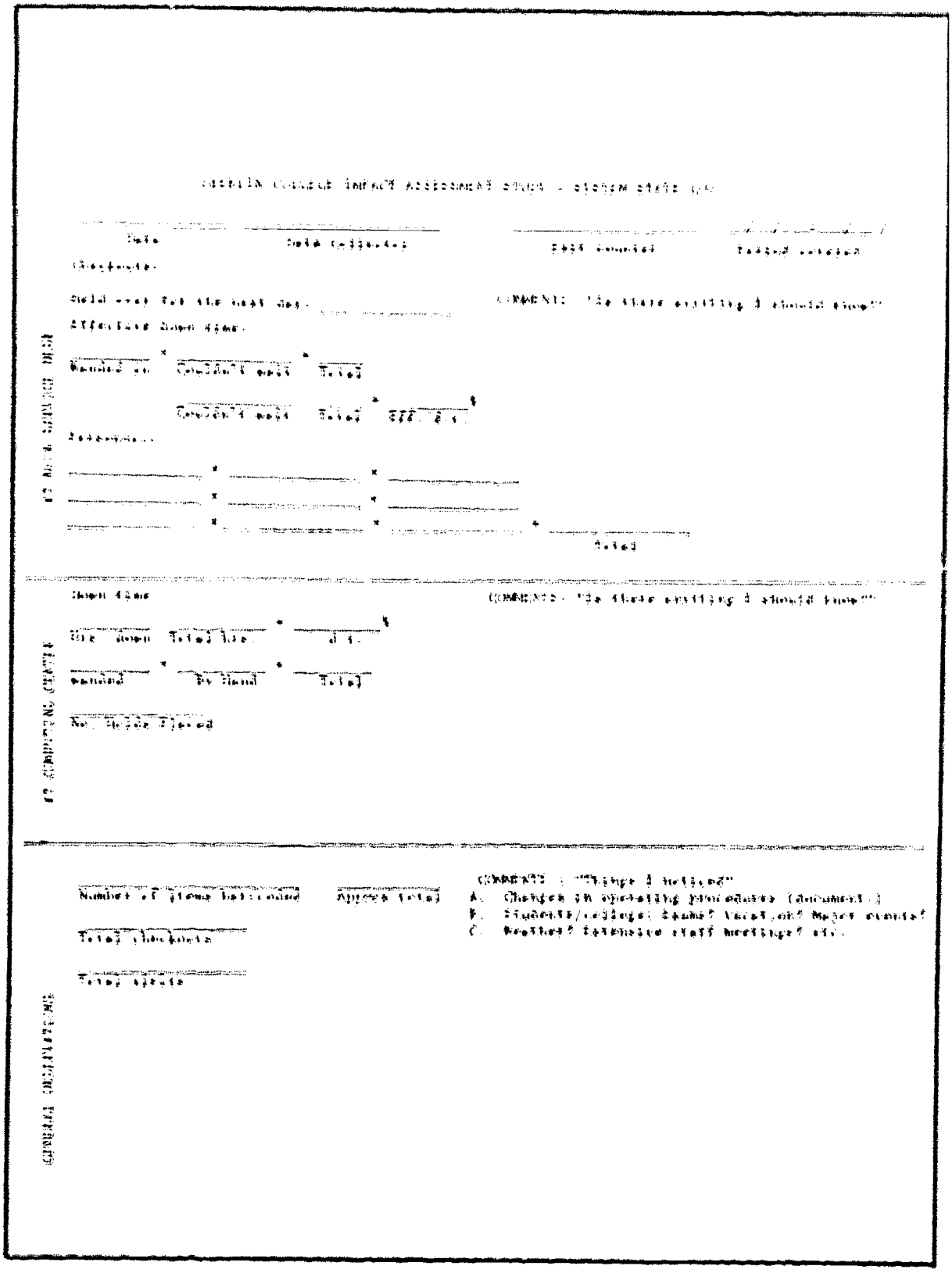
These data were recorded through the fall of 1981 by R. Almony and M.J. Demopolous. At that time, regular reporting by the circulation system itself replaced the need for a log. Figure 4.11 is an example of the log. Log data include:

- Total items barcoded
- Barcoded transactions vs. keyed transactions
- Exit counter tally (number of patron visits)
- Machine down time
- Machine response time

In addition, special events such as unusual weather, power failures, etc. were recorded in the log.

Figure 4.11

System State Log



Chapter 5

Statistical Modelling in the Social Sciences

The Method

The application of precise analytical techniques has been notoriously difficult in the social sciences. Human attitudes and subjective standards of quality are difficult enough to describe in imprecise terms, much less to quantify. The distinction between quantitative and qualitative aspects of service has long been known but has discouraged the objective study of qualitative aspects.

This project is atypical in that it employs quantitative techniques to analyse qualitative characteristics. For example, we use the library component of availability (see chapter 6) as a qualitative aspect of service measuring how efficiently the library controls its collection.

The surveys described in the previous chapters have provided large quantities of data from which we need to find patterns; patterns which will enable us to test our hypotheses. This chapter describes how we find those patterns and how we ensure our conclusions are mathematically valid.

As a preliminary step, we have the data we have gathered through various types of objective sampling and plot it on a graph. An example of such a plot is given as figure 4.1 - Proposed Time. Since faster response time is considered "better" we adopt the convention of having the fastest response time at the top of the graph and the slowest at the bottom. Visual inspection of the plot shows a sudden increase in the amount of time required to check out a book (clearly a negative development), a jump to a faster point as more materials are barcoded, and a leveling off as system response and percentage of materials circulating which are barcoded stabilizes.

If we were to plot the values of other variables and find the same general shape curve, e.g. drop, increase and leveling off, we would immediately suspect a pattern. Although such a pattern be highly suggestive visually, it must be verified by mathematical means. To do this we use the chi-squared test to measure agreement of observation and theory. This test depends on the precision of the observations.

Standard Error

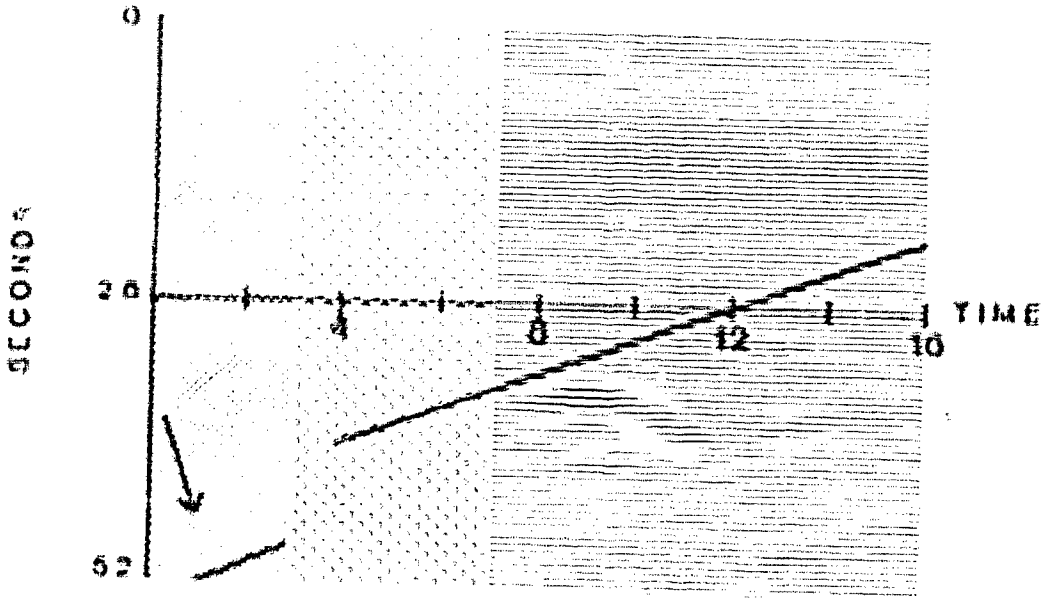
Every data point in this project has a sampling error associated with it. For example, availability data (Figure 4.4) has an error of about 1-2%. This error is computed by:

$$\varepsilon = \sqrt{p(1-p)/N}$$

where p is the particular computed availability and N is the number of observations.

FIGURE 6.1

CHECKOUT TIME



For the activity data, the total number of user service hours for the week can be represented as a weighted sum of patron weights. This sum is customarily treated as following a Poisson distribution. A Poisson distribution is chosen because patrons carry out their activities independent of each other and with a constant mean population. For purposes of computing the standard error it is satisfactory to regard the total hours as being simply proportional to an unknown number of persons sampled. The constant of proportionality is the number of hours during which the library provides service (56 hours) divided by the number of sweeps (20). Finally, the standard error of a Poisson variable is the square root of that variable. Thus the reported values C have standard errors of

$$\sqrt{C \cdot \frac{100}{20}}$$

The Variables

All objective and attitudinal variables are regarded as functions of the time, represented by the variable T. There are a total of 20 observation times as follows:

T	Survey No	Description
0	1.	The prior. Early Fall 1978.
2	2.	During the transition. Winter 1979.
3	3.	During transition. Spring 1979.
4	4.	Transition-Response. Early Fall 1979.
5	5.	Response. Late Fall 1979.
6	6.	Response. Winter 1980.
7	7.	Response-Recovery period. Spring 1980.
11	8.	Recovery period. Spring 1981.
12	9.	Recovery period. Early Fall 1981.
15	10.	Recovery period. Spring 1982.

