INFORMATION TO USERS

This material was produced from a microfilm copy of the original document. While the most advanced technological means to photograph and reproduce this document have been used, the quality is heavily dependent upon the quality of the original submitted.

The following explanation of techniques is provided to help you understand markings or patterns which may appear on this reproduction.

1. The sign or "target" for pages apparently lacking from the document photographed is "Missing Page(s)". If it was possible to obtain the missing page(s) or section, they are spliced into the film along with adjacent pages. This may have necessitated cutting thru an image and duplicating adjacent pages to insure you complete continuity.

2. When an image on the film is obliterated with a large round black mark, it is an indication that the photographer suspected that the copy may have moved during exposure and thus cause a blurred image. You will find a good image of the page in the adjacent frame.

3. When a map, drawing or chart, etc., was part of the material being photographed the photographer followed a definite method in "sectioning" the material. It is customary to begin photoing at the upper left hand corner of a large sheet and to continue photoing from left to right in equal sections with a small overlap. If necessary, sectioning is continued again – beginning below the first row and continuing on until complete.

4. The majority of users indicate that the textual content is of greatest value, however, a somewhat higher quality reproduction could be made from "photographs" if essential to the understanding of the dissertation. Silver prints of "photographs" may be ordered at additional charge by writing the Order Department, giving the catalog number, title, author and specific pages you wish reproduced.

5. PLEASE NOTE: Some pages may have indistinct print. Filmed as received.

Xerox University Microfilms
300 North Zeeb Road
Ann Arbor, Michigan 48106

THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

BEHAVIORAL RESPONSE TO THE LOCATION OF A REFERENCE SERVICE IN AN ACADEMIC LIBRARY ENVIRONMENT

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF PHILOSOPHY

BY

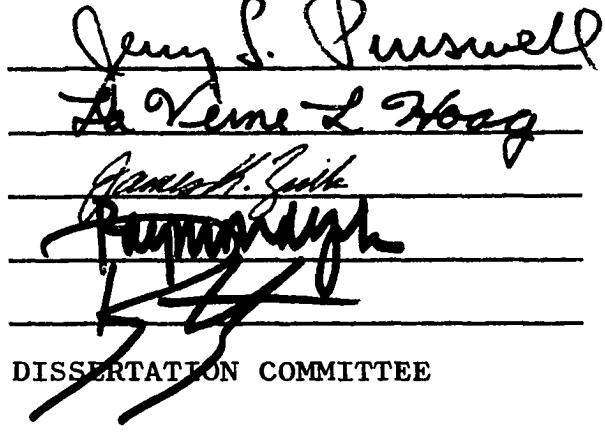
LARRY LARASON

Norman, Oklahoma

1975

BEHAVIORAL RESPONSE TO THE LOCATION OF A REFERENCE SERVICE IN AN ACADEMIC LIBRARY ENVIRONMENT

APPROVED BY



DISSERTATION COMMITTEE

ACKNOWLEDGEMENTS

I would like to thank the members of my Advisory Committee, each of whom made an individual contribution to this effort. The reference staff of Bizzell Memorial Library also deserves my gratitude, especially Shirley Pelley, Jan Hurst and Lenore Clark.

Others who have aided me in this endeavor include Marty Peters, Katherine Larason, Mary Koutsy, Ann Rounds, William Etheredge and Cynthia Duncan. I sincerely thank each of them.

TABLE OF CONTENTS

		Page
LIST OF TABLES		vi
LIST OF FIGURES		ix
Chapter		
I.	INTRODUCTION	1
	Scenario Discussion Statement of the Problem	
II.	BACKGROUND	10
	The Library Use System The Reference Interface Informational Needs Location of Reference Services Arrangements of Systems Components Discussion Summary	
III.	CONCEPTUAL FRAMEWORK	35
	Brief Review of Systems Characteristics of Passive Systems Environmental Programming Limits of Environmental Programming	
IV.	MODEL OF THE USE OF REFERENCE SERVICE	52
V.	LITERATURE REVIEW	62
	Introduction Scope Library Use Patterns Awareness of Reference Service Measuring the Use of Reference Service Measures of Areal Central Tendencies	

Chapter Page

VI. THE EXPERIMENTAL SYSTEM 76

General Statement
Assumptions
Subjects
Equipment and Procedures
Experimental Design and Analysis
Experimental Controls

VII. RESULTS AND ANALYSIS 110

General Statement
Population Characteristics
Head Count
Usage Measures
Environmental Variables and Prediction Model

VIII. CONCLUSIONS 185

Summary and Conclusions
Evaluation and Need for further Research

REFERENCES AND BIBLIOGRAPHY 198

LIST OF TABLES

Table		Page
1.	The Experimental Schedule	87
2.	Academic Status: Response to Daily Survey of Users Entering Site	116
3.	Summary Data for Class Standing Chi Square Test	117
4.	Correlations of Estimated Number of Users in Specified Classes with (a) Total Usage, (b) Usage at the Office, and (c) Usage at the Desk Positions	119
5.	Response to Question Regarding Last Time at Experimental Site	121
6.	Response to "Last Time on This Floor" Question by Phases with Chi Square Test Data: (a) Observed, (b) Expected, and (c) Chi Square Contribution	122
7.	Correlations of Estimated Numbers of Users in Last-Time-on-Site Categories with Total, Office and Desk Usage	124
8.	Response to Question Regarding Length of Stay	126
9.	Correlations of Estimated Numbers of Users in Length-of-Stay Categories with Total, Office and Desk Usage	127
10.	Intent of Users from Responses to Survey Instrument	129
11.	Correlations of Estimated Numbers of Users in Intent Categories with Total, Office, and Desk Usage	130
12.	Response to Question Number Six on Instrument Relating to Possible Reexposure to the Experimental Stimulus	133

Table Page

13. Percentage of Total Daily Usage Occurring at the Desk by Desk Position 134

14. Head Count of General Population Entering Experimental Site for All Trial Periods 137

15. All Reference Usage at All Locations during Experimental Periods in Chronological Sequence . 139

16. Summary of Results of Usage Regressions on Head Counts 145

17. ANOVA Table: Regression of Total Reference Use on Head Count 146

18. ANOVA Table: Regression of Reference Usage at the Office Only on Daily Head Count 146

19. ANOVA Table: Regression of Reference Usage at the Experimental Desks Only on Daily Head Counts. 147

20. ANOVA Table: Regression of Total Usage at All Locations during the Eighteen Days of Experimentation on Daily Head Count 147

21. Residuals of Usage Regressions on Head Counts for Office and Desk Positions Arranged Chronologically 148

22. Usage at the Office Only Arranged by Treatment Level, Normalized by Head Count and Expressed as a Percentage 150

23. ANOVA Table: Effects of Treatments on Use at Office Only 150

24. Total Use at Both Office and Desks Normalized by Head Count and Expressed as a Percentage . . . 152

25. ANOVA Table: Effect of Treatment on Total Daily Use at Both Locations 152

26. Summary of Usage by Type for the Four Locations . 154

27. Correlation Matrix for Environmental Variables and Usage (Y_i) 156

28. Correlations of D_i with Other Variables in General Model 158

Table Page

29. Frequency of Occurrence of PMAT by Module Coordinates by Phase of Experimentation 160

30. Visibility: Measures and Computed Values of the Variable 162

31. Measures and Values of the Floor Density Variables 167

32. Daily Percentages of Users Travelling into Aisles One to Six after Entering the Site or Traversing the Main Aisle on Days when Location 3 Was in Use 168

33. Variable Matrix for the Regression Model 171

34. Correlations of Various Combinations of Candidate Variables and Y_i 172

35. The Results at Each Stage of the Forward Selection Regression Procedure 173

36. Values of the Observed and Predicted Criterion Variable with Associated Residuals 175

37. The Derivation of the Contribution of the Independent Variables to the Reduction of the Sum of Squares in the Best Model 179

38. ANOVA Table for the Regression Model 180

LIST OF FIGURES

Figure		Page
1.	Library Use System	13
2.	User/Information Retrieval System Interface. Adapted From: Blunt, Charles R., et al., "A General Model for Simulating Information Storage and Retrieval Systems," State College, Pennsylvania, HRB-Singer, Inc., 1966 (AD636 435)	20
3.	Stereotypic System	37
4.	Reference Room in a Western University Library	54
5.	Experimental Site: Western One-Half	79
6.	Experimental Site: Eastern One-Half	80
7.	Users Filling Out Survey Instruments at the South End of the Main Aisle	82
8.	Experimental Site: View Toward the West in the Northwest Quadrant	82
9.	Experimental Site: View of the Northeast Quadrant Study Area	83
10.	Experimental Site: View Toward the East of the Study Facilities in the Southeast Quadrant	83
11.	Experimental Site: View of the Office from which Reference Service is Normally Provided	84
12.	Desk Location Number One as Seen from a Point at the Center of the Floor in the Main Aisle	84
13.	Desk Location Number Two as Seen from the Entry at the Main Stairs	85

Figure		Page
14.	Desk Location Number Three Viewed from in Front of the Elevators	85
15.	Experimental Instrument	89
16.	Schematic Diagram of Alternate Entering Pathways	103
17.	Total Daily Reference Use at All Locations Plotted on Daily Head Count	141
18.	Daily Reference Use in Office Only Plotted on Daily Head Count	142
19.	Daily Reference Use at Experimental Locations Plotted on Head Count	143
20.	Total Daily Reference Usage on 18 Days when Desks were in Use	144
21.	Daily Observed and Predicted Values of y_i Arranged in Rank Order of the Observed Values of y_i	176
22.	Daily Observed and Predicted Values of y_i Arranged on the Horizontal Axis Chronologically within Desk Position	177

BEHAVIORAL RESPONSE TO THE LOCATION OF A REFERENCE SERVICE IN AN ACADEMIC LIBRARY ENVIRONMENT

CHAPTER I

INTRODUCTION

Scenario

A student who has heard of several best selling books dealing with parallels between human and animal behavior wishes to obtain some of them for use in writing a term paper; offhand, he cannot recall either the titles or the authors' names, but he knows that the subject matter is referred to as "Ethology." He goes to the library hoping to find several interesting works in this field from which to select material for his paper.

He knows that in order to find a book in a library he must obtain the call number from the card catalog as a first step; however, when he looks in the subject catalog for "Ethology" he encounters a barrier: the only card carrying this heading reads "see, Character, Ethics." He reasons that this must be a term used in philosophy prior to the current use of the same word and tries to think of another approach.

He still cannot recall authors or titles for the

books he has heard of, although he can recall the dust jacket that was on the one that he looked at in a bookstore (Ardrey's African Genesis). He decides that "Psychology" may be the proper heading and returns to the catalog. He is dismayed to find that there are three or four drawers full of cards for this topic, and he is not even certain that the books he wants would appear under this term.

If he is like many library users, he may despair and either retreat to the bookstore or choose another topic. If, however, he believes that the library must have the desired materials he may turn to a reference librarian for assistance.

The librarian may also be somewhat uncertain about the "proper" subject descriptor, but he may recall either Ardrey's name or the titles of one of the same author's books when the student describes what he needs. Using either approach should break down the barrier because, having found one appropriate title, the librarian may check the subject tracings at the bottom of the card and inform the student of the subject headings to look under for similar works.

Discussion

The scenario gives one example of what Taylor (1970) meant when he wrote: "To an outsider, a library is a very complex organization and frequently a very frustrating system to use." Referring to the type of problem shown in the

scenario, Taube (1953) has said,

> Many catalogers . . . are convinced that reference librarians must mediate between the patron and the catalog since the patron cannot be expected to master the complicated . . . rules and cross reference structure required to make large catalogs self consistent and logical instruments.

Taube could have substituted "bibliographic tools" for "catalog," as all attempts to classify information suffer to some extent from the same distortions.

Verner Clapp (1967) asks, "Why can't the collection service itself?" Since WWII librarians have been assuming more and more that it can, and libraries have tended to model themselves more closely on department stores and supermarkets, becoming "bibliographic warehouses" where the patron serves himself among the open stacks displaying informational wares like canned goods.