The variable T, used in regression analyses, counts (roughly) quarters of a year from the beginning of the project. Thus, a measurement at T+4 occurs at the same point in the academic calendar as the measurement T. T=0 represents the begining of the project, before the circulation system was installed. T = 2,3 and 4 represents the time during which the variables were responding to the introduction of the system. Points 5, 6 and 7 represent the response period where the system was stabilizing and variables were beginning to recover. Points 11, 12 and 15 represent the third period wherein most variables returned to their original values.

Plots of all variables against time are made using this standardization of the time variable. In addition, the plots of various variables emphasize the three critical time periods of the project -- transition, response and recovery.

Goodness of Fit

Once a visual pattern has been established with a set of data and appropriate errors have been calculated, mathematical tests can be run to determine whether the type of curve one sees visually will be valid statistically. In other words, a goodness of fit test assesses our confidence that a particular hypothesis fits the observed data.

Goodness of fit is determined by examining the following sum:

$$\chi^2_{N-k} = \sum_{i=1}^{n} \frac{\left(y(t_i) - y^{theor}(t_i)\right)^2}{\varepsilon_i^2}$$

The goodness of fit criterion was based upon the total square deviation between the model and the observed data. Since all the data analyzed here are based upon sampling studies, each data element carries with it a statistical error estimate, the standard error. On the usual assumption that observations are normally distributed about their means, the weight of each observation is inversely proportional to the expected variance of that mean. The resulting weighted sum of square deviations should then follow the chi-squared distribution for N-k degrees of freedom. In this formulation low values of chi-squared correspond to significant fits, while high values lead to rejection of the model.

Standardizing or Normalizing Data

The last concept we employ in making sense of our data is to standardize or normalize the data collected. There are many ways we can present the data we have discovered. For example, activity data can be presented as raw user service hours — the actual number of hours patrons used the building in a particular category. Unless one has experience with sizes of library buildings, number of seats offered and hours during which the building is open, these data become difficult to assess. A more relevant method would be to examine the relative shape or change in the data over time. If one is examining the impact of a perturbation at a particular point, the particular values of an observation are not important, but only how they have changed as a result of the perturbation.

Let us give an example of this notion using another analogy - the concept of percentages. When comparing rates of performance of a class on a test, the actual numerical score is not generally considered, but rather the percentage of questions answered correctly. Similarly, by normalizing data on a graph, we can observe the changes in a variable without being confused by its absolute value. Therefore, activity data have also been presented as percentages (Figure 6.3) and resulting variations are much easier to see.

Much of the data for this project are presented in normalized form. The value of a variable which existed at T = 0 on the project is taken to be a zero point and the changes in the variable are plotted toward

+1 for positive changes and -1 for negative changes. We can then more readily emphasize the change associated with the circulation system; e.g. the shape of the change as opposed to the absolute value of the change.

Causality

Fitting data to a mathematical expression could be a misleading process. When we summarize data in the form of an equation, it does not mean that one effect has been shown to cause another. The equation could be rewritten in such a way that the opposite would be true. What we are able to show by the modelling process is that changes in one variable occur in association with changes in the other. The judgement of the analysts must determine whether this association is causal.

In the analysis of the data at hand, we feel there is a relationship between attitude and system state. For example, question 16 which queries the frustration of delays at checkout, should be related to the objectively measured checkout time. Judgement dictates that attitude is responding to delay at checkout, not that poor attitude causes long checkout times.

Unfortunately, a statistical analysis would give the same results if any other variable which increases steadily over time were substituted for system state or checkout time. We must rely on the intelligence

and common sense of the analysts to ascertain if such a variable exists. In this project, there does not seem to be such a variable. We doubt that attitudes improve with the age of the students, for example. The impact of a new director on student attitudes would be expected to level off and diminish rather than grow over time. There is always a possibility that some extremely subtle variable is contributing to the changes documentated by this project. It is obviously necessary to weight each point according to its precision. However, from the available data, we know only the statistical uncertainties of a given value. It is certain that there are additional systematic sources of uncertainty such as variations due to weather, the personality of those distributing availability forms, variations in academic work load and so on. These factors are of unknown size but we judge that they are not larger than the statistical uncertainties reported with the data.

Key Variables

To test the project hypotheses a series of variables were extracted from the data collection discussed in Chapter 4. These variables fall into five groups:

A-type: indicators of patron attitude towards the library

S-type: descriptors of the circulation system's operating state and extent

Q-type: objective measures of the quantity of service rendered

L-type: Objective measures of the quality of service rendered

K-type: Patron evaluations of specific aspects of service

In analyzing the variables listed above, two types of behavior were anticipated: Steady rise to a new equilibrium level (Hypothesis 1) and rise followed by decline (Hypothesis 2).

The final set of data elements used in the main library analysis are given as Figure 5.2. Many other variables were examined in the analysis, but only those shown in Figure 5.2 were found to be useful in analyzing the automated circulation system.

Figure 5.2

Data Elements Used in Main Library Analysis

Variable	Description
System State	
S4	Fraction of all Transactions Barcoded
S6	Checkout Time
Objective Measures of Quantity	
Q1	Hours of Library use for all purposes
Q2	Number of books circulated
Q3	Number of Visits to the library
Objective Measures of Quality	
Z1	Circulation Component of Availability
Z2	Library Component of Availability
Z3	Nuisance Factor (Accessibility)
Attitude Measures (see Figure 7.1 for more detail)	
A1	General Scale Variable Thurstone (Q22)
A2	Respondents Perception of Satisfaction (Q13)
A3	Perception of other's satisfaction (Q14)
A4	Change over last 3 months (Q15)
Patron Evaluations of Specific Aspects of Service	
H1	Frustrated by Service delays at Checkout (Q16)

CHAPTER 6

ANALYSIS OF OBJECTIVE DATA

SYSTEM STATE VARIABLES

System state variables are indicators of the degree of implementation of the system. Although this project was designed to consider the circulation system as being "turned on" at one point in time, we know that the system was gradually introduced as more and more materials were barcoded and as bugs were eliminated from the operational aspects of the system. Those factors which measure the extent to which the system may be described as "turned on" are the System state variables.

There are two important variables describing system state:

- Checkout Time
- Fraction of all transactions which are "wanded" (that is, entered into the circulation system using the machine readable barcode)

other descriptors of system state which were gathered through the life of the project, such as machine down time and machine response time, did not vary significantly over the four year span of the experiment and were not used in this analysis.

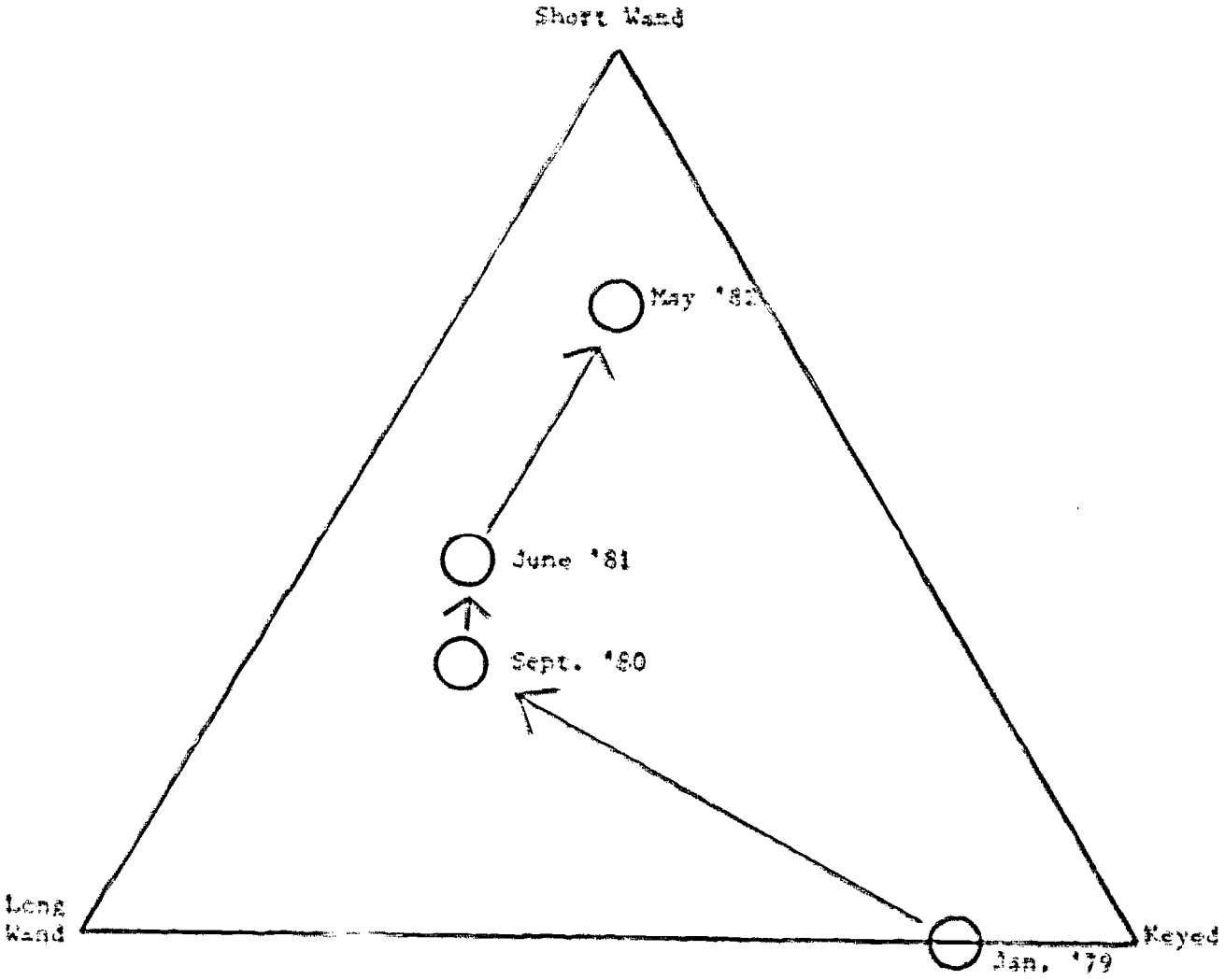
1. Fraction of transactions which are barcoded