Clapp then relates the role of the reference librarian to explicating the catalog and continues, "Why does a device possessing such capacity and versatility . . . fail so conspicuously in providing information regarding itself?" He then considers reference service in a broader light:

> There is no doubt . . . that much of the work of the reference staff consists in giving instruction in the use of library tools and procedures. It appears to follow that adequate prior instruction (of patrons) would significantly free the reference staff for other work. But how to effect such prior instruction? This is a problem of long standing . . . (but) no universally satisfactory solution has been found.

Many techniques of educating the user have been tried; among them are guided tours, self-directed tours, how-to-use

pamphlets, television shows on educational channels and programmed learning media. Follow-up studies on many cases are lacking or, methodologically at least, not very satisfactory.

Griffin (1972) writing on education of graduate students in library use notes that "Traditionally, library orientation has focused on the assumed needs of freshmen. . . ." He continues, "No one appears satisfied that we . . . have solved the problem of orientation at the undergraduate level, although a good start has been made on many smaller and medium-sized campuses."

One of the unresolved problems is "What should the user know?" This is often more easily determined at the graduate level of library use, but, as will be pointed out again, the user's qualifications vary relative to his goal in use. Bates (1971) in her comments on the problems in measuring user knowledge of libraries, said, "Because a user does poorly on a library knowledge test does not mean that he will do poorly in using the library. There are degrees of knowledge and degrees of need to know."

The how-to-use courses offered (sometimes for credit) in universities consist, usually, of long lists of reference books for the students to gain on-hands experience with and/or memorize, plus a lecture or two on the history of books, printing and libraries. The development of principles of using libraries and information is often neglected, and not only in terms of educating the user, but also in the

education of librarians. Focke (1967) sums up the problem:

> More than one person has suggested that documentalists are "rediscovering the wheel," that they are continually rediscovering things reference librarians already knew about the way people ask for information, how they use the literature, and what sort of tools they need. In a few cases, this may be true. But part of the fault is ours (reference librarians). We have developed our "know-how" by rule of thumb, through experience handed down among ourselves informally, and we have not reported our data systematically or objectively.

Another lack in this area of knowledge is information regarding what the "average" user does not know about libraries. Bates (1971) found in her survey of the literature of library use that "User knowledge itself is a very sparse field of research."

The overall mission of reference services is, then, to aid those users whose qualifications fall short of what is needed in order to solve their present use-problem. The most often repeated instruction to library users must be "When in doubt, ask a librarian." But as Taylor (1968) points out:

> It appears that there are a large number of users of information systems who, for a variety of reasons, will not ask a librarian for assistance. They develop their own search strategy, neither very sure of what it is they want nor fully cognizant of the alternatives open to them.

In 1963 Line (1963) found that 52 percent of the users of his library were reluctant to ask for assistance. His study is rather unusual in that he actually tried to determine the need for assistance that was not being fulfilled and took steps to change the use patterns. No other survey of untapped demand for reference service has been encountered.

The picture that emerges is that the user probably follows habitual search patterns that have paid off in the past, and, thus, are repeated with little consideration of their applicability to the present need in terms of either effectiveness or efficiency. Librarians encounter this situation constantly when users try to locate information in entirely inappropriate access tools. One personal example was that of a student looking for human engineering and anthropometric information related to the design of furniture in Reader's Guide; he had come to the conclusion that there had been no research in this area because all he had found were articles on interior decorating, fabrics, color schemes, etc. As a matter of fact, this came to light in an informal discussion outside the library setting; he had not asked for assistance through a formal channel.

The questions that patrons do not ask may not, in all cases, be critical to their success in using the library. The user whose need is such that he cannot accept failure, when encountering a major problem will more likely request assistance; a lesser degree of need or a less critical problem may result in the acceptance of frustration or failure.

The viewpoint expressed by Kilgour (1967) seems to be appearing more frequently in the literature of late, but too often is paid only lip service: "As soon as users are considered as part of library systems, it is clear that user costs are systems' costs." This would seem self-evident, but

usually only the efficiency of the staff is considered in system design. Since the user is not on the payroll, his time is worth nothing. As Waldhart and Zweifel (1973) put it, "Library administrators do not have to defend user costs . . . at budgeting meetings, but they do have to defend library operating costs."

Statement of the Problem

If the user is considered as a part of the system, it is clear that principles used to improve staff performance are, or should be, equally applicable to the user as operator. The uncertainty experienced in such attempts is due to the multiplicity of goals of use--each patron comes into the library for a different, often highly personal, reason, with the result that each requires a different mix of library tools and materials. As has been pointed out, the general training, that is feasible, is only a partial solution; the reference services must fill the gaps on the scene. However, the users are often reluctant to use the services. In order to reduce the cost of the use, the operator must have the information that only reference can supply, so the problem is to increase the use of the service.

Increasing the use of the service entails increased awareness of the service on the part of the library users and, presumably, a lower cost of use in order to overcome the reluctance to request assistance. This study intends to approach the problem of enhancing reference service usage as

a problem in environmental programming; the proposition is that by designing the environment in such a way as to increase the probability of awareness and to reduce the cost of use the behavior of the user can be influenced, or programmed.

The two goals of this study were: (1) to demonstrate that the usage of the service could be changed by simply changing the location of the service point, and (2) to attempt to identify environmental variables which would serve in a regression model to predict the direction of change. The variables were derived from a general model of reference usage based on cost of use and factors of information sensing and processing.

Before developing the model of reference usage, a more general model of overall library usage will be presented in Chapter II in which the multitude of goals of use are reduced to a manageable number of operational objectives. Following that, a look at the user/reference interface will be presented, but only briefly since the problem is to get the user to initiate the interaction.

The general model of library use allows the informational needs of the user to be analyzed into three categories. Also in Chapter II these categories will be examined for spatial distribution of occurrence, and the problem of location of the reference service will be related to the analysis of user information needs. Concepts from marketing and merchandising will be adapted with use of the reference

service being compared to impulse buying.

In Chapter III a system analysis approach will be used to develop a broad conceptual framework for the experimentation. The term environmental programming, which does not yet have a standardized usage in the literature, will be defined and its conceptual validity examined.

Chapter IV will develop a conceptual model of the use of reference services in which the user is considered as both an operator of a system to be trained and as a customer to be sold a product.

Chapters VI and VIII recount the experiment undertaken and the attempt to fit a regression model to the resulting data.

CHAPTER II

BACKGROUND

The Library Use System

The mission of the library is to obtain, organize and control information transferring media for the purpose of study, research and/or general recreational use. This definition was adapted from a report by the Historical Evaluation and Research Organization (1968); it is preferred to definitions positing the library's role as providing information, per se, at least for the purpose of this study, because the information transfer in most academic libraries is a personal process engaged in by the patron alone. This reflects the academic emphasis on the student performing his own work.

Clapp (1964) also reflected this media orientation when he said,

> Stated in the simplest terms, the function of the research library is to enable inquirers to identify library materials relevant to their inquiries and to supply them with copies of these materials for their use.

Taylor (1970) added a more active emphasis to the definitions above when he said, "The major function of the library . . . is to raise the probability that a person will find messages . . . of concern to his expressed and

unexpressed needs." Thus, the library management should attempt to alert the user to the multiplicity of information channels, rather than simply warehousing them. To achieve this goal the library must (1) provide the media or means of access to it if the material is not in the local system, and (2) display the materials or their surrogates in a fashion that communicates its availability so that the user becomes aware of potentially useful items. In some cases an aggressive approach to alert users is employed by means of SDI notices or lists of current acquisitions. Most libraries rely on the traditional and more passive tools such as the card catalog and indices or bibliographies. Ranganathan (1963) has succintly stated all of the above as: "Each reader his book. Each book its reader."

Paraphrasing a statement by Manheim (1964) regarding transportation facilities, seldom is the access to information considered an intrinsic end; it is usually an instrumental one. The purpose of information provision is to aid in the achievement of other goals; thus, information facilities must be evaluated, ultimately, in terms of the extent to which they achieve the broader goals of that portion of society which they serve. The difficulties of a "social evaluation" were stated by Hamburg, et al. (1970) when they pointed out the problem of separating the effect of the library on a community from the effects of schools and other educational institutions and media.

Although each user brings his own goals into the library, there are certain operational objectives which are

susceptible to analysis. For the purpose of this study the media consumer, as opposed to the study hall user, is being considered. The goal is to ensure his access to the store of media. The operational objectives pertain to the type of media and means of access. Figure 1 is a general depiction of the process of library use.

The set of feasible, operational objectives proposed are:

1. Location of a discrete item of information in a media component.
2. Discovery (identification) of probably useful, discrete media components relative to a topic by means of bibliographic tools.
3. Location (obtaining) of items discovered through the tools from either within or outside the local collection.
4. Use, evaluation or selection of the most appropriate media items obtained.
5. Alternatively to the sequence of activities described by objectives 2-4 above: identification of useful items by browsing through a class of probably useful materials.

Other objectives that follow those above in the use sequence overlap with the goals of study hall users, e.g., read or study the obtained materials.

These five operational objectives correspond closely to the list of types of user requests given by King and Bryant (1971) which they adapted from Menzel (1964) and others. Their list:

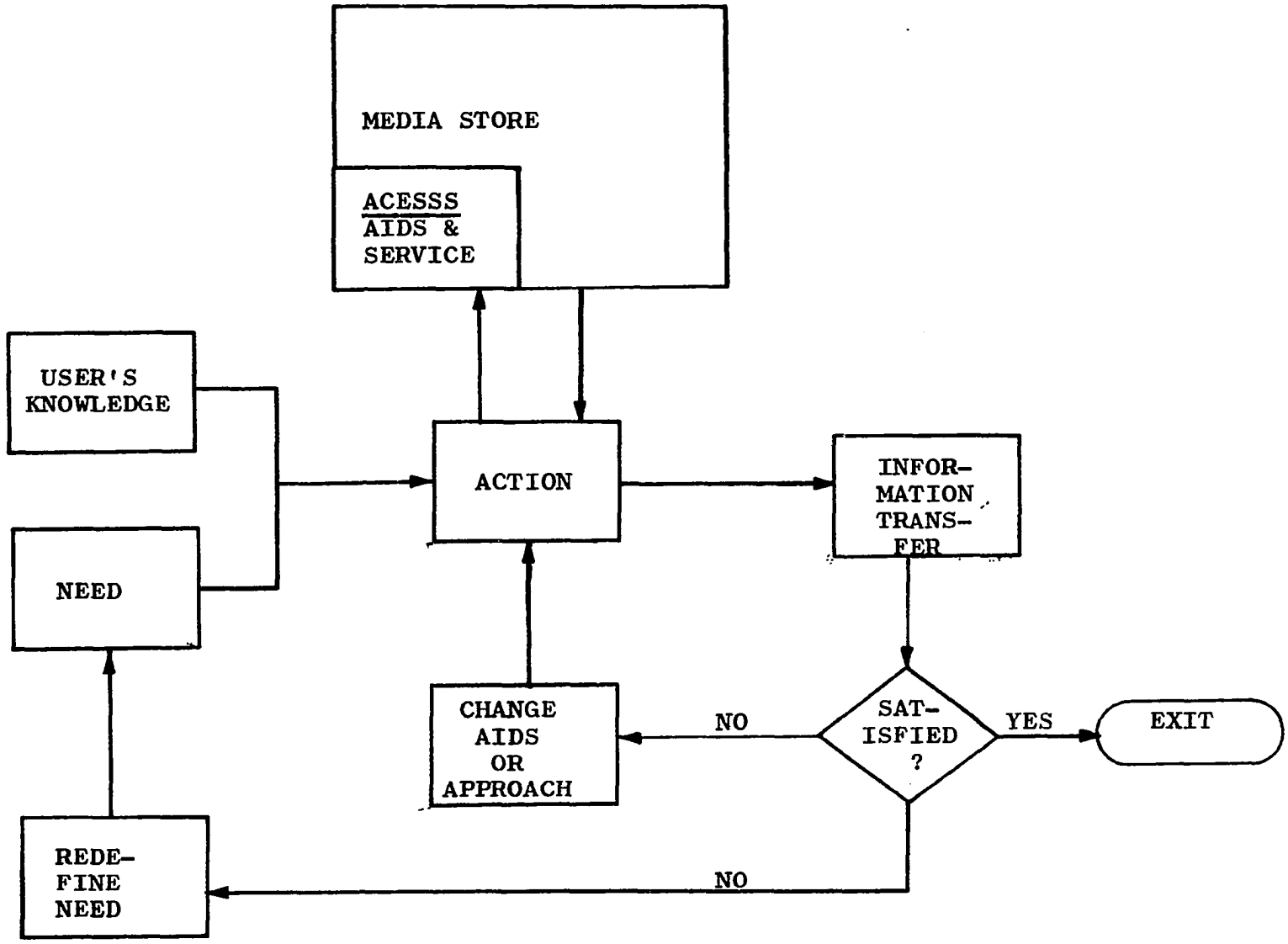


Figure 1. Library Use System.