During the course of the study a "short wanding" procedure was introduced, so that variable 34 becomes a three component variable: long wanding (involving author/title), short wanding (call number only), and keying (manual input). The available data not only cover checkouts, but also all types of transactions, including discharges, queries by call number and holds on books already checked out. The most desirable state for efficient charging and discharging is to have all transactions short-wanded. We can build a picture of barcoding in the library system using Figure 6.1. If we designate the top of the triangle as all materials being short wandable, the left corner as all transactions long wanded and the right corner as all transactions keyed, we can graphically display changes barcoding over a period of time.

The system came up in 1978 with a small proportion of materials barcoded, as represented by point 1. During the Summer of 1980, a major barcoding effort was done in the main library, with the result that by September 1980, some 75% of the checkouts could now be long or short wanded. As more materials were barcoded and as the short wanding procedure was introduced, more materials became available

Figure 6.1

Fraction of Transactions Barcoded



for short wanding, and the transactions moved toward the top of the graph.

It is interesting to note that number of transactions which must be keyed per semester appears to have levelled off at about 15%. (Books not barcoded circulate via their pocket card and are keyed into the circulation system. They are barcoded when returned.) This concept would be consistent with our very large, old Dewey collection which circulates infrequently. It would appear that about 85% of our circulation (not collection) consists of books which are "repeaters" and the remainder circulate infrequently.

2. Checkout time (36)

The time required to check out items according to four different methods is summarized below. These mean times were determined in a set of trial runs.

Method	Mean time per transaction
Manual (slipping card)	20 seconds
Keyed into system	60 seconds
Long wand (involving a/t)	30 seconds
Short wand (call number only)	19 seconds

The variable checkout time is computed using the following formulas:

$36 = 10\%(\text{keyed}) * 30\%$ .. (sw) up to T = 5

$36 = 20\%(\text{keyed}) * 10\%$ .. + 15%(sw) after T = 5

and was presented in figure 5.1. A change in checkout procedure at T = 5 shortened the time to checkout a barcoded book. Before T = 5, patrons waited at the desk while the charge was keyed in; After T = 5, patrons signed the pocket card and the charge was keyed from the card at a later time.

Because the circulation system was modified for Oberlin's use, it was deemed advisable to run it in tandem with the previous manual system for a period of several months. As a result, there was a clear drop in the speed of service which students received when the system was first installed. Therefore, checkout time jumped down and then linearly decreased (got faster) over the four years. The average checkout time at the end of the project was 21.0 seconds, clearly faster than the manual system.

Conclusion: By the end of the project checkout time was faster than the manual system.

1. Number of visits to the library and number of books checked out for the four years of the project are given as Figure 6.2. They show that, while circulation has been steadily decreasing, number of visits to the library has been steadily increasing.

Figure 6.2
Measures of Quantity

Year	No Books Circ	No Visits
1	63,290	541,328
2	49,484	507,657
3	49,230	576,266
4	45,344	578,000

2. Hours of use of the library were gathered through the activity survey presented in Chapter 4. Total use of the building in user service hours is given in Figure 4.6. Inspection of total user service hours shows that total usage tends to be higher in winter than in April, but there was no consistent increase or decrease in total usage. To more readily test for change within categories of use, these data were converted to percentages and are shown as Figure 6.3. These percentages should be compared vertically across the chart, not horizontally. Whereas there are fluctuations from year to year, they do not have any definite pattern.

Figure 6.3

MAIN LIBRARY ACTIVITY SURVEY RESULTS

Expressed in Percentages

	78/79	79/80	80/81	81/82
	Year 1	Year 2	Year 3	Year 4
October				
Use	45	50	***	48
Search	01	03	***	03
Study	51	52	***	51
Other	34	35	***	34
December				
Use	***	39	***	***
Search	***	03	***	***
Study	***	38	***	***
Other	***	28	***	***
February				
Use	22	35	***	***
Search	01	03	***	***
Study	49	42	***	***
Other	35	28	***	***
April				
Use	27	28	38	33
Search	04	03	02	03
Study	43	39	47	48
Other	28	30	33	26

If users were being frustrated by the old system and if the new system allowed them to express their demands, one would expect to see the number of books circulating increase or the categories of 'search' and 'use' increase. Inspection of the data clearly shows this not to be the case

We can identify only one factor other than the circulation system which might be expected to influence usage of the building. In Spring, 1980 the Director of Libraries began a system of assigning carrels in the building on a semester basis. Therefore the facilities for in-house use by that time included:

40 scholar studies, double assigned

200 carrels, double assigned

several hundred tables and lounges useable on a first come-first serve basis.

80 lockers - single assigned

If encouraging use of the building by assigning carrels were to change usage, one would expect the number of user service hours to increase overall. The number of books charged out would probably increase since books may be charged and kept in scholar studies and carrels, thus avoiding the inconvenience of carrying books back and forth from dorm to library. The number of visits to the library might or might not increase.

Unfortunately, the changes in patterns of use do not match these predictions, therefore we can only conclude that:

- Total usage of the building did not change
- Number of books circulating decreased
- Number of visits to the library increased

all of which occurred for reasons which cannot be linked to the automated circulation system or to any other change in the building.

3. Accessibility

Another indicator of system performance may be derived from the activity survey -- the Nuisance Factor or Accessibility (Kantor, 1982). This factor is obtained by comparing the time spent searching with the total time spent either searching or using library materials. Use of the library for study and "all other" purposes is not included in this factor.

Accessibility = Search/(Search + Use)

More accessible materials result in smaller percentages. Conversely, the larger the fraction of time spent searching, the less effective the library is in satisfying the needs of its patrons.

Data on accessibility is tabulated in Figure 6.4, and presented graphically in Figure 6.5. It shows a decrease in the percentages for every horizontal observation.

Since the December point was missing from the data for the first year, we have interpolated that point to match the general shape shown by year 2. Additional points for years 3 and 4 show that the general shape is consistent. The average drop from year 1 to year 2 is 2.5% and, as the standard error on this figure is .7%, this is a statistically significant change.

CONCLUSION: Materials became slightly more accessible after the circulation system.

AVAILABILITY MEASURES

Data on availability is gathered via the surveys described in Chapter 4. As we indicated, two components of availability (catalog skills and shelf skills) varied little over the life of the project. Ownership, library factors and circulation did vary over the life of the project.

1. Ownership component of availability

The probability that the library owned the book sought ranged over about 15 percentage points during the four years of the project

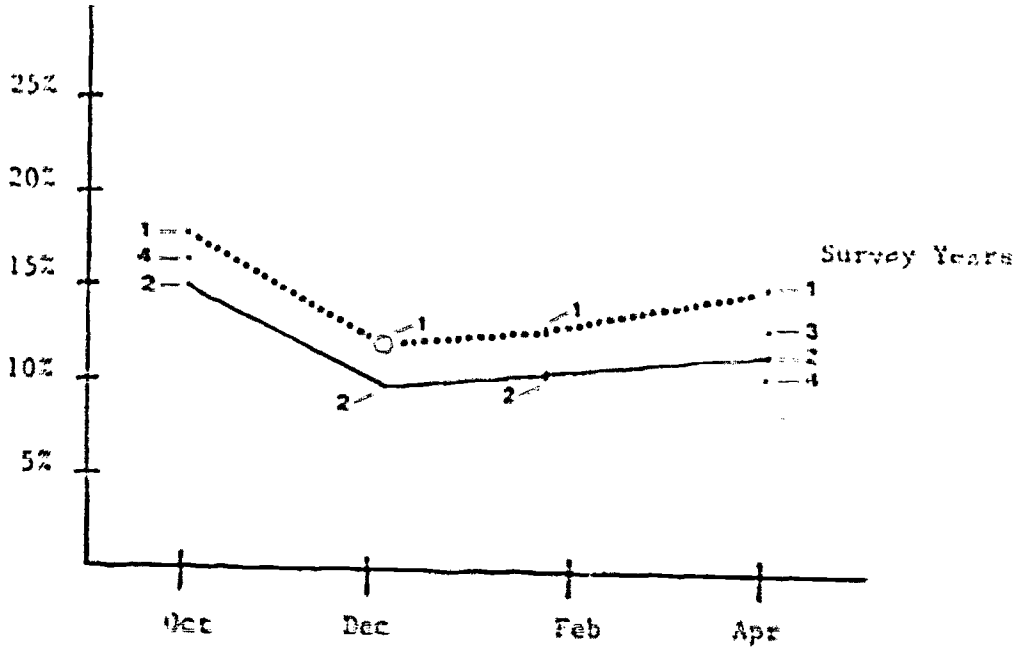
Figure 6.4

Material Accessibility

	78/79	79/80	80/81	81/82
October	17.3%	15.0%	x	16.4%
December	x	10.0%	x	x
February	13.2%	10.9%	x	x
April	14.7%	11.5%	12.8%	11.1%

Figure 6.5

Accessibility



and ended at an extreme low of 79.1%. There is no particular reason that the probability of ownership should vary according to the academic calendar. This factor is more obviously a measure of the library's monograph budget. Oberlin did have a crisis in its monograph budget which reached a peak in 1979. We were able to acquire significantly more funds for book purchases in 1980/81. If an availability study can be done in the spring of 1981, it will be interesting to see if increased monograph purchasing will be reflected in an increase in the ownership factor.

CONCLUSION: Ownership changed but for reasons not connected with automation

F. Circulation Component of availability

The graph is shown as Figure 6.6. It displays the sawtooth pattern associated with the semester loan period. The November and April points occur toward the end of the semester, and at that time, more books are in the hands of borrowers, decreasing the chance that books can be found in the library. Figure 6.6 shows that this variable did experience an overall increase over the 4 years. While there is no particular reason that books are less likely to circulate with an automated circulation system, there might be two explanations for this phenomena.

Figure 6.6

Availability = Circulation Factors

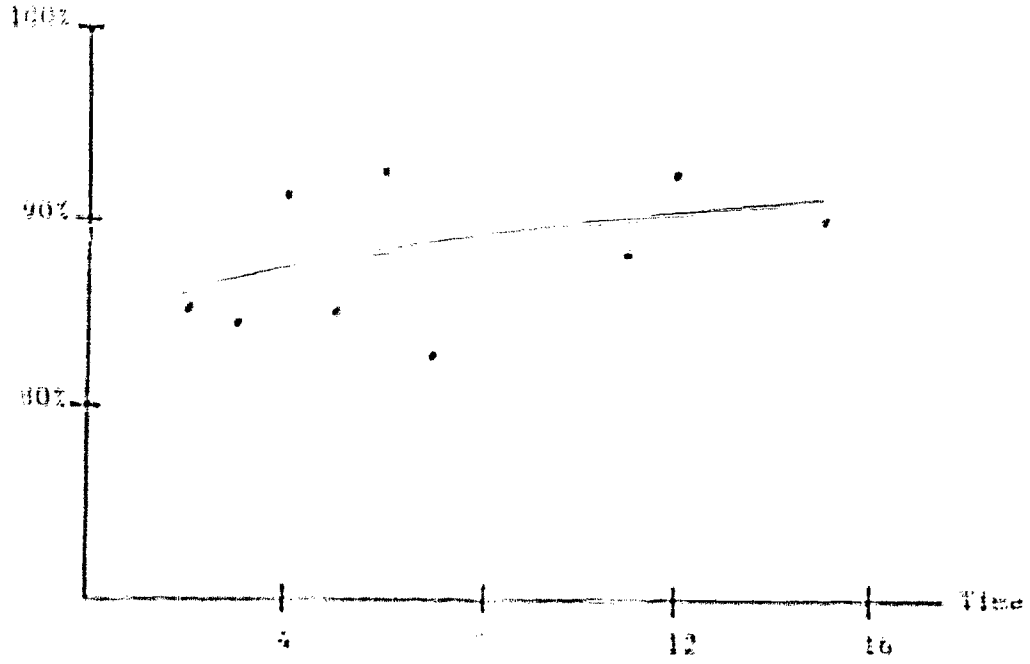
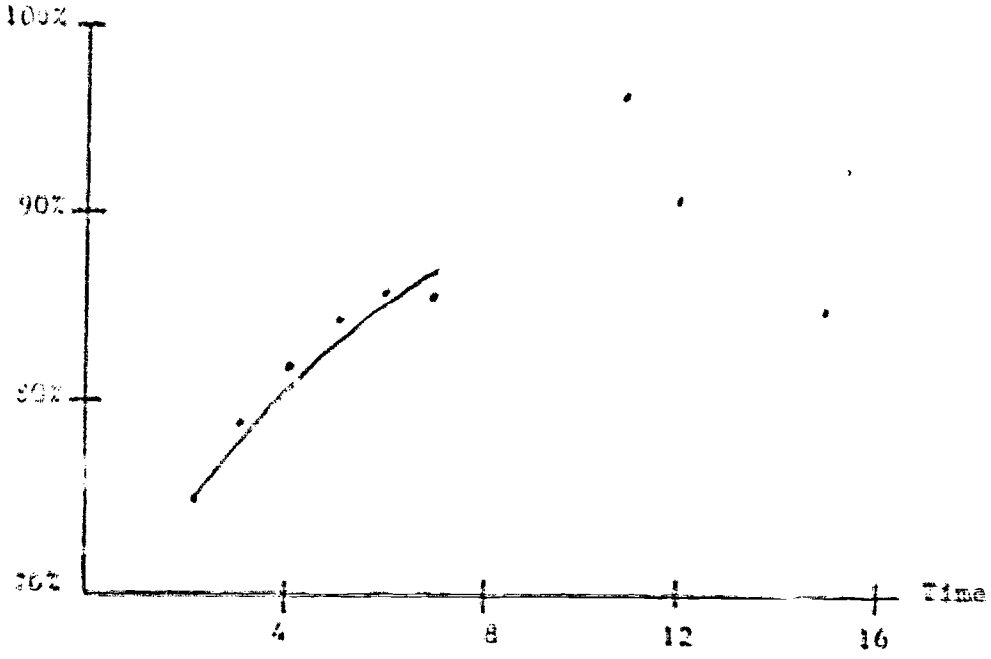


Figure 6.7

Availability = Library Factors



a. The decrease in number of books circulating is reflected by a decreased probability of books being out when requested.

b. The automated circulation system caused increased confidence in the ability of the system to find books and reduced the tendency of students to hoard books by checking out more than they really needed. From the data in this project, there is no means of knowing if either or both of these possibilities is true.

c. Library Component of Availability

The graph of this variable is shown as Figure 3.7. Whereas there is a clear increase in the library component of availability in years 1 and 2, the behavior of the graph is less clear for years 3 and 4. After hitting a remarkable peak of 90% in May 1981, the values began to drop. Possible explanations for this effect are explored in the last chapter.

Chapter 7

Analysis of Attitude Data

Derivation of Attitude Variables

As indicated in Chapter 5, five questions from the attitude survey were used in the final analysis of this report. They are:

Variable	Question	Content
A1	20	General Scale Variable (pick the statement which most reflects your feelings)
A2	11	Indicate your personal satisfaction with the library
A4	14	Indicate your perception of others' satisfaction
A5	15	Has the library improved in the last 2 months?
A7	16	Frustration at delays at Checkout

To further refine the variables, we split the responses to Question 13 and 14 into two groups. We chose that set of respondents who picked "Very satisfied" and used a tag of "V" on those variables which represent their answers, e.g., A2V and A4V.

To indicate changes in responses we employ a technique common to statistical analysis. We construct a "[illegible]" subdivision of [illegible]

A.I. = Every + (Sometimes × [illegible] of Level[illegible]

A.P. is similarly derived. Those respondents who checked "equally satisfactory" are not counted in this analysis.

Of the three options in question [illegible], "Has the library gotten better, worse, or stayed the same" we chose the response "gotten better" for analysis. Figure 7.1 summarizes the derivation of the attitude variables from the attitude questions.

The calculated values of the attitude variables are given as Figure 7.2. For each point in time corresponding to a survey, it gives the number of persons responding to the question, the calculated value and its error.