1. Requests for specific documents.
2. Requests for information by subject.
3. Exhaustive search.
4. Browsing.
5. Current awareness.

The fifth, "current awareness," could be subsumed by other categories, in terms of operations performed to achieve the goal.

Most previous studies of library use have concentrated on the decision to use the system; in this study the emphasis is on internal use of subsystems. The decision to use the library is independent of the actions within; the decision may be influenced by many things, but once within, the user is constrained by the structure of the system and his understanding of it. Assuming that he is rationally pursuing a specific informational goal, the library presents the user with a variety of alternative information channels, operational modes and related tools or aids from which he must choose the most appropriate. When the operational objective is specified, the behavior of the user is broadly predictable; however, the variable of his understanding of the system adds a randomizing effect which more or less negates any attempt at discrete prediction of his use-path.

When stated as above, the operational objectives imply few of the constraints of the user. Some examples will illustrate the structure of the system and its effect.

The first objective is usually the simplest to satisfy.

A user wanting some discrete fact may employ a number of possible channels or components that will probably satisfy his need--encyclopedias, dictionaries, almanacs, handbooks and other standard "ready reference" works. Locating an appropriate source is the primary constraint; these types of books are usually placed near reference desks and access may be tightly controlled. Also, users are seldom aware of the full range of items available, and, even when aware, do not know the title or author and find the approach through the subject catalog difficult.

If the user chooses the fifth objective--to use the subject classification as an access tool--he must familiarize himself with appropriate call numbers. This "serendipitous" approach is frequently highly lauded; however, the power of library classification schemes to pull literature together for the user is somewhat overrated. Stevens (1956) cites several studies indicating that large portions of books relevant to a subject discipline are not so classed; as one example, Broadhus found only 32 percent of the serials and 10 percent of the non-serial publications of importance to sociology[1] classed in "sociology" call numbers.

Considering the sequence described by objectives 2-4, a series of decisions may be more clearly stated. First, the user must decide that he wants something other than a simple

---

[1]The importance to the field was determined by a study of numbers of citations in relevant bibliographies.

discrete item of information and that he will attempt to locate the target item(s) through bibliographic tools (rather than browsing). Second, based on his knowledge of information sources, he must select the type of material he wishes to consult. This decision can be more or less critical; a user looking for governmental statistics in popular journals will probably spend a great deal of time tracking down what he wants when the answer might be quickly available in a government document or a reference source such as Congressional Quarterly.

Third, the choice of access mode is usually predetermined by the informational goal. The user may choose from author, title or subject approaches, and, in some cases, date of publication, country of origin, and language, etc., although these latter modes are usually in conjunction with the first three, rather than entirely independent options. For example, seeking information on the presidential campaign of Victoria Woodhull in the 1870's, the user would probably turn first to periodical indexes of the literature of that era (notably, Poole's Index to Periodical Literature) rather than to a current issue of Reader's Guide, although the latter might list some of the recent general interest articles on this subject.

This last example prefigures the next decision: the choice of appropriate bibliographic tools. The index to the book (monograph) collection in most libraries is the card

catalog. Journal articles are accessible by a multitude of indexing and abstracting services, each of which has its own methodology, coverage, and list of descriptors. The last step the user must take, then, is to reformulate his need statement in terms of the tool being used.

This sequence of decisions can be referred to as "search strategy;" this is a term frequently used by librarians, usually to describe a process that is, at best, heuristic, and more often simply intuitive. Summarizing these decisions:

1. Choose an operational objective from the set of feasible objectives; that is, transform the need statement into a standardized use pattern.
2. Choose an appropriate access mode based on prior knowledge, i.e., subject, author, title, etc.
3. Choose one or more types of materials appropriate to the need, if the need statement is not explicit in this regard.
4. Choose the appropriate access tools--card catalog; call number array (browsing); regional, national, international bibliographies; etc.
5. Redefine the need statement in terms of the structure of each of the tools selected.

These decisions are not independent; each can be complexly related to the others, and they need not occur in the sequence listed. In many cases the decisions are probably

not consciously made in terms of the specific need.

Swenson (1965) presents an interesting attempt to rationalize search strategy: in a small, specialized research library a flow chart was prepared that showed the decision points, including a surrogate display of the major tools of access linked, in this case, to types of materials.

The Reference Interface

The reference service is being considered in this study as an immediate source of information for the user experiencing difficulty in using the library. It might be well to review, briefly, at this point the overall set of assignments generally considered appropriate to this service in an academic library. The following list is adapted from Nelson (1973).

--Ready reference or providing factual information in response to simple questions from a variety of almanacs, encyclopedias, etc.

--Reference questions requiring a search to obtain the information.

--Obtaining information from experts, possibly outside of the parent institution, rather than from media items.

--Preparation of bulletins and handbooks.

--Preparing lists of reference books for specific courses.

--Tours and lectures for the general population or specific classes.

--Preparing bibliographies on "popular" topics for general distribution.

--Collecting and maintaining a file of pamphlets and ephemeral materials.

--Providing interlibrary loans (in some cases separated administratively from the reference service proper).

--Advice and assistance in use of the library.

--Administrative duties with regard to the collection.

Documentalists usually consider the interface of user and information system in the manner of the diagram adapted from Blunt (1966) in Figure 2. While this specifically represents a mechanized system, the steps are equally applicable to a human/human interface. In a seminal paper, Taylor (1968) looked at the user/librarian interface and distinguished four levels of questions ranging from a vague dissatisfaction, perhaps not even conscious, to the final detailed question, which he posits is the result of a "negotiation" between the user and either colleagues or librarians, much as the feedback from the system in Figure 2 serves to define the question.

Taube (1953) stated this function more generally, "Users of the [information] system must be ready to adjust their immediate aims . . . to the internal requirements of the system." The system may not reflect the stored information in a structure predictable by the user, but it can be assumed that in nearly every case there is a channel of access to the desired information.

However, in the self-service situation encountered in most academic libraries, the user interfaces a passive system component that cannot interpret his questions or provide meaningful feedback to a wrong use, in most instances; he must by trial and error find the correct reformulation of

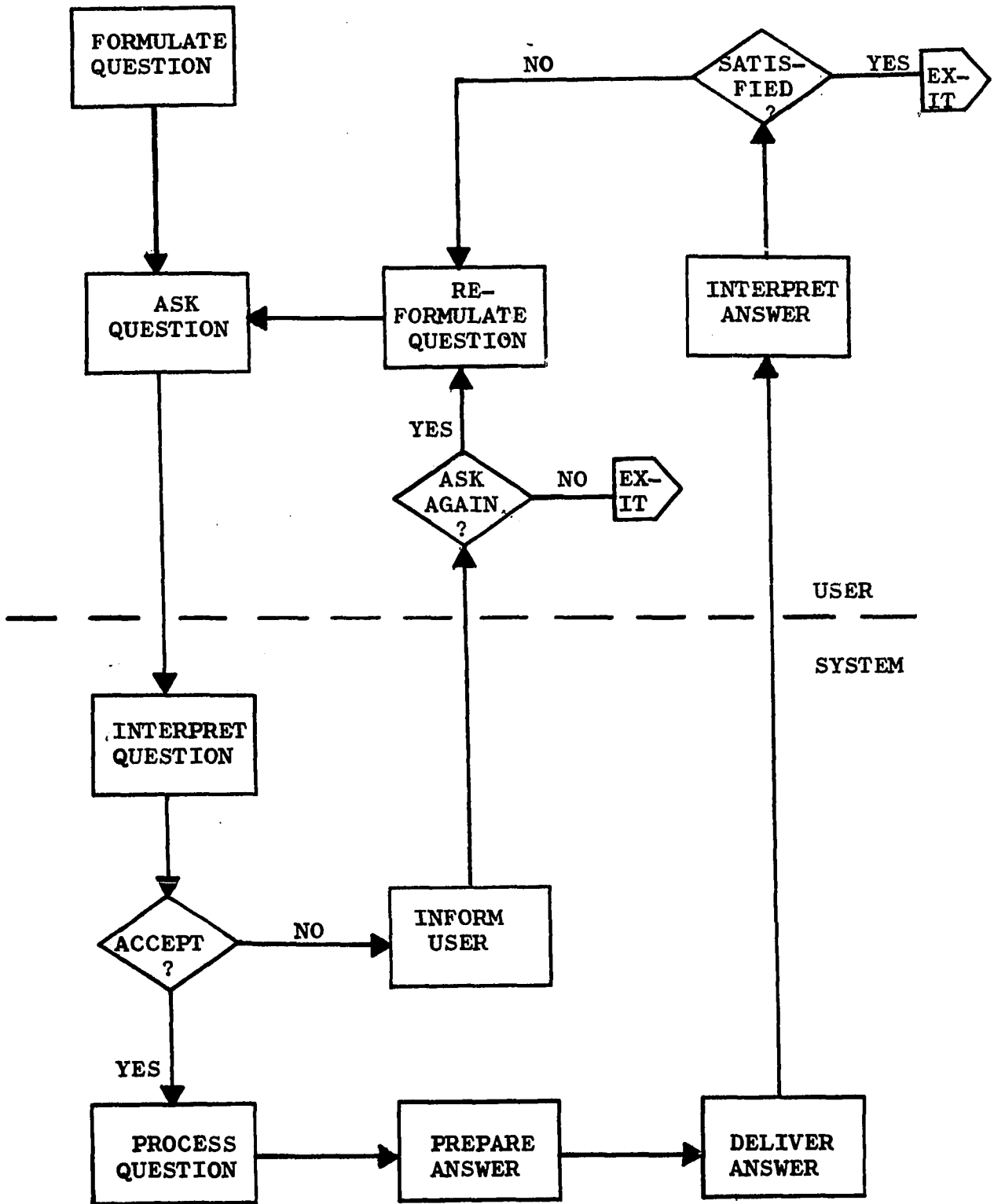


Figure 2. User/Information Retrieval System Interface. Adapted from: Blunt, Charles R., et al., "A General Model for Simulating Information Storage and Retrieval Systems," State College, Pennsylvania, HRB-Singer, Inc., 1966 (AD636 435).

his need with regard to the appropriate tool. The user's knowledge or lack of it is the primary constraint on his success, unless he calls for assistance from the reference service which is the only source of feedback.

Informational Needs

The user's problems can be reduced to three general types:

(1) Search strategy uncertainty: the need to choose between alternate channels of information and tools of access in approaching the media store.

(2) Uncertainty in reformulating his needs in terms of the tool's structure or difficulty in using the selected channel of access.

(3) Orientation and location uncertainty; locating identified materials or simply finding one's way around in a large or complex environment, especially during the first use.

The problem of finding the location where a selected item should be, but is not, is considered an administrative one and is excluded from this consideration.

In the following discussion each of the three types of informational needs will be examined for spatial foci.

The first class of problems cannot be said to have one specific spatial focus, however, two loci are generally indicated: (1) the user who realizes his lack of qualifications in relation to his use task may seek assistance at the beginning of his use-path, i.e., at the entrance to the library; (2) the user who chooses an inappropriate tool will realize this after an abortive attempt at use, so that this type of problem will occur at the site of the tools.