MODELLING ATTITUDE DATA

1. General Change Variable (A1)

A variety of possible models have been explored; none [illegible] able to fit all of the data. For examples of various types of models used in prior analyses, see Fienberg (1971). The model giving greatest success consists of three linear parts, showing a drop, an increase and then a levelling off or decline. To demonstrate this general[illegible]

FIGURE 7.1

ATTITUDE VARIABLES

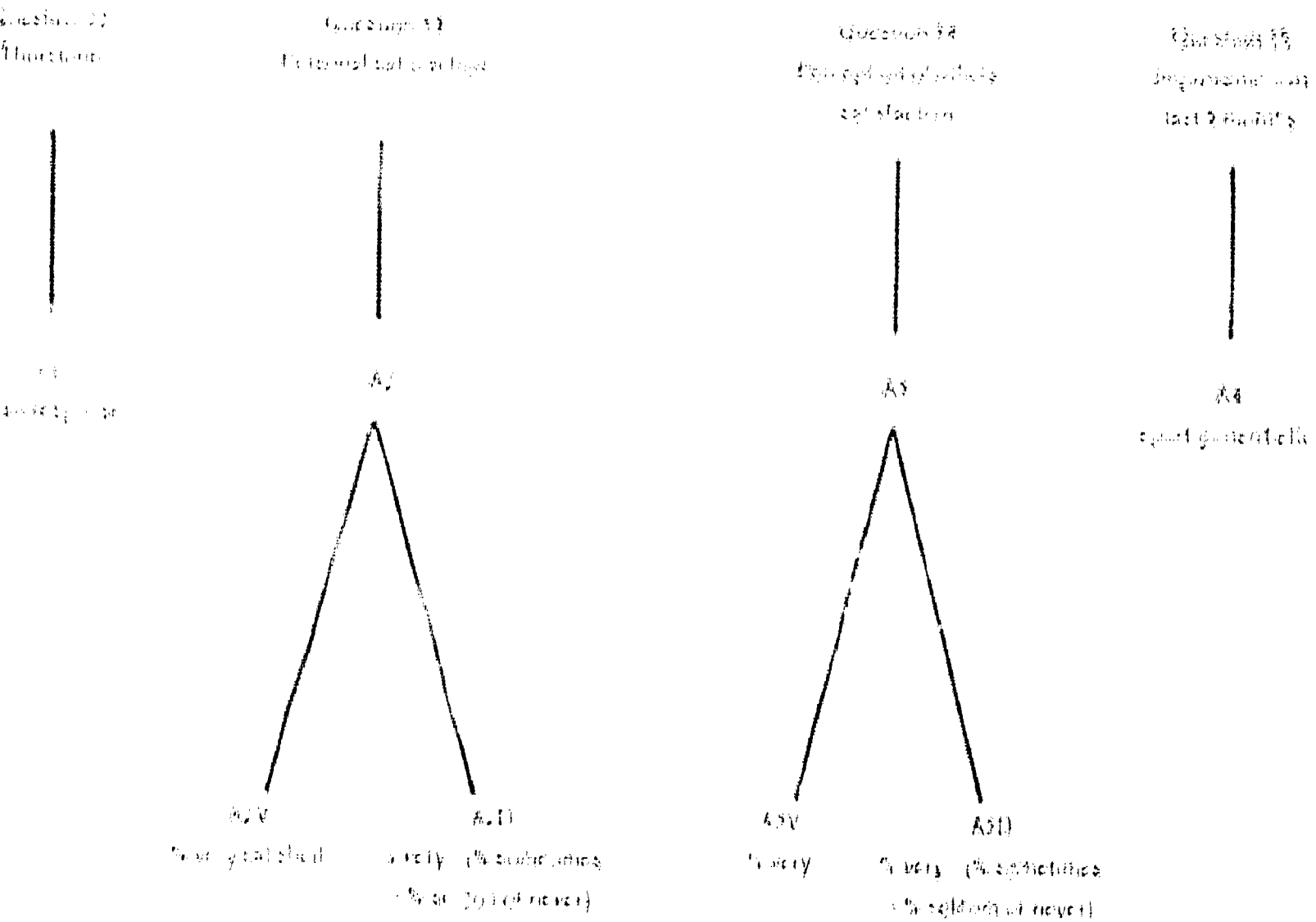
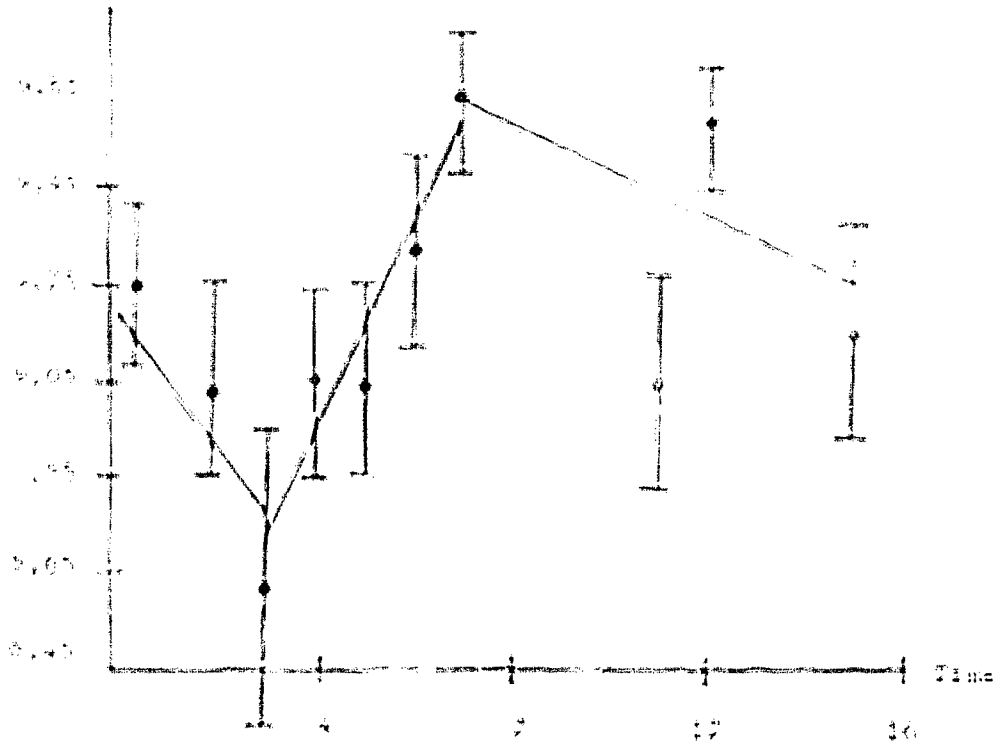


Figure 7.[illegible]

[illegible] Variables

[illegible]	No. of Class.	A1	eff	[illegible]	eff	[illegible]	[illegible]	[illegible]	eff	[illegible]	[illegible]	[illegible]	eff	[illegible]	[illegible]
0	[illegible]	[illegible]	.1[illegible]	[illegible]	[illegible]	11.0	[illegible]	11.0	2.1[illegible]	-[illegible]	[illegible]	6.[illegible]	1.05	[illegible]	[illegible]
2	150	[illegible]	[illegible]	20.0	6.0	[illegible].0	[illegible]	5.0	[illegible]	-15.0	5.15	10.0	[illegible]	[illegible].0	4.14
3	85	[illegible]	.5[illegible]	9.0	6.0	[illegible].0	[illegible].0	4.0	[illegible]	-[illegible]	[illegible]	41.0	5.40	45.0	5.46
4	1[illegible]	[illegible]	.[illegible]	10.0	6.0	[illegible].0	4.5	[illegible].0	1.[illegible]	-[illegible]	[illegible]	[illegible].0	[illegible]	55.0	4.[illegible]
5	116	[illegible]	.[illegible]	9.0	6.0	20.0	[illegible]	6.0	[illegible]	-17.0	[illegible]	[illegible].0	4.5[illegible]	50.0	[illegible]
6	11[illegible]	[illegible]	.30	10.[illegible]	6.0	20.0	[illegible]	5.0	[illegible]	-10.0	[illegible]	[illegible].0	4.1[illegible]	61.0	[illegible].57
7	[illegible]	[illegible]	.16	[illegible].0	6.0	12.0	[illegible].0	15.0	[illegible]	[illegible].0	[illegible]	[illegible].0	[illegible]	[illegible].0	[illegible]
11	100	[illegible]	.[illegible]	[illegible].0	6.0	[illegible].0	4.5	[illegible]	[illegible]	1.0	[illegible]	11.0	[illegible]	[illegible]	4.[illegible]
12	110	[illegible]	.[illegible]	26.[illegible]	[illegible].0	[illegible].0	[illegible]	1[illegible]	[illegible]	-[illegible]	4.66	[illegible]	2.[illegible]	67.0	[illegible]
1[illegible]	[illegible]	[illegible]	.[illegible]	[illegible].7	[illegible]	[illegible].0	[illegible]	[illegible].6	[illegible]	14.[illegible]	[illegible]	1[illegible]	[illegible]	6[illegible]	4.[illegible]


Time

[illegible] of the overall scale variable, [illegible] as shown in Figure [illegible] [illegible] is the [illegible] [illegible] through the [illegible] segments of the [illegible] on the [illegible] time point [illegible] and [illegible] point [illegible].