Problems of the second class dealing with the structure

of access tools are the most studied of all user problems, especially with regard to language elements. Taylor (1968) points out that the tools and mechanisms developed by librarians and information scientists are "frequently oversophisticated, at least in the display forms in which they presently exist." These types of problems are the least susceptible to environmental influence, however, and do not need to be further discussed, except to point out that they will necessarily occur at the location of the tools and will be clustered spatially to the extent that the tools are clustered.

The third class of problems relates to the identification or "mapping" of destinations. Griffen (1972) observed:

> There are "special" collections hidden from the public in most large library systems as well as local variations in filing or shelving that often confuse students, librarians and faculty alike.

Uncertainty regarding destination probably occurs most frequently at the entrance to administrative areas, assuming that the area is too large to be comprehended at first glance, and/or that a large part of the area is obscured by intervening components. The user faced with an unknown space may attempt to orient himself by random perambulations or movements based on generalized expectations formulated in similar environments.

Problems encountered by patrons regarding the use of call numbers will be considered as directional or locational problems, although they might as well fit under the category of tool structure uncertainty.

These uncertainties could be further analyzed, but the point has been made that at least a part of user uncertainty has its origin in the layout of the library environment, and that there are probably spatial foci of uncertainty. For the purpose of the experiment this latter idea will not be pursued, rather, the probability of uncertainty will be assumed to be equal for all points in the environment.

The three part approach to user problems stated earlier is not entirely unique, but it is not a standard classification of reference use--see Rothstein (1964) for other classifications.

Because this is non-standard, and because of certain professional prejudices regarding what constitutes a reference question, there is no indication in the literature of the relative magnitude of the three types of problems. Since they are, at least to some extent, linked to a specific environment, figures for one library would probably not be fully applicable to any other institution.

At the University of Oklahoma Library a study of user problems (Harrelson, 1972) yielded 537 responses dealing with orientation problems from a random sample of 343 persons. In the category of tool use only the card catalog and serials records were covered in the questionnaire, but the same sample returned 253 responses regarding problems experienced with these two components. The structure of the survey does not allow any generalizations from these

figures, except that the sample was probably representative for the given campus, but it should be clear that the number of uncertainties experienced by library users is significant.

Location of Reference Services

The names most often offered as experts on academic library buildings are those of Keyes Metcalf and Ralph Ellsworth. Metcalf's work (1965) is certainly the standard work on academic library architecture. He offers the following advice regarding location and fitting of reference services:

> The library public-service staff must have a desk or a counter as a home base where it can be readily available to the readers. (p. 87)

> What public services should be close to the entrance lobby? At least the control, circulation, reference. . . . (p. 92)

> The average librarian will serve twice as many readers if the reader is standing. On the other hand, both persons will find it undesirable for the reader to stand while the librarian is looking up at him. It is suggested . . . that a reference desk be a counter . . . at least 42 in. or perhaps preferably a little higher, with the librarian sitting on a comfortable high stool. . . . (p. 235)

The latter statement was included only because it considers proxemic factors in line with the findings of Hall (1969) and Sommer (1969). Metcalf's other comments on reference services do not relate to location.

Ellsworth (1968) discusses the placement and furnishing of reference services in somewhat more depth, but primarily as a problem in workplace design. He lists several considerations including: (a) work assignments to be performed

at the desk will affect the spatial needs; (b) the reference collection to be used for the staff should be close to the service point; (c) office space should be provided for extended discussions between patrons and librarians; (d) the service point should be so located as not to disturb other readers during the reference interaction.

Not all librarians consider reference services to be an adjunct of the catalog, but, since many do, it seems surprising that neither Ellsworth nor Metcalf mentions this possible relationship.

The location of services does not seem to have been considered as either a problem of user cost or as an information sensing and processing problem by librarians. Discussions of patron needs for spatial orientation are encountered occasionally, but not in relation to the problem of service location, except in one instance: Jestes (1968) stated, "From the entrance to the reference room, there should be a direct line of sight to the main locating system, the card catalog or the librarian."

One notable example of the concern with orientation appeared in a conference presentation of building plans by Frank Lundy (1967): first he quoted the architect (Lawrence Enerson) who designed the C. Y. Thompson Library for the University of Nebraska as saying, "A library should be self evident to the reader." Lundy then continued:

> When the reader walks into the building, he should not have to wonder where he can go. . . . The main floor

> [of the Thompson Library] is wide open. The card catalog, the indexes, the book-stacks and tables are clearly in view on the left. Current periodicals, bookstacks and tables are clearly in view on the right.

Eugene Fickes (1967) a panelist at the same conference, stated, after an examination of a number of building plans, "Poor locations for library staffed public service desks were noted--some situated where they were too off-center or too remote from the areas they were to serve." He did not elaborate on this point or state criteria for the evaluation.

Given the few guidelines in library literature on location of reference services in academic libraries, it would be appropriate to briefly review a more general approach to location of system components.

Arrangement of System Components

The accepted principles of arrangement serve largely to minimize the effort required of the system operator. However, in some cases they may be difficult to apply. The principles, as listed by McCormick (1970), and a discussion of their application to a library system follow:

1. Principle of frequency of use.

Figures are often kept relating the frequency of use as a justification of a service or system component. In a system with few obligatory components, however, the frequencies may be a function of the display; a system component may have great potential value to a large number of users who are unaware of its availability.

Correspondingly, a component may be of great value even though it is only needed occasionally.

Frequency of use is of value when the analyst is assured that the system is functioning satisfactorily and that the potential users are familiar with the component in question, or when the use is routine and clearly defined. In this case the goal is to place the most used components so as to reduce the length of the use-path. The frequency criteria can be applied to major call number groups or obligatory services (e.g., the circulation desk).

2. Principle of sequence of use.

Once the most used components are identified, the sequence of use must also be considered. As an example, consider the card catalog in a library; even though it may be frequently used, the origins of the use-paths leading to it may not be at all singular. That is, it is possible that the numbers of patrons approaching the catalog from internal points may equal those who use the catalog before branching to the various shelving areas. In order to shorten the use-paths of the majority of users, the sequence, obviously, becomes important. Logically derived sequences may not accurately describe use paths; observation is often necessary to verify actual patterns. For example, it has been assumed in the past that most users would obtain a call number prior to going to the shelves, but researchers in England have found, "In known-book searches an average of 39 percent consulted the catalog

first, while 50 percent went straight to the shelves." This was found in a study of 21 British academic libraries, reported by Seymour and Schofield (1973). In two libraries the figures were highly deviant from the average, but the authors disclose nothing that may have influenced the variant behavior.

Corresponding to the problem of locating the catalog to reduce the use cost is that of locating it so that non-users are not required to pass through the area housing it. Sommer (1970) has stated this same principle in relation to the study-hall users of libraries who must traverse areas irrelevant to their purposes in order to locate desired facilities.

3. Principle of functional relationships.

Two broad functional concepts are usually employed in the arrangement of academic libraries:

a) Arrangement by type of material--media groupings (monographs, serials, microforms, maps, etc.); this type of arrangement has generally fallen into disfavor since about the time of WWII.

b) Arrangement by subject divisions--all media pertaining to a specified subject discipline or group of disciplines pulled together.

There is a continuing debate among librarians as to which best serves the user; however, it should be noted that neither mode is normally employed as an exclusive organizational rubric in any one library. Increasing theft and

mutilation of journal material are causing more librarians to look favorably on the previously unfashionable periodical department with closed stacks even in subject divisional libraries. Also, microforms and readers are frequently located in the same area as an economy measure, although some subject divisional libraries provide readers for each subject area and maintain the subject arrangement of such material.

To apply the principle to the problem at hand, given a knowledge of the greatest sources of user frustration, reference services could be located near those facilities to reduce the cost of approach.

4. Principle of arrangement by importance.

This principle is concerned with the degree to which the use of a component is essential to the objectives of the system or user. As McCormick (1970) points out, the determination of relative importance is largely subjective. Only in the case of safety is it reasonably clear cut. The pitfalls of assigning importance based on the frequency of use have been discussed.

Discussion

Application of these four principles is relatively straightforward, given the measures of frequency, sequence, etc. Algorithms for computerized design have been reported; one such (Progressive Architecture, 1967) allocates space based on minimal requirements for the components and the indicated constraints on relationships between components.

Many similar approaches are presented in Moore (1970).

Library buildings are commonly arranged to reduce staff travel time between departments and from work stations to commonly used tools, but very little in this line has been done with regard to library users. The trade-offs are frequently difficult to evaluate. For example, periodical indexes may be located far from the periodicals to which they refer in order to support and supervise the use of either or both as a part of a coherent service function.

Some additional considerations in arrangement include the following:

1. Lesser used components may be grouped in order to reduce the cost of staffing for maintenance or support. For example, microforms and maps could be placed under one administrative blanket for this reason, although the two formats share no common features.
2. Spatial compromises are frequent in crowded structures; administrative compromises may also result in less than optimum arrangement, from the user's standpoint. An example of the latter, with which the author is familiar, occurred in a western university where the ERIC microfiche collection was housed in a special area, but the indexes, without which the microfiche is largely useless, were located on a different floor as a part of the reference collection. The reasoning was that the users of the indexes required the assistance of a trained reference

librian--a service not normally available in the microfilm area--and that the reference librarians needed the indexes closer in order to keep the availability of the collection in mind when assisting patrons who could possibly use the ERIC materials. Although the arrangement was inefficient for the user, it probably did result in a higher use of the collection.

3. Hall (1969) states, "Man's feeling about being properly oriented in space runs deep. Such knowledge is ultimately linked to survival and sanity. To be disoriented in space is to be psychotic."

   The arrangement of an environment can assist the inhabitant in his orientation by providing information to the user. "Mumford has observed that the uniform grid of our cities 'makes strangers as much at home as the oldest inhabitant.'" (Hall, 1969) Arrangement is information in that it serves to reduce uncertainty as it discloses itself through: (a) direct lines of sight to possible destinations, or (b) an array so that the user can better conceptualize the whole by extrapolation or, perhaps, the gestalt principle of closure. The first method above is also suitable for the presentation of alternatives which may have been previously unknown to the user.

4. The above statement represents a strategic approach to planning an environment; a tactical approach can similarly

be taken to one or more elements of the environment. Both approaches are used in merchandising, although the principles of application seem to be more or less intuitive at this time. In both strategic (arrangement) and tactical (location) applications, the goal is to change the behavior of the user or operator, but not necessarily in the direction of less effort, as is implied in the four principles given by McCormick. An example is the placement of "routine goods" at the rear of a store in order to increase the shopper's exposure to other goods.

Two other concepts from merchandising should be discussed as they relate to the locating and arranging of system components. The first is that of "impulse shopping." Engel (1968) reviews the various definitions that have been proposed for this concept; the essential element is that the shopper did not intend to purchase the item until he encountered it in the store. This concept is not well developed; indeed, Engel reviews a hypothesis proposed as an alternative to the usual one of in-store stimuli, that is, that the apparent unplanned purchasing is simply an artifact of the interviewing techniques that have been used--that the shoppers were unable or unwilling to "commit the time and cognitive resources necessary" for accurate measures.

There seems little argument, however, that unplanned purchasing does occur, only the magnitude is challenged.

Reference service usage is, at least partially,

unplanned for by the users entering the library; it may often be a contingent action. In this sense it is only somewhat different from two of the modes of impulse buying proposed by Stern (1962); (1) reminder impulse buying--the shopper is stimulated by encountering the product to remember (or make conscious) a need; (2) planned impulse buying--shopping based on prices, specials, etc., e.g., planning the week's menu in the supermarket based on contingencies occurring during the shopping trip. In an analogous case, the user may encounter a problem and more or less give up; if he passes a reference service point, however, he may be "reminded" of the availability of assistance and stop.

Stern indicates that in the case of "reminder" impulse purchasing, prior awareness of the product or experience with it is assumed. That is, the product has an established identity for the shopper. However, it would seem that packaging or display which identified the product or service quickly and clearly could serve to create "instant" demand under some circumstances.

Gist (1968) elaborates the location concept into one of arrangement. First, in the macro-environment he proposes "intercepting locations" based on prior traffic patterns. The basic tenet is to locate a store between the source of traffic and the destination (especially if a competing store is further from the source on the same route). This takes advantage of existing patterns, rather than attempting to

divert patrons into new routes.

Inside the store, with the control to create traffic patterns, a strategic approach can be taken; "The problem is then, conceptually, to arrange the merchandise and the in-store road network in such a way that customer needs are correctly anticipated." (Gist, 1968)

The "generator" departments, that is, the merchandise which represents the destination of the majority of shoppers (routine goods), are located at a distance from the origin of the traffic flow; weak generators are located in intervening positions to obtain greater exposure or "interception." In a library the books, or tools, are what bring the patrons in; reference service usage in most cases would seem to be a contingent need, and as such may be considered as an impulse good to be located in an interceptive position.

Summary

The need for reference service grows out of the complexity of the library system, its non-operant state and the problems inherent in generalized training for the user. In this review of the library use system and considerations in arrangement of systems the concepts of cost of use and of information sensing and processing (as merchandising principles) have been illustrated to some extent. In the following section these will be further elaborated in a systems approach to environmental design.

CHAPTER III

CONCEPTUAL FRAMEWORK

The following discussion, admittedly simplistic in part, presents a conceptual framework for the proposed research. The use of the systems approach is not new in the area of environmental design, but it may be of value to develop a more general model of the interaction between users and environment than has yet been proposed.

The following discussion is in three sections:

1. A brief review of some of the salient points of systems analysis.
2. A consideration of the library-use system as a representative of a class of systems that is herein designated "passive systems."
3. A demonstration of the conceptual validity of the term "environmental programming"--that is, the programming of user behavior through the structure of the environment--and some of the uses and limitations of this approach.

Brief Review of Systems

The systems approach is concerned with "black boxes." A black box is considered as a "grouping of detail" or a "set of operations." (Hare, 1967) The set of operations is

contained within and obscured by a boundary (the box). The nature of the operations is either not known or considered irrelevant, if the nature of the transformations performed upon the input can be specified. That is, a system is defined when the output can be predicted from a knowledge of the input.

The input includes all controlling values received from the environment surrounding the black box. For example, considering a typist as a system, the obvious input is the written information that she reads; the output is the series of actions that she performs on the keys of the typewriter in order to transmit the information to the sheet of paper on the platen. Less obvious inputs (noises rather than signal) are the surrounding temperature and humidity; these may affect her performance, and, if not included in the system description, may invalidate predictions of the accuracy or rate of output.

Systems, especially those including human components, may not display the expected invariance of operation unless the output is defined stochastically and the frame of reference is broadly defined. That is, "Any transduction process can be fully described if the probability density function over all possible outputs is specified for each of the possible inputs." (Fogel, 1967)

The conventional concept of a system is represented in Figure 3. The system's activity is constrained by an

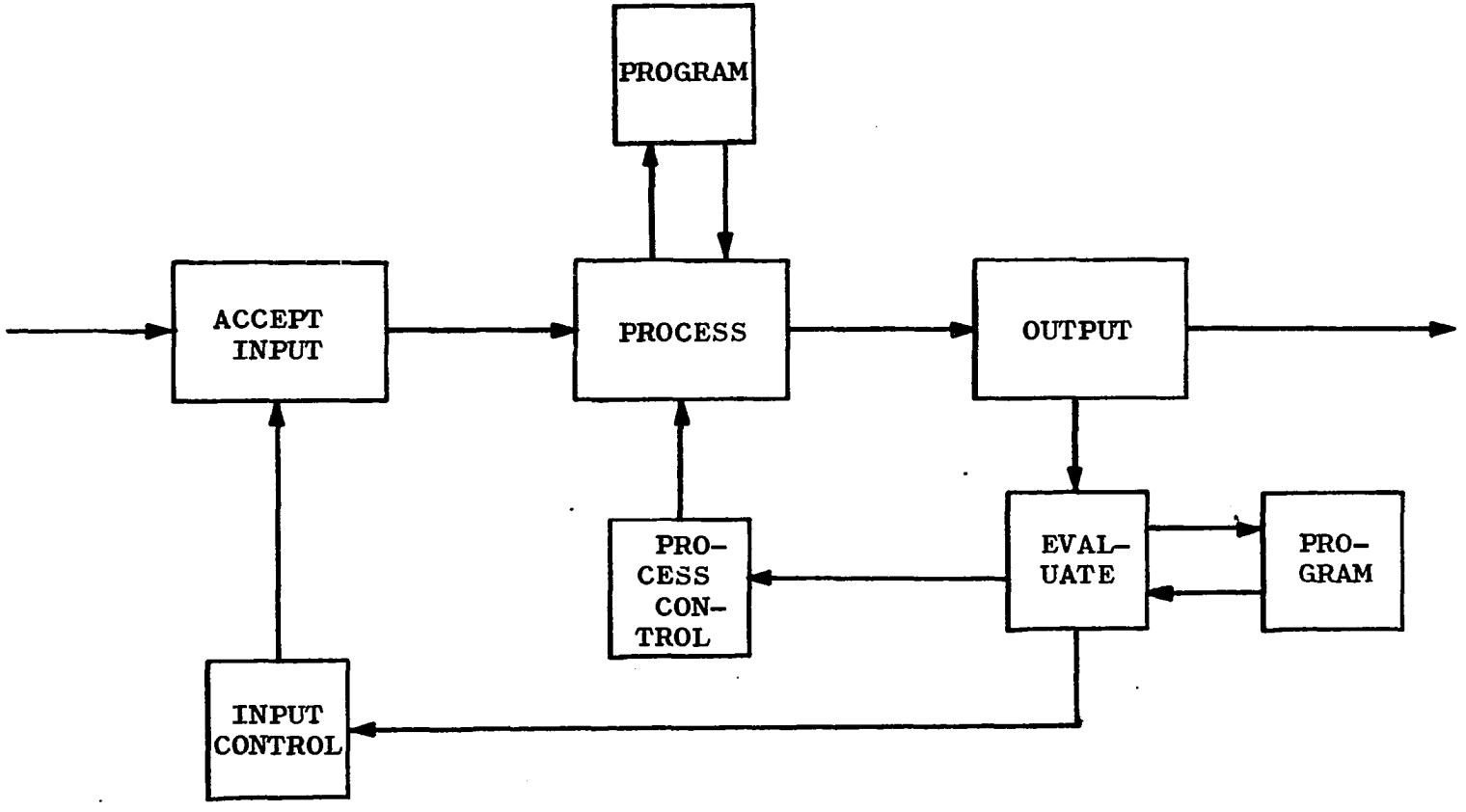


Figure 3. Stereotypic System.

evaluative and program module in order to maintain consistent output. It is the usual case that the output is indirectly controlled by the program acting on the input and processing functions.

Input control is basically a selective operation, that is, blocking or filtering to control rate or amount, quality or type of input. The input may consist of physical objects, energy, or information.

Process control implies (a) action to change the state of the system[1] (e.g., temperature, order, arrangement) and (b) action to change the functioning (rate, sequence, direction of motion). The process function is usually an active one, involving some reaction to or action upon the input.

The output may be any type of "goal" from a product to an intangible state or event. The object may be arrival at a destination, the definition of which serves as the initial input. In this case the goal of the system is not predetermined, but is stated for each use. The system may be flexible, in other words, as to statement of objectives, assuming that the objective is one of a set of feasible operational objectives, but the processes engaged to achieve the goal may be standardized or routine.

In a man/machine control system, the operator controls

---

[1]This is a somewhat unconventional usage of "state of the system."

the system with the aid of varying degrees of automatic feedback. In this case some portions of the programming may be stored in the memory of the human operator. If full training is not feasible, then manuals, job aids, policy statements (heuristics) may be used to complete the program function.

The monitoring function may be continuous or in the form of special measures (spot checks or sampling), or a combination of the two modes. Monitoring is usually performed on the output, but may be applied at any of the points or a combination of them.

It has long been assumed that the environment influences human behavior, but the mechanisms are not fully understood. Much research has gone into establishing proper environmental ranges of the more directly quantifiable variables such as heat, light, space for movement, etc., which have measurable physiological correlates. The social environment has also been studied for its effect on behavior, e.g., experiments in "social facilitation;" and the interaction of social and physical environment is considered in "proxemics" or "personal space" investigations. The field of environmental psychology is concerned with the effect of environmental structure, esthetics, and other physical elements on the attitudes, mental state and behavior of the inhabitant.

At the simplest level, the structure of the environment serves to constrain the behavior of the inhabitant, or, in other words, forces him to include certain constraints in

his self-programming. In this sense, the environment is a black box acting on the user (who is also a black box); although this control is not exerted actively and seems to function in ambiguous ways.

Characteristics of Passive Systems

What is referred to for the purpose of this study as a passive system is the result of the interaction between a human operator (user) and a man-made structure. The structure is assumed to be tangible and to display some degree of patterning or conceptual organization indicative of planning. The structure is not active but provides an environment within which the operator pursues an objective. Although the structure will have some degree of specificity of function, or expected usage, it will admit a variety of individual goals, including, in most cases, inappropriate ones.

To clarify the discussion from this point some operational definitions would be appropriate:

Environment will be used to specify the internal environment of the system (the man-made structure); surroundings will designate the external environment.

A component is any item in the environment--a book, partition, door, etc.

A facility is any composite element or grouping of components installed for the use of, or aid of, the human operator. Examples are coin-operated copy machines, groups of books on the shelves, the public catalog. The distinguishing

characteristic is that a facility is unmanned.

A service is a manned facility, such as an information desk, a loan desk, a staffed copy service. The activities of the staff in aid of the patron (directly or indirectly) are the products of the service.

The input to the system is the user. He brings with him the goal of his use. To the extent that he understands the system he is self-programming. The user receives signals from the environment; the signals are transduced, ultimately, into behavior. However, the signals may be erroneously interpreted, ignored, or not received under some conditions.

The environment, by its structure, contains an implied program and/or set of feasible operational objectives. These constraints are invariant regardless of the objective, the degree of need, or the qualifications of the operator.

Although the operator does not directly control the environment he becomes a component of the system as it influences other users. That is, he imposes additional constraints on others by increasing congestion, disordering components, etc.

Looking at the car and driver as a user unit of the network of streets and highways, it is apparent that although the street is passive, it restrains the actions of the driver into an implied program. The street network offers optional paths to the destination and the driver chooses from the alternatives one that will minimize time or effort, or enhance

his pleasure in making the trip.

The driver is probably unaware of all of the possible alternatives open to him; the library user, likewise, is unaware of the multiple channels of information. When the library user desires many items relating to the same topic but only locates a few, there is no feedback to enable him to estimate the probable number remaining or the time required to locate them.

Management usually assumes that the users of passive systems are all equally qualified. This is an operational decision only, and is forced because a passive system does not easily admit the programming function. The reasons are several: (a) there is no selectivity as to whom is admitted to the system (lack of input control); (b) there is a high degree of goal uncertainty, and qualifications vary for different use tasks, with the results that users tend to reject other than minimal or immediately relevant training; and (c) in most cases the use of the system is an instrumental objective and the performance may not be considered important so that, again, other than minimal training is rejected.

Environmental Programming

As every structure implies some use patterns (program), environmental programming represents an attempt to make the implied program more explicit, or to more explicitly consider the behavioral correlates of the design. The concept of such planning is not new; the practice, however, is still

in the formative stages and is hampered by the lack of underlying knowledge required for design.

For the purpose of this discussion the following distinctions will be made:

Environmental design will be considered as the overall field of knowledge concerned with architectural, physiological and psychological factors involved in creation of structures to house human activities.

Environmental engineering is defined as the consideration of human factors necessary to ensure minimal performance within the environment including heat, light and other physical variables with established physiological correlates.

With regard to library environmental engineering, Metcalf's standard work on academic library buildings and equipment (1965) is admirably supplemented by his work on library lighting (1970) although this latter book may be somewhat dated in view of recent trends. The ergonomic viewpoint is well presented, although briefly, by McCarthy (1964) whose work should be considered with that of Metcalf.

Environmental programming is the attempt to direct behavior in a passive system, both by tactical and strategic arrangements and allocation of facilities.