This three-part [illegible] of the attitude [illegible] of [illegible]. The table of chi-squared values with four degrees of freedom is shown as Figure 7.4. [illegible] percentages as indicators of better fit, [illegible] in the [illegible] can be rejected with any confidence.

Figure 7.4

Chi-squared Values for Attitude Variables

VARIABLE	CHI-SQUARED	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
* [illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
* [illegible]	[illegible]	[illegible]

*Can be rejected with [illegible] or more confidence.

Figure 7.4 shows that the 3 part linear model provides a good fit to the observed data with some exceptions that we shall presently explore. The quality of this model may be more easily determined if we transform the data into standardized form as explained in Chapter 5. Using this method, the absolute values of the responses are suppressed in favor of the relative shape of the changes. This has the additional advantage that anything above the zero point represents positive feelings and anything below the zero point represents negative feelings. In addition the transition, response and recovery periods are represented by background shading on the graph.

The General Scale variable, A1, is re-plotted as Figure 7.5 in normalized form. The value at T=0 (the 'prior' value of attitude) is taken as the zero point and the low value of the plot at T = 3 is taken as -1. The other values of the variables have been recomputed on this scale and in drawing the lines through the points. The gaps at T = 5 and 7 have been closed. The change of origin and scale have no effect on the overall appearance of the plot, so, except for closing the gaps, Figure 7.5 is identical to Figure 7.3.

In computing the rest of the variables in standardized form, their value at T=3, the end of the transition period, is taken as plus or minus 1 (as appropriate) and the rest of the values are recomputed on that scale.

FIGURE 7.5

A1 - GENERAL SCALE VARIABLE - STANDARDIZED FORM

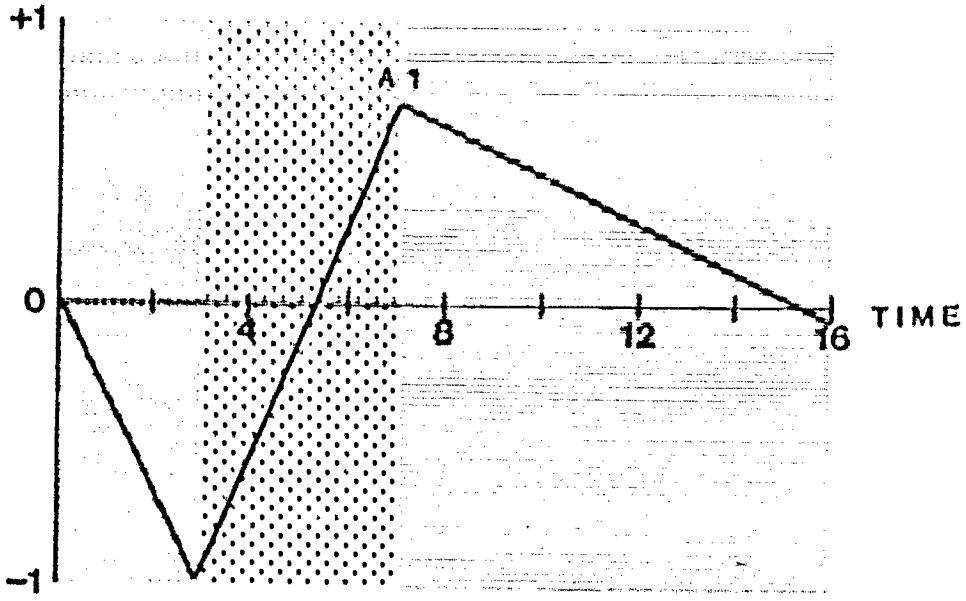
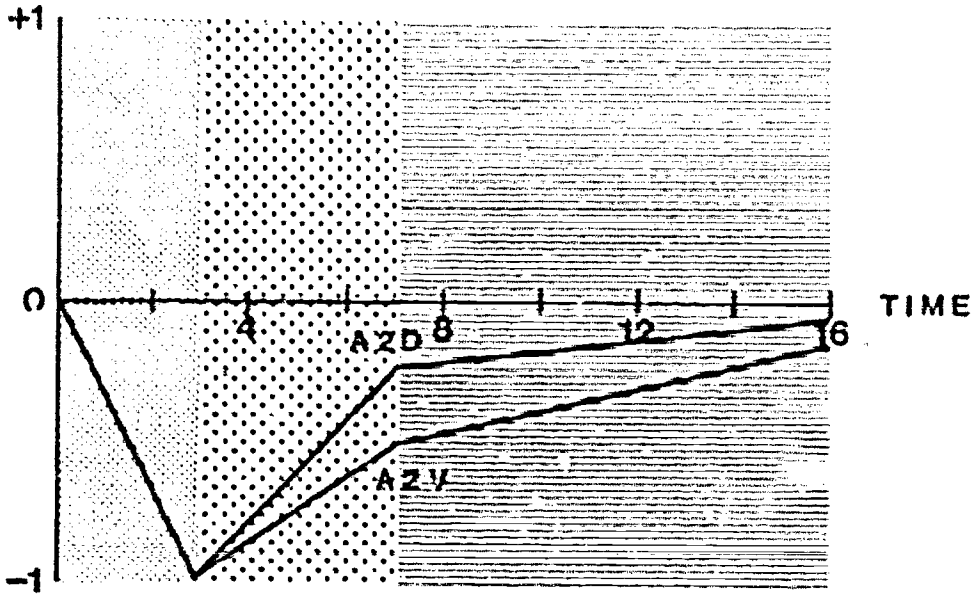


FIGURE 7.6

A2 - PERSONAL SATISFACTION - STANDARDIZED FORM



2. Personal Satisfaction with the Library (A2)

A2V, and A2D are plotted in standardized form in Figure 7.6. It can be seen that they have the same general shape as A1, a drop, an increase and a levelling off to about their original values.

3. Perceptions of Others' Satisfaction (A3)

A3V and A3D are plotted as Figure 7.7. As in the other variables, they experience a sharp drop, an increase and then at point 7, A3V begins to drop again and A3D begins to rise so that the two variables end up on opposite sides but about equidistant from the zero point.

There is no particular reason we can discover for the inconsistent behavior of A3. We can only suggest that reporting the opinion of others is less reliable than the reporting of one's own opinions.

4. Improvement in Last 3 Months (A4)

The graph of A4 is shown in Figure 7.8. It can be seen visually and through the chi-squared values that A4 does not fit the general pattern of decline, increase, decline. Indeed, it experienced a sharp rise and a gradual levelling off to the zero point.

During the interval between points 2 and 3 (February 1979), a new Director arrived at the library and instituted several highly visible changes including a question and answer board. Since A4 focuses on a

FIGURE 7.7

A3 - OTHERS' SATISFACTION - STANDARDIZED FORM

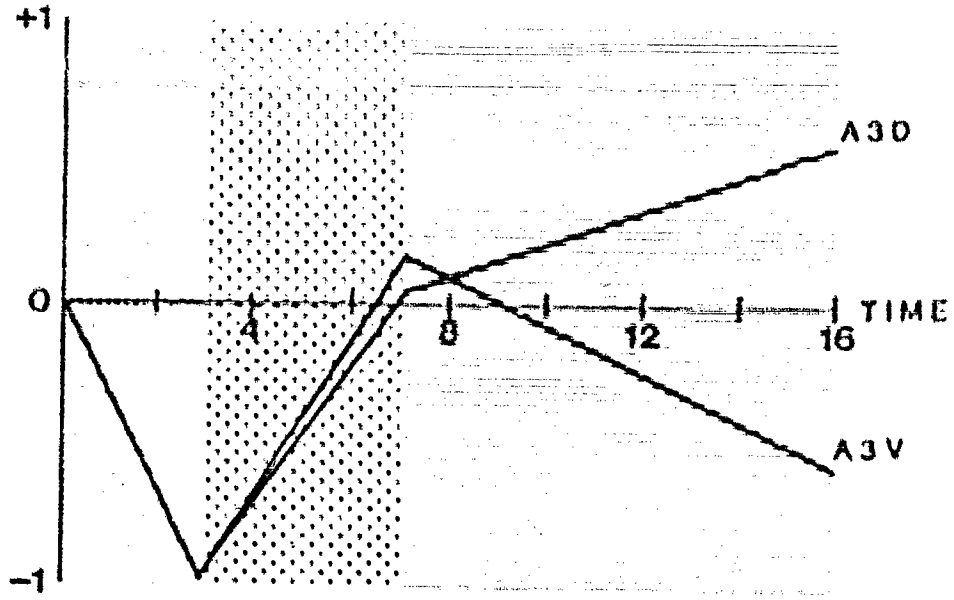
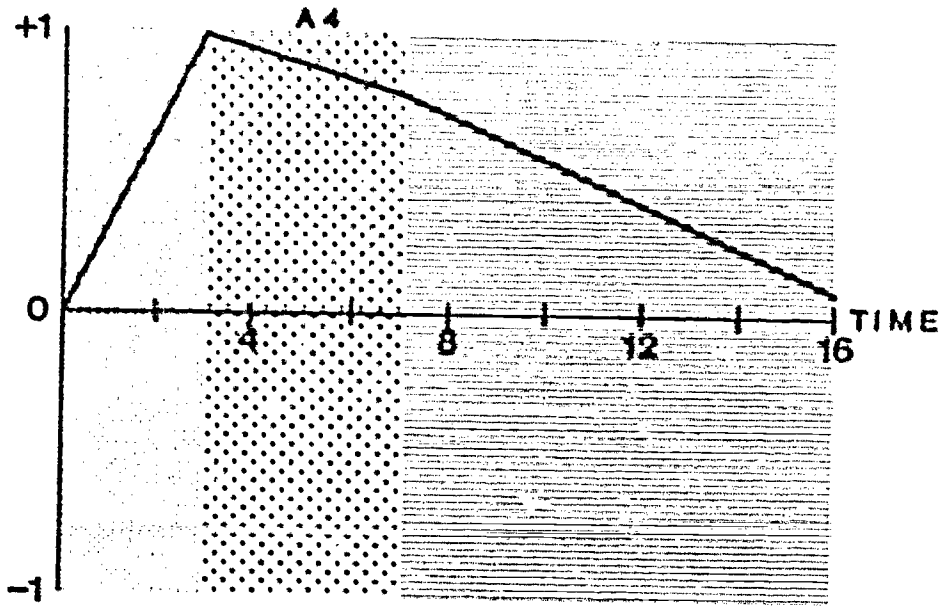