"Environmental programming" is encountered occasionally in the literature; however, it is not a standardized term. Programming in a literal sense is defined as systematic planning so as to provide automatic solutions to anticipated problems. Obviously, in a passive system with lack

of direct control any programming will tend to be heuristic rather than algorithmic; that is, the use-path or sequence of decisions, actions and events cannot be rigidly defined.

To direct the use-path, the planner may either constrain or allow. The absence of direct control and feedback reduces "Thou shall" to "Thou may;" and "Thou shall not" becomes "Please don't." In the absence of actual physical barriers the users are constrained only by their implied consent in using the structure, just as there is no certainty that a driver will not cross an intersection against a red light.

Eastman and Harper (1971) give the following two goals for "behavioral planning:"

> To encourage existing propensities of users by providing support for the anticipated activities of all peoples. This goal maximizes <u>behavioral freedom</u>. When considering how people allocate themselves in space the attempt to maximize the value of space to each user and thus allocate support in proportion to users is an example of this objective.
>
> To encourage some activities while discouraging others through the support or non-support of various activities. In this way, the designer <u>channels behavior</u>. (Italics theirs.)

Not stated is the problem that an activity may be automatically restricted if it is unanticipated and there has been no appropriate spatial or equipment allocation.

Osmond (1970) restates these goals as the "preservation and limitation of choice," and adds "the reduction of ambiguity and uncertainty" as further refinement of his design goals. He turns around the architectural dictum of "Form

follows function," with his statement "Structure will determine function unless function alters structure."

Christopher Alexander has stirred much interest among architects with his theories of objective design methods, first presented in Notes on the Synthesis of Form (1964). The brief presentation of his approach to environmental programming that follows is drawn from that work and the article expanding on that presentation by Alexander and Poyner (1970). He says that given a clear building program stating what the desired building is supposed to "do," there still is little knowledge imparted regarding what the building must be like to meet the specifications, or of whether the specifications are "proper." He proposes to put design on a factual basis by studying the needs of the building users.

Needs, as Perin (1970) among others has pointed out, are those "totally nonoperable adjectives" such as "comfortable," "efficient," and so on. Alexander proposes to observe tendencies, replacing "needs" with "what people are trying to do." A tendency is defined as an operational version of a need. In other words, Alexander proposes to bring a behavioristic approach to design.

He asserts that a "good environment is not so much one that meets needs as one that allows men to meet needs for themselves." If this is true, then what is the role of the designer? "Under certain conditions tendencies conflict,"

he points out; "Under these circumstances the environment does need design." A good environment, then, is one in which the potentials for conflict have been reduced to a minimum.

Alexander considers conflicts between users' tendencies and management's objectives, between two or more users' tendencies, and conflicts occurring internally to one user.

He is attempting, in most cases, to serve behavior rather than shape it by allowing tendencies to be expressed rather than suppressed. However, serving behavior is often difficult. Simple provision of physical facilities is often not enough, as has been pointed out by Sommer in his various articles, by Deasy (1968) in his article about designing a "park" in conjunction with an office building, etc. For example, in some older libraries when the stacks were opened to public use, carrels were located in the stack area to facilitate reading close to the shelves where the books were stored. However, the lighting and ventilation in these old stacks was often so poor as to discourage the patron's staying for any length of time; that is, his tendency to remain near the shelves to read was overcome by his tendency to escape from the poor environment.

Three modes of environmental programming can be identified:

1. Use of physical constraints that will block movement, vision and auditory transmission or intrusion (partitions, doors, intervening placement of various blocking components)

and/or the provision or lack of certain components required for the efficient performance of certain tasks or activities (tables, chairs, etc.).

2. Use of display and arrangement for display purposes to provide information in support of certain activities, for example:
   a. Display of components or surrogates of the components.
   b. Arrangement of components in such a way that the arrangement acts as a mediating factor to the user.
3. Use of arrangement to reduce length of the use paths associated with specified tasks. The technique of link analysis is based on the previously discussed principles of frequency and sequence of use and is employed to reduce the effort required of operators.

The first mode is more or less self-evident; staff members and users may require privacy and protection from interruptions in many tasks, and require seating or other equipment in order to perform their tasks.

The second mode is primarily an information transfer problem, usually in support of the user's objectives, although signs may also present prohibitions (e.g., "no smoking").

Ideally, the environment with no spatial compromises would display every significant system component to the user upon his entering. In larger systems this is obviously infeasible, but it is still a valid design goal. Some smaller libraries have very nearly achieved this condition. When

faced with the usual library building, a collection of boxes dropped in a larger box, the manager must simply attempt to anticipate the directional information needs at various points and provide for them with surrogate displays and/or a service point to handle questions.

One prominent example of environmental programming by arrangement is the use of arrays (ordered sequences) as an aid to cognitive mapping. City planners frequently use this technique in naming streets in an array by alphabetical or numerical order. In the library, the basic call number array is often grouped into sub-arrays by broad subject disciplines, much as a city will designate quadrants for street numbering, although in this case, the "quadrants" are usually somewhat fragmented. The expected results are that (a) the user can more easily orient himself without recourse to detailed maps or other aids, and (b) the cost of use of materials is reduced by bringing together related items.

The overall goals of the environmental programmer are analogous to those proposed by Crawford (1962) for the training subsystem; paraphrasing, and slightly expanding Crawford's statements:

1. increased proficiency of users, or regularizing behavior at some specified level of performance
2. decreasing time and cost to learn the system's characteristics
3. decreased aptitude requirements.

However, the problem of training users of a passive system is analogous to the advertiser's problem of identifying the potential market for a new product and directing his communications to its members.

Limits of Environmental Programming

Handler (1972) comments that the assumption that human performance is functionally dependent on the arrangement of a structure implies that performance varies directly with the expenditure of energy and the ease of communication. He challenges this physical determinism saying that experiments have not shown unambiguous results except in short-term and stress situations; only when the institutions have properly motivated the individual operators will their performance be enhanced by a properly designed environment. Obviously, he continues, there are cases where an outmoded building serves as a straightjacket, but institutions usually modify buildings to serve their own purposes within feasible limits or adapt to the constraints.

Rusch (1972) dismisses the idea that an environment can be "therapeutic"[2] in any significant way or that it can influence group dynamics. The designer can reduce conflicts between desired patterns of use and the physical environment; this does not reduce personal conflicts. He adds, "We

---

[2]Much of the reported research has been done in hospitals and homes for the aged where, for example, seating has been rearranged to encourage social interaction, etc.

perceptually structure our environment much more than it structures us." The object of a person's attention at any given moment has little to do with the design of the physical environment; however, those responses which can in some way be controlled by design are those outside of consciousness. This minimal control is dependent upon the tacit consent of the inhabitants. Rusch concludes that even if the feasibility of such control can be demonstrated the designer must reject it on moral grounds and seek only to serve prior behavior.

The statement by Rusch about "responses . . . outside of consciousness" implies that subliminal perception is the available controlling mechanism. Dixon (1971) reviewed the literature in psychology extensively in his work on this topic. He came to the conclusion that subliminal perception may, under certain conditions, direct overt behavior in the absence of strong, prior habit structures or contrary drive states. The effect is the greatest when the subject is relaxed and passive and the stimulus is well below the threshold of awareness. By and large, the effects possible with this mechanism are uncertain and the user of a passive system is assumed to be active (at least, in the proposed experimental situation) so that the conditions for subliminal influences are less than ideal.

It is unreasonable to assume that a large and complex library can be so arranged and the components so displayed

that all uncertainty is reduced for the user. Also, the structure of the access tools is beyond the library's control and will continue to provide frustrations to the users; the operational decisions will still have to be made. These decisions are not susceptible, by and large, to being aided by environmental programming techniques. So, after the best possible arrangement there will still remain ambiguities for which the only recourse is to provide reference services.

The service itself, however, may reach a greater number of users if it is positioned appropriately. This consideration is the topic of the next chapter.

CHAPTER IV

MODEL OF THE USE OF REFERENCE SERVICE

Considering reference service as a product to be merchandised, the following axiomatic model of non-use of the service has been adapted from various sources in marketing literature.

The library patron who does not use reference service:

1. does not need the service.
2. is unaware of the service.
3. does not understand that the function of the service is applicable to his problem.
4. cannot locate the service, at least, in what he considers a reasonable amount of time.
5. does not expect the service to provide a worthwhile product or prefers a competitive source of information.

The second case is a system failure; the service requires a better display and/or more surrogate displays to direct the user's attention to the service point. Following Line (1966), this unawareness probably indicates a need for more public relations effort.

The third case is similar to the second, but involves the functional identity of the service instead of the location.

This case is partially susceptible to environmental manipulation; for example, the language attributes of the service may not imply the function to the user, or the sign may be located so that it is not clearly related to the service.

The fourth case assumes that the user is aware of the probable existence of the service and its function, but either (a) the service is not perceived as such, or (b) the area served is large and the service is not in the immediate vicinity.

The first case need not concern the environmental planner; the last one has to do with the quality of service or the attitudes toward the institution, and no amount of environmental manipulation can overcome bad staffing or poor public relations.

To illustrate a few of these points, I will call on an example from personal experience. The reference room at a western university was laid out as shown roughly in Figure 4; this diagram is not to scale. The signs identifying the two reference points (A and B) were suspended from the ceiling, and, while large enough to be read from all vantage points, they were so high that even some of the librarians failed to notice them for a few days after installation. The result was that the desks were not identified clearly with any language attributes.

Desk A was flanked by a bookcase, a planter and the call number location chart--free-standing, about six feet

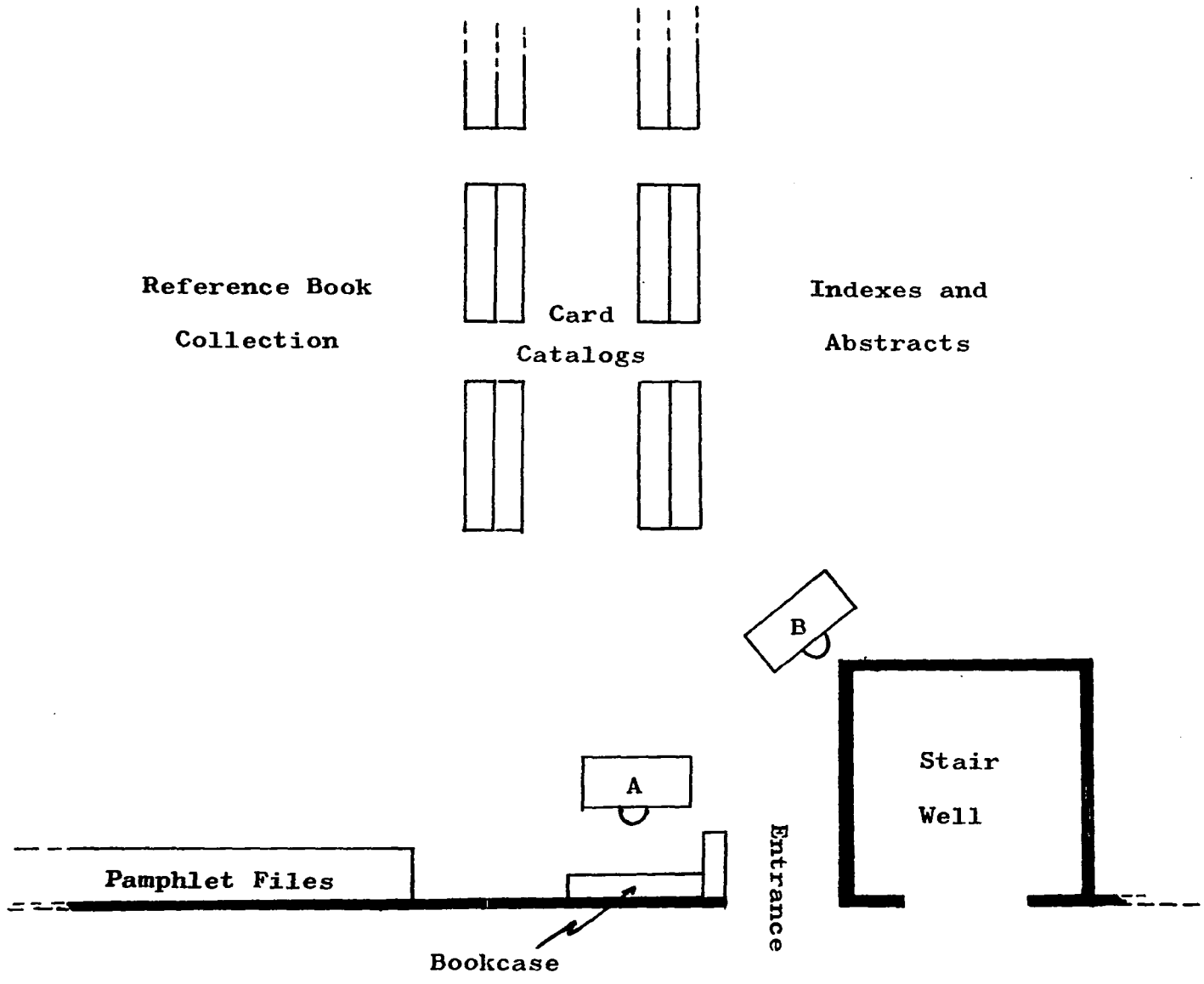


Figure 4. Reference room in a western university library.

high. Desk B was very plain and had no shelves or other attributes nearby.

While the reference teams were on duty the administrative instruction was that both desks were to be staffed. However, it was the common experience that Desk B was so little used that the second librarian usually ended up standing beside his partner at Desk A to handle questions. During occasional peak periods patrons would queue at Desk A, while the librarian at Desk B had no business.

Possible explanatory factors include the following: (a) Desk A predated Desk B by several weeks, so there may have been some degree of habit involved, but this would seem minimal; (b) Desk B's function was ambiguous due to the lack of attributes symbolizing its identity; (3) as the majority of patrons began their exit path from the card catalog, the traffic pattern led them directly past Desk A, creating an interception pattern, that is, they could hardly fail to be aware of the position of the desk, and the cost of use was at a minimum.

Restating the model in a positive mode:

$$\text{Use} = \left[\text{Awareness} + \frac{\text{Need}}{\text{Cost}}\right] - \text{Irrational Factors.}$$

That is, assuming a need for the service, the user who is rationally pursuing a library problem will ask for assistance if (1) he is aware of the existence (location) and function (identity) of the service, and (2) the cost of use is low in relation to his degree of need.

The definition of "rational" or "irrational" action is difficult. See, for example, the discussion by Schoefler (1954). Nicosia, reviewing marketing models of consumer behavior, summarized his findings rather sarcastically: "At best, one may conclude that the class of 'rational orientation' includes only one variable: rationality; at worst this class is empty because, as long as we do not know the dimensions of rationality, one may say whatever the consumer does, he does it rationally."

In this problem, rationality will be considered as the absence of any personal or social constraints operating to induce the user to accept less than maximal performance. Proxemic factors could be considered as irrational in terms of this definition; they will be discussed below.

Need is also a difficult topic. Simon (1959) indicates that conditions for the satiation of need are set by aspiration. The latter factor varies based on experience and tends to adjust to the attainable. Menzel (1964) reiterates this point: "The expressed and conscious wants of individuals in any area are constrained by their perception of what is feasible." The third axiom in the first model, therefore, can limit the user's perception of his own need for information. Continuing with Simon's discussion, when performance fails to meet aspiration levels, aspiration falls to a more attainable level and adaptive behavior is initiated; if, however, satisfaction is still not obtained,

apathy or aggression will replace rational adaptive behavior and the task will be abandoned.

Due to the ambiguous nature of need, no attempt was made to measure it in this research project; the point is, simply, that less critical uncertainties will result in a request for information as the cost is reduced.

Assuming need for the service and concentrating on awareness and cost aspects, the following discussion will be in the order of the outline below:

A. Awareness

    1. Functional

        a. Prior awareness
        b. Perceptual variables

    2. Locational

        a. Prior awareness and perceptual variables

B. Cost

    1. Distance from point of need

    2. Social or psychological costs

C. Combination variables

Prior awareness of the functional identity of the service refers to the user's expectation that the service is provided. This expectation is based on prior experience in either the same or some other library. He may observe another person obtaining aid or hear about it from an acquaintance. Surrogate displays (signs, advertisements) may contribute to his awareness. There may still exist some uncertainty regarding the appropriateness of the service to his own

information need, however. In the experimental site a user can infer the location of the service on one floor by knowledge of another floor, as the floors are approximately congruous.

It seems reasonable to assume that most library users are aware, to some extent, of the availability of assistance (e.g., see Nelson, 1973); whether or not they request aid probably depends more upon the cost of approach and manner in which the service is displayed.

The perceptual elements involved can be broken into two classes: (1) attributes and (2) spatial relationships.

Attributes are any of the visible features or aspects of the facility housing the service, including language elements or signs attached to the facility. The use of the service would be expected to vary in relation to how well the functional identity is communicated, or symbolized, by the attributes. Arnheim stated:

> A percept will be classified instantaneously only if two conditions are met. The percept must define the object clearly and must resemble sufficiently the memory image of the appropriate category. . . . (1969)

An example of perceptual ambiguity in library design was given to the author by Mr. Ralph Funk, Oklahoma State Librarian (1973); in the Oklahoma Department of Libraries the entering patron is faced by a standard office desk clearly labeled "Reference Service;" this desk is located at the end of a long counter, waist high, which was provided specifically to shield the telephone switchboard from interruptions.

The experience has been diametric to the expected results, however, in that patrons tend to ignore the desk and, instead approach the counter to ask questions; the switchboard operator then must refer them to the librarian at the desk.

With regard to locational awareness the spatial relationships between the service and the facilities to be supported may be considered as a perceptual element rather than a cost element; that is, a service located near a facility is more likely to receive questions dealing with the facility than is one located at some distance from the supported facility due to the increased likelihood of conceptual association of the service and the nearby facility. The orientation of the service relative to a facility could also exert some influence it would seem; a service facing away from a given facility might tend to indicate non-support of that facility in the absence of other cues.

It would be very difficult if not impossible to separate the effects of these aspects of proximity from the cost aspects in an experiment that attempted to maintain the field approach of non-disturbance of the environment. The influence of proximity on the perception of identity is probably minimal, but uncertain in any case.

Given adequate functional identity, the prior awareness of the location of the service is a matter of display and perceptual factors. The position of the service relative to a major traffic flow or an obligatory point in the traffic

pattern might enhance the probability of the user being aware of the location of the service when he experiences uncertainty. Alternatively, placing the service so that it is visible to a user at any point where he is likely to encounter a problem would provide a display at the time when the user is ready to perceive the service, that is, at the point in time when the service becomes relevant to his task. Given a spatial mapping of problems encountered by users, the variable of visibility of the service could be used in a manner similar to a link analysis to locate the service optimally in relation to the greatest concentrations of uncertainty.

Cost will be considered primarily as distance to be traveled in order to initiate the reference interface. This is, more properly, the cost of approach rather than the cost of use; the latter term would include queue time, and the actual negotiation for the information, etc.

The social and psychological costs are primarily functions of personality types; one type of social constraint, that of proxemic or personal space factors, has been shown to be a strong behavioral influence (Sommer, 1969). The main concern in this respect applying to the experimental situation is that if the placement of services is such that the patron approaching the service is required to invade the librarian's personal space, this would be expected to deter the use of the service.

The idea of traffic focus, or, as it was previously

discussed, "interceptiveness," incorporates aspects of both cost and awareness. The cost is presumably reduced by placement near a high probability traffic path, and the awareness should be enhanced by exposure to a large number of possible users. In short, the variable of traffic focus is an extension of the idea of reference service as an impulse good to be merchandised in the appropriate manner.

In the experiment to be described in Chapter VI, variables relating to the factors mentioned in the foregoing discussion were manipulated at different levels to attempt to judge the effectiveness of each in improving the use of reference services. The variables fall into three categories:

1. Visibility of the service within the administrative area served,
2. Cost of approaching the service from all points within the administrative area served, and
3. The traffic focus of the service location.

CHAPTER V

REVIEW OF THE LITERATURE

Introduction

The following general topics will be discussed below:

1. Feasible generalizations about library use patterns.
2. Awareness of reference services.
3. Measuring the use of reference services.
4. Measures of central tendency.

The primary emphasis in this review is on the library literature including relevant materials from the related field of information science.

The literature of human communications was briefly surveyed but seemed largely inappropriate because the paradigm of this discipline assumes an active "sender" while a library environment is passive.

Material was found in the literature of marketing that was, at least, suggestive; these articles have been mentioned in previous sections.

The literature of human perception was also found to be suggestive but lacking in hard data that would be applicable to the experimental situation. Specifically, the hope had been to obtain a definition of the field of

vision during movement that could be related to the variable of traffic focus, however, rather than make tenuous extensions or interpretations of the conclusions of researchers in this field, the variable was defined in operational terms.

Library Use Patterns

The studies of library usage, with some notable exceptions, were found to be repetitive, exploratory and statistically naive. As most of the information is either peripheral to the topic at hand, or not susceptible to generalization, only an overview is presented. Two comprehensive literature surveys have been very helpful to this writer: Bates (1971) in a bibliographic essay covered 181 selected papers published in English prior to 1969; Wood (1970) reviewed more than 100 use studies published from 1966-1970, but even more critically and with less discussion--he complains that most of those he read should not have been published.

The discussion below is presented as a set of generalizations each of which is followed by an examination of supporting literature.

1. A large part of the variation in library use between campuses and on the same campus can be attributed to teaching methods and faculty attitude.

The two classic studies in this area are those by McDiarmid and Knapp. Both were originally done as dissertations; I have adapted the following discussion from other sources.

McDiarmid (1935) studied library use at seven college campuses during the Spring semester of 1932-33. A record of all titles borrowed by students was made and records were supplied by the college administrations relating to the students' grades, etc. From this data McDiarmid concluded that women are heavier readers than men (this was found by researchers on other campuses also); that the use of library books varies directly with class standing, although he relates this to a similarly increasing gradepoint average; and, that there was no significant correlation between the number of titles checked out and the GPA during the semester.

The most interesting finding, and, one that has not been replicated to my knowledge (Bates concurs) is that "Institutional differences outweigh class, sex, and scholarship differences." He concludes:

> . . . that institutional objectives, methods of instruction, and provisions for library service are more important in determining the extent to which students use the library than such factors as the distribution of the student body into class and sex groups.

McDiarmid rejects the contention of most of the more recent writers that students will not read unless required to by noting that "At certain institutions most students read widely, and at all institutions some students read widely. . . ."

Knapp (1959) performed her research at Knox College in Galesburg, Illinois, in the spring of 1954. Among her conclusions:

(a) More than 90 percent of the circulation of library materials was stimulated by courses.

(b) One-fourth of the courses on campus accounted for almost 90 percent of the circulation.

(c) Less than one-tenth of the courses stimulated four out of five of the enrolled students to use library books.

(d) The only decisive factor in the "library dependent" courses was the instructor's attitude--the students used the library when he expected and planned for it.

(e) Almost invariably, the students' use of the library was less than the instructor had planned for.

Other studies that tend to confirm Knapp's conclusions include Lubans (1971) and a tightly controlled experiment by Long (1967) at Minnesota University; in the latter case the author concluded: "A student's registration in one quarter in a course with substantial library referral had no effect on his library use or course grade in the following quarter."

These conclusions appear fairly clear cut, but none of the authors have considered the effect of the library environment on use. That is, the students may avoid the library until forced to use it by class assignments because it provides an unpleasant environment or the cost of use is high. These factors are discussed in the next two generalizations.

2. The cost of use is a highly significant factor in determining use of an information system.

Wood (1971) provides a striking example of the effect of location of a library on the source of its users; fully half of the users of the (British) National Reference Library came from within a mile of the institution and "only 2 percent worked outside the South East of England." Significant effects of distance were reported by Campbell and Metzner (1950) with respect to public libraries and Haas (1962) for academic users of all types of libraries in the New York City metropolitan area.

Rosenberg (1967) is representative of the information science approach; his study confirmed the principle of least effort in information gathering.