FIGURE 7.8

A4 - IMPROVEMENT IN THREE MONTHS - STANDARDIZED FORM



specific time period, the "last three months", it may cause the respondents to focus on recent, visible events. It is reasonable to conclude that Ad is responding to the presence of a new director.

Since Ad responds to short term change, it should drop very quickly when there is no change. The fact that Ad returns to its original value gradually rather than quickly may indicate that other changes during the life of the project, such as assignment of patrols, kept respondents' perceptions high.

9. Frustration at Checkout (Fr)

The standardized plot of those reporting frustration at delays at checkout is shown as Figure 7.9. This plot follows the general model in that it drops and then increases, but from points 7 to 15 it continues to gradually increase, ending above the original value.

Since this variable is tied to checkout time , it would lead us to believe that as more materials have become available for short wanding (see Figure 6.1), checkout time would decrease and frustration would also decrease. Indeed, since Figure 7.9 is drawn to the same scale, it and Figure 6.1 can be superimposed (Figure 7.10). It can be seen that the two variables have the same general shape and that patron perception lags slightly behind objectively measured checkout time, although they end close to the same point. Therefore, patron frustration at checkout time follows checkout time itself and is an accurate measure of it.

FIGURE 7.9

H1 - FRUSTRATION AT CHECKOUT - STANDARDIZED FORM

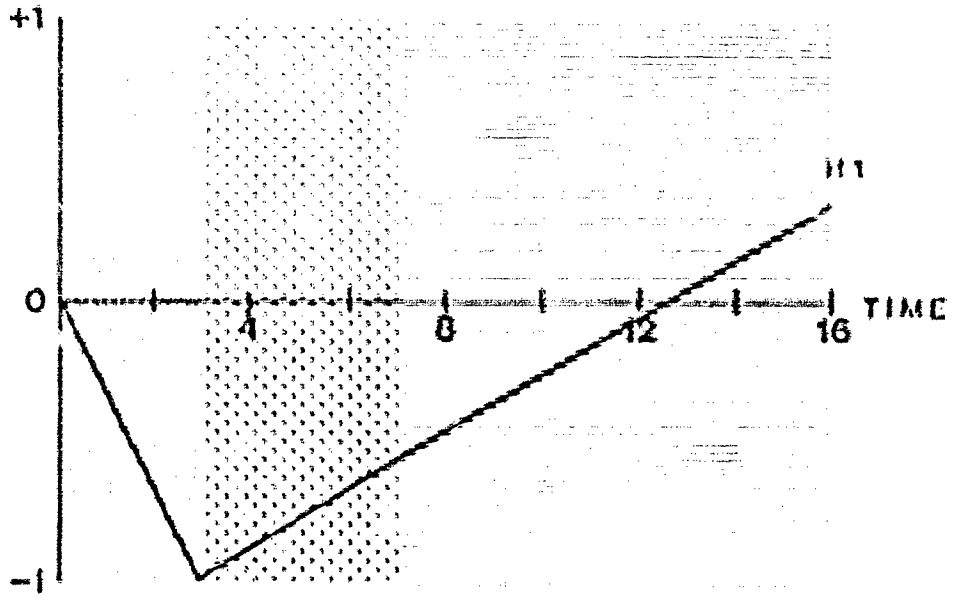


FIGURE 7.10

H1 AND CHECKOUT TIME SUPERIMPOSED

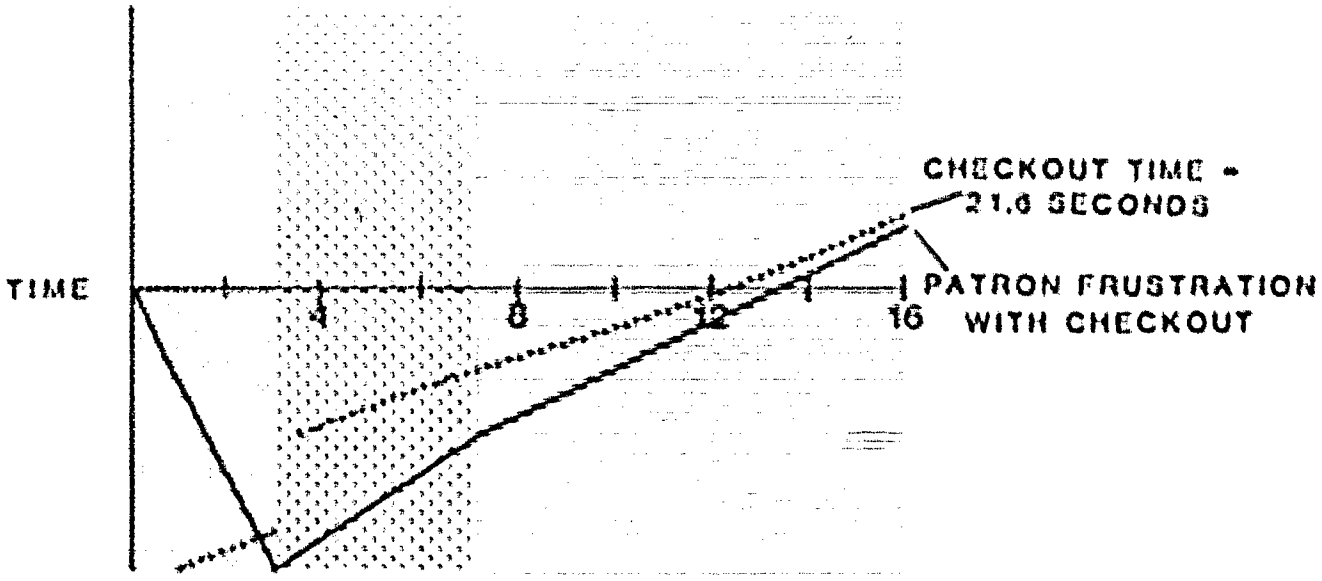


TABLE 7.11
SUMMARY OF SIMULATION

Variable	Description	Results of Pilot Simulation
System State		
S4	Fraction of transactions barcoded	Increased toward short waiting
S6	Checkout time	Tried higher than prior value
Objective Measures of Quality		
*Q1	Rate of Lib Use	No change
*Q2	Number of books circulating	Increase
*Q3	Number of visits to library	Increase
Objective Measures of Quality		
*Z1	Site Component	Gradually increase
Z2	Library Component	Dramatic increase followed by decline
Z3	Accessibility	Small but valid improvement
Attitude		
A1	General Scale Variable	Return to "prior" value
A2	Personal Satisfaction	Return to prior value
A3	Others' Satisfaction	No pattern
A4	Change over 3 months	Return to prior value
Evaluations of specific aspects of service		
M1	Delays at checkout	Return to higher than prior value (Follows S6, checkout time)

* Variables which are not influenced by automated circulation system.

Chapter 8

Conclusions

The Validity of the Data of Relation to the Qualitative and Homeostatic Hypotheses

As we shall see in Chapter 2, the homeostatic hypothesis asserts that, after an increase in the quality of service, previously frustrated demand on the system would cause an increase in the quantity of service. This increased quantity would force a decrease in quality as the staff and system would be unable to cope with demand. Although there has been some decrease in the quality of service, it still remains much higher than the level which existed when the manual system. In this project, there has been no change in the total quantity of service, and indeed, number of checkouts has decreased. Therefore, we have no evidence to support the homeostatic hypothesis.

The qualitative hypothesis, on the other hand, asserts that quality will increase and demand will not change. It makes no statement about attitude. The analyses in Chapters 6 and 7 shows that the qualitative hypothesis is preferred. Quality, as measured by the library component of availability, did increase by a significant amount and another measure, accessibility, increased by a smaller amount.

[illegible] change and the number of changes even decreased. The attitude variables experienced a slight decrease during the changeover period of transition, increased except for A?, and returned close to their original values. Attitudinal measures of [illegible] at [illegible] [illegible] [illegible] over the course of time and both ended at a value higher than existed with the manual system.

[illegible]

Attitude Variables

We believe the return of some attitude variables to their prior levels can be explained by the constant turnover in the student body. The change in the mix of students can be demonstrated with reference to Figure 5.[illegible]. This figure shows that over the four year life of the project, the composition of the student body was constantly cycling in a new group of freshmen and cycling out a graduating group of seniors. Therefore the shaded area represents that group of students who had experience with the manual system, a group that is gradually decreasing. In year one of the project, three-quarters of the student body had experience with the manual system. By year four, none had experienced the manual system. This constant recycling of fresh attitudes into the attitude pool should explain the tendency of some of the attitude variables to return to their original levels. We call this the replacement effect.

FIGURE 6.1

REPLACEMENT EFFECT

SURVEY YEARS

1	2	3	4
SO	JR	SR	FR
JR	SR	FR	SO
SR	FR	SO	JR
FR	SO	JR	SR

we have no explanation for the behavior of [illegible] as [illegible] an indicator of attitude as the other variables. [illegible] however, as we suggested in Chapter 5, that persons' reporting opinions of others are not as accurate a measure as persons' reporting their own opinions.

It is also interesting to note that attitudes did not start at a high level as the project began. The general scale variable, which provides a numerical value of good or bad attitude, shows that attitudes toward the library began at a fairly mediocre level and returned close to that value by the end of the project.

Quantity of Service

As we indicated in Chapter 5, we cannot causally relate the behavior of the quantity variables to the circulation system. The rise in the number of books checked out may be related to increased input in the system or some unknown external factor (such as general increase in studiousness of the college population of the United States). It may be that the increased number of visits and shifts in building usage are related to the new system of assigned carrels. Another possibility may be that a very large building such as the main library is just not taxed to anywhere near its full capacity. Preliminary studies of building usage before this project was initiated indicated that the building was used to under half its capacity.

The rise in the circulation component of availability is of secondary interest. After the implementation of the circulation system, books requested by patrons were less likely to be checked out by about 5%. It may be that this variable measures some subtle change in patron trust in the system. If patrons have more confidence that they will find what they need when they need it, are they less likely to hoard books? There are no means of proving this from the available data.

Quality of Service

As we review the original design of the project, it seems unfortunate that we did not include a component to measure staff reaction to automation. Certainly there were major changes in staff as a result of the system. One ten month, half time employee transferred to another department and was not replaced, representing a real savings in staff time due to the automated system.

The only variable in this project which can be considered a reaction of the staff to the system is Z2, the library component of availability. There is no doubt that most of the sharp increase in Z2 is due to real efficiencies introduced by the automated system, particularly in discharging. The decrease in Z2 in years 3 and 4 of the project is less easy to explain. A discussion of the Hawthorne effect might help shed light on this problem.

The term Hawthorne effect is derived from studies of Western Electric's Hawthorne plant conducted in the 1930's (Landsberger,

1958). The original intent of the study was to determine the effect on productivity of physical changes in the environment of assembly line workers. Instead, the researchers found that the increased attention given the workers as a result of experiments increased productivity more than physical change in the environment.

In one famous experiment, the illumination of the work area was being tested. The research team, headed by Elton Mayo, found that productivity increased with changes in illumination but also increased when illumination was returned to its old level. Clearly the increases in productivity were not being caused by physical factors but by other factors in the environment of the workers. Further analysis of the situation led to the conclusion that the increased attention paid to the workers by management and the research team was responsible for the increased productivity. High morale prompted by increased status, working with congenial colleagues and being allowed to express grievances to a responsive authority was more important to the workers than illumination, rest breaks or hot meals. Increasing the attention paid to workers, which occurred by placing them in an experiment, changed their behavior. This phenomenon has come to be called the Hawthorne effect. The existence of this effect can seriously restrict a researcher's ability to isolate variables which change performance in a consistent manner.

We believe it is quite plausible that the Hawthorne effect caused some of the increase and subsequent drop in the library component of availability in this project. To defend this assertion, we provide some history of the circulation department and its personnel.

Until Fall of 1979, the circulation department did not have a professional head. The unit's supervisor was a high level member of the support staff, reporting to the Head of Reader Services. The nature of the work tended to be extremely repetitious in nature, involving manipulation of the cumbersome, two pocket card system. Means by which circulation policies could be enforced were minimal and indeed, some books had been checked out to faculty for 15 or 20 years. Furthermore, job descriptions were not explicit and clear lines of responsibility were not drawn.

When the automated system was installed in November, 1978, an ad hoc committee composed of all circulation workers in the library system began to meet on a regular basis to work out the common policies and procedures necessary if the automated circulation system was to be used by all libraries at Oberlin. In addition, a Systems Librarian was hired not only to coordinate and implement the introduction of the system but to have line responsibilities as Head of Circulation in the main library. The Director of Libraries was also new in February 1979 and was most concerned that the circulation system should be a success, not only because of the financial investment but because of the major influence the treatment of patrons at the circulation desk has on the attitude of patrons toward the library as a whole. The Director was therefore most responsive to requests for equipment, student staff, etc.

All the ingredients for the effects described by Hawthorne were in place.

The ad hoc circulation committee provided a forum by which problems and confusions about the new circulation system could be aired in an environment of peers. The Head of Circulation standardized job descriptions and equalized the division of labor among the circulation staff. As a result, each of the four supervisors had clearly defined areas of responsibility and power to hire, fire and train their own student staff.

The Director of Libraries supported the lending policies of the circulation department and expedited their clearing up the backlog of manual files. Presentations on the need for consistent enforcement of lending regulations were made to the faculty library committee and through them to the faculty as a whole.

The circulation system further caused a general increase in the complexity of the clerical jobs in the department. The staff was now required to operate a computer system, to perform simple trouble-shooting of system problems. The staff was required to learn about computers, barcodes and the circulation system in a short period of time. Because the computerized system relieved the staff of manual manipulation of a file of pocket cards and of manual typing of various types of notices, they were able to turn their attention to more qualitative aspects of their jobs -- interaction with patrons, better training of student staff, effective administration of recalls and overdues, etc. Recognizing the increased complexity of the jobs, the library reclassed many members of the department up one grade with a commensurate increase in pay.

Perhaps the benefit rendered by the system which was of most significance to the circulation staff was the impact on the "end of semester crunch." Because of Oberlin's semester loan period, almost all books which circulate are renewed or returned the last week in December or May (on the order of 10-15,000 books). With the manual system, books were piled six feet deep on the floor of the discharging room and reshelving was not completed for 2-3 months.

Using the automated system, two important features became possible. A drastic reduction in the time needed to discharge books meant the same level of student staff could spend time shelving instead of discharging. The second factor was the ability of the system to generate on-demand lists of what is charged to a pat-on. Thus persons could come to the library at any time and request a list of materials in their possession. More importantly, the staff began to mail a list of books charged to every borrower three weeks before the semester ended, reminding them that the materials listed should be returned at the borrower's earliest convenience. This letter had the effect of spreading out the return of materials over three weeks instead of one. Clearly it is much easier to process 10,000 to 15,000 books over a three week period than one week. A letter to every borrower listing materials charged is a practical impossibility with a manual system.

In the past two years, the practices and policies which were once fresh and exciting have become routine. The circulation committee meets relatively rarely since most of the common policies have been established. Because staff members expect the circulation system to

operate at a high level, they are frustrated and annoyed when the system is not operating well, even though "not operating well" is still much more efficient than the old manual system ever was.

Although the library factor of availability appears to be decreasing somewhat from its remarkable peak of 96% in April 1981, we feel it will maintain a level permanently higher than the 75% level experienced before the system was introduced. An additional availability survey to be performed April 1983 will help test this hypothesis.

Discussion

This project has demonstrated several interesting facts about automation. Because of the replacement effect, attitudes are not a reliable indicator of quality of service. Documenting the decrease or increase in levels of service must be measured directly, not through an attitude questionnaire.

We have shown that efficiencies of automation do significantly influence the productivity of a library in discharging quantities of books, but that the Hawthorne effect also seems to influence production. We have shown that some of the changes in patron attitude can be linked to two factors--the degredation of checkout time at the beginning of the project, which in turn, was a measure of the number of barcoded books. The other factor was the effect of a new director. Because of the replacement effect, the influence of these changes levels off over time.

Members of the library community planning for automation can look to this study for the following advice:

- Automation will introduce efficiencies in production and thus better quality service.

- Patrons will respond to the visible changes of automation but this will return to original values as patrons cycle out of the student body.

- Patrons appear not to make increased use of the system even though it is easier to use.

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