> Research and nonresearch professional personnel in industry and government do not differ to any appreciable extent in their evaluation of information gathering methods; and the preference for a given method reflects the estimated ease of use of the method rather than the amount of information expected.

While the studies of public library use tend toward simple distance as the cost measure, the information scientists usually include other measures of convenience. In the case of academic library use studies, with the exception of Haas', there is little consideration of use/non-use figures in relation to the areal distribution of student population or proportion of commuters, etc. It does seem clear, however, that the distance between origin and the library is a strong influence on the decision to use in the

macro-environment. Internal studies of the influence of cost on the use of components have not been encountered. One paper is suggestive, however: Slater (1963) gathered "impressions" regarding use from personal observation and comment of librarians. She found one library which had been shifted from "a site actually within the works to the administrative block, about three minutes' walk away." Following the move the use of the facility dropped off, and the type of user changed from primarily technicians to administrative personnel.

3. Facilities and "atmosphere" probably influence use or choice of competing environments.

Rarely does an academic user have a choice of libraries, but a study conducted in New York City in the spring of 1960 (Haas, 1962) studied such a case. The sample consisted of 2.5 percent of the 200,000 students in the area, and the research dealt with their "migratory" use of libraries other than the ones on the "home campus." The principle of least cost (distance) was confirmed as the overriding factor in choice of library used; the second most important factor was the adequacy of the collection; and among the secondary influences were facilities and services including open stacks, skilled staff and comfortable surroundings.

Slater (1963) wrote of the influence of aesthetics on use of industrial libraries:

> The more modern and attractive libraries seem to draw custom irrespective of size of collections or

> status of library staff. In some cases the less exploited libraries had large and appropriate subject collections, and a large number of people in the firm who should have found some use for them. But these libraries lacked comfort and visual appeal, and were sometimes also understaffed.

Most other evidence for this conclusion is indirect. The studies by Sommer (1970) and The Committee for New College (1960) dealing with, what Sommer called, the ecology of studying are suggestive. The advantages of various locations in both studies fall into the expected categories of convenience, quiet, comfort and availability of snacks, smoking facilities, and so on. The Committee's report states: "The most significant finding . . . is that for most students, use and approval of study space vary inversely with size." Sommer, however, found that within the library about one-half of the students preferred open spaces with tables and chairs over carrels and isolated stacks locations; they were apparently better motivated when in the presence of others engaged in similar activities.

In attempting to reconcile what could be social or temporal differences in the two sets of findings reviewed above, it appears to me that the Committee may have erroneously attributed the contributions of some variables; they did note the important influence of cost, but no indication is given of the relative costs of use or relative comfort of competing sites. In both studies a comparison of between campus variation and investigation of facilities differences would have been valuable. Sommer's conclusion,

in any case, is more cautious; he says that there is no ideal study environment--what is needed is a variety of facilities.

An example of his contention is found in Estabrook and Sommer (1966) where the authors related study habits to extroversion/introversion scales. Extroverts preferred couches and beds for studying while introverts preferred tables or desks. Extroverts also considered the availability of snacks to be important during study periods.

In short, the population of any given site is unlikely to be representative of the general population at large, as a site will appeal to only certain segments of the general population.

4. <u>It seems feasible to regard the use patterns on any given campus as more or less persistent, or only slowly changing, if other factors are relatively constant</u>.

This is a seldomly studied topic; information regarding persistence of use patterns was encountered usually as a by-product of studies with other primary foci. Only the study by Line (1966), previously mentioned, was found to consider change in patterns after an attempt to improve use of services.

Barkey's article (1965) provides an example of data obtained for other reasons. Student usage at Eastern Illinois University was studied for thirty days in the spring of 1962. The finding that 63 percent of the students on campus did not use the library during that period proved so

disturbing that the experimenter retested in the fall semester of 1963. Enrollment was larger by nearly 1000 students in the second survey, but the non-use figure obtained was 62 percent, indicating a relatively constant pattern. In both cases the proportion of use was inverse to the usual findings relating to class standing in that use fell off with higher class status, dropping from 44 percent of the freshmen to only 28 percent of the graduates.

The users of the four largest libraries on the campus of the Massachusetts Institute of Technology were studied by Nicholson and Bartlett (1962) in terms of population make-up and purpose of use. Although the study was very poorly controlled for cyclical variation, the authors concluded that "the pattern of use of our libraries remained relatively unchanged over an eighteen-month period."

Steig (1942), in an article on the pitfalls of using circulation records as a measure of library use, pointed out a persistent pattern for students at Hamilton College to withdraw more books during the second semester than the first in both of two years.

Patterns of use of materials by subjects have been of increasing interest in recent years as more libraries find themselves in cramped quarters. Although of somewhat peripheral concern to the topic of this paper, one example will be mentioned to buttress the contention of persistence of use. The classic study of this type is that by Fussler and

Simon (1969). They undertook to answer the question, "Will any kind of statistical procedure predict with reasonable accuracy the frequencies with which groups of books with defined characteristics are likely to be used? . . ." Their conclusion was somewhat hedged, but, "The variable of past use is sufficiently powerful that for libraries with twenty year use records the objective characteristics make little further contribution."

Awareness of Reference Services

Nelson (1973) sampled 30 percent of the faculties at six California state colleges with a questionnaire asking about the local availability of 13 reference services, eleven of which were available on all of the campuses. Persons sampled were generally aware of about one-half of the standard services. Faculty awareness increased with increasing frequency of use of the services, length of tenure on their specific campuses, and faculty rank. Humanities and education faculties were more aware of library services; science faculties rated lowest in awareness. As a whole, the between campus variation was insignificant except at one school where the library staff had a tradition of interacting and communicating aggresively with the faculty. Still, even at the "best" campus some "less visible" services were not well known.

Of the eleven regularly provided services the awareness levels were as follows (abridged from Nelson's Table 1):

Advice and assistance in library use	95%
Library bulletins and handbooks	74%
Library instruction for classes	65%
Lists of reference sources for classes	17%
Bibliographies for general distribution	38%
Vertical (pamphlet) files	40%
Interlibrary lending	85%
Answers to factual questions	61%
Answers to factual questions by phone	36%
Answers which require a search	22%
Answers requiring contacts outside the library	40%

Nelson concludes that "universality of demand for service and the ease with which it can be provided . . . seem to affect awareness." He also found that both the number of people who (a) approve of a service and (b) those who desire a specific service are larger than those who are aware of the prior existence of the service.

Measuring Use of Reference Service

Rothstein (1964) performed an extensive literature review covering "the measurement and evaluation of reference services." He notes that "most reference librarians have remained unconvinced of the worth of such studies and uncertain in their methodology."

He also points out that the bulk of such studies have been reported by public libraries. "The reference service of college and university, school, and special libraries has been subjected to very little quantitative analysis in any of its aspects other than inter-library loans. . . ."

His findings regarding measurement approaches reported in the literature are summarized below:

1. A simple tally of use of all types of "too crude to be meaningful" and is likely to be as much as 40 percent incomplete over time.
2. Classed tallies are often used, "none of which . . . has been considered wholly satisfactory." This approach includes:
   a. Time taken in answering questions as a measure of the level of complexity.
   b. Type of question ranging from "directional" through "ready reference" to "reader's advisory and search." The traditional orientation of reference librarians, however, often results in the directional class being omitted from consideration "as not really calling for any professional skill."
   c. Classification by subject, primarily of value in establishing criteria for training of librarians or establishing priorities for the purchase of reference books. Cole's study (1946) is a notable example of this approach and deserves replication.
   d. Various other categories such as "purpose served," or the materials used in locating the answers.

Rothstein points out that "none of these methods has been as yet sufficiently standardized to allow for reliable comparison of findings."

Although in the writer's opinion all questions asked at a service point are valuable, it is of interest to know

whether the relative proportions of types of questions vary from one treatment to another. For this reason, the personnel in the experiment were requested to class the questions they were asked in a manner similar to approach 2b above. Details of this scheme will appear in Chapter VI.

Measures of Areal Central Tendencies

In defining measurements of the cost of approach to a service within an area, some means of measuring and manipulating the spatial distribution of potential users must be found. Specifically, identification of an appropriate central-point measure seemed critical.

Hart (1954) reviewed the use and misuse of three measures of central tendency for areal distributions. His presentation is summarized below:

1. Mean Point: a center of gravity measure which can be treated algebraically and around which the "sum of rectangular deviations" equals zero. This measure is greatly affected by extreme points and any movement of population within the area.
2. Median Point: the center of the distribution disregarding distances, equally affected by all items in the distribution. This measure is relatively insensitive to movement of population within quadrants; diagonal quadrants are equal in value, but adjacent ones are not.
3. Point of Minimum Aggregate Travel: This is defined by Hart as "that point which can be reached by all items of

a distribution with the least total straight line travel for all items." Eells (1930) pointed out that the belief of at least 20 years standing that the median was the point of minimum aggregate travel was in error. Hart relates this measure to the mode of continuous distributions, which it resembles. He footnotes that the median does coincide with the point of minimum aggregate travel when travel routes are confined by a rectangular grid of roads or streets and the axes used to located the median are parallel to the grid structure.

Obviously, the point of minimum aggregate travel (abbreviated henceforth as PMAT) would be the proper measure to use "in selecting theoretically optimum locations for . . . service centers. . . ." (Hart, 1954) However, since in the library environment travel is confined by bookstacks and aisles laid out rectangularly, the median should coincide with the PMAT.

Deviation of the service point from the PMAT, or theoretically optimum location, would seem to be one appropriate measure of cost of approach. The means of quantifying a variable based on this measure will be given in the next chapter.

CHAPTER VI

THE EXPERIMENTAL SYSTEM

General Statement

The experiment which was undertaken was based on the proposition that a reference service would receive differing amounts of use if it were located at different positions within the environment. Within a library site three locations were chosen as service points, and a desk was moved among these positions. Each location was scheduled three times during each of two three-week time periods, or phases of investigation.

A one-week exploratory period prior to the first phase of experimentation demonstrated that the amount of variation in the make-up of the general population from one day to the next prohibited taking measures prior to the experiment from which to extrapolate for the period of experimentation. This finding conflicted with the expectations based on the literature search; had a longer time period been feasible for the investigation some of the variation would probably have smoothed out. However, since the experimentation was required to be completed within a short time period to avoid interference with the routines of the library staff,

all measures were made on a daily basis during each experimental period even though this constituted an environmental disturbance, the effects of which are difficult to evaluate.

Assumptions

The following assumptions were made for the purpose of this study:

1. The areal distribution of the population segment of media consumers (as opposed to study hall users) is proportional to the distribution of the total population within the experimental site.
2. Any media user is equally likely to encounter a problem or experience uncertainty in using the library and may be considered as a potential user of the reference service.
3. The probability of a user experiencing uncertainty is equal at any point within the site, if qualitative aspects of the uncertainty are ignored.

All these assumptions may be stated as: demand for the service is distributed within the site proportionally to the distribution of users.

Subjects

A subject was considered to be any media user on the floor during the experimental periods. Estimates of the proportion of study hall users in the general population range upward to 90 percent (Sommer, 1970). The number of media consumers was estimated from the head count of

persons entering the area during each experimental period and the proportion of potential uers indicated by the sampling with the survey instrument; this is discussed in more detail at a later point.

Equipment and Procedures

The experimental site was the second floor of the Bizzell Memorial Library on the University of Oklahoma campus. The floor plan, adapted from official blueprints, is represented in Figures 5 and 6. The materials on this floor relate to social sciences, education and library science.

The floor is divided down the center by a "main" aisle which runs between the two entrance areas. The main entrance, or the one preferred by the majority of users, is the staircase opposite the elevators. Both the back stairs and the elevators are seldom used, at least on this floor. The main aisle contains only some lounge furniture and two photocopiers, one of which was inoperable throughout both phases of experimentation.

The western half of the floor (see Figure 5) contains the reference offices, the E.R.I.C. collection and, immediately in front of the "work room" the reference collection and index tables. Study carrels are arranged around the walls, and other furniture is interspersed among the book stacks. The experimental reference service points are indicated on the floor plan by hexagons enclosing numerals.

The eastern side of the floor (see Figure 6) is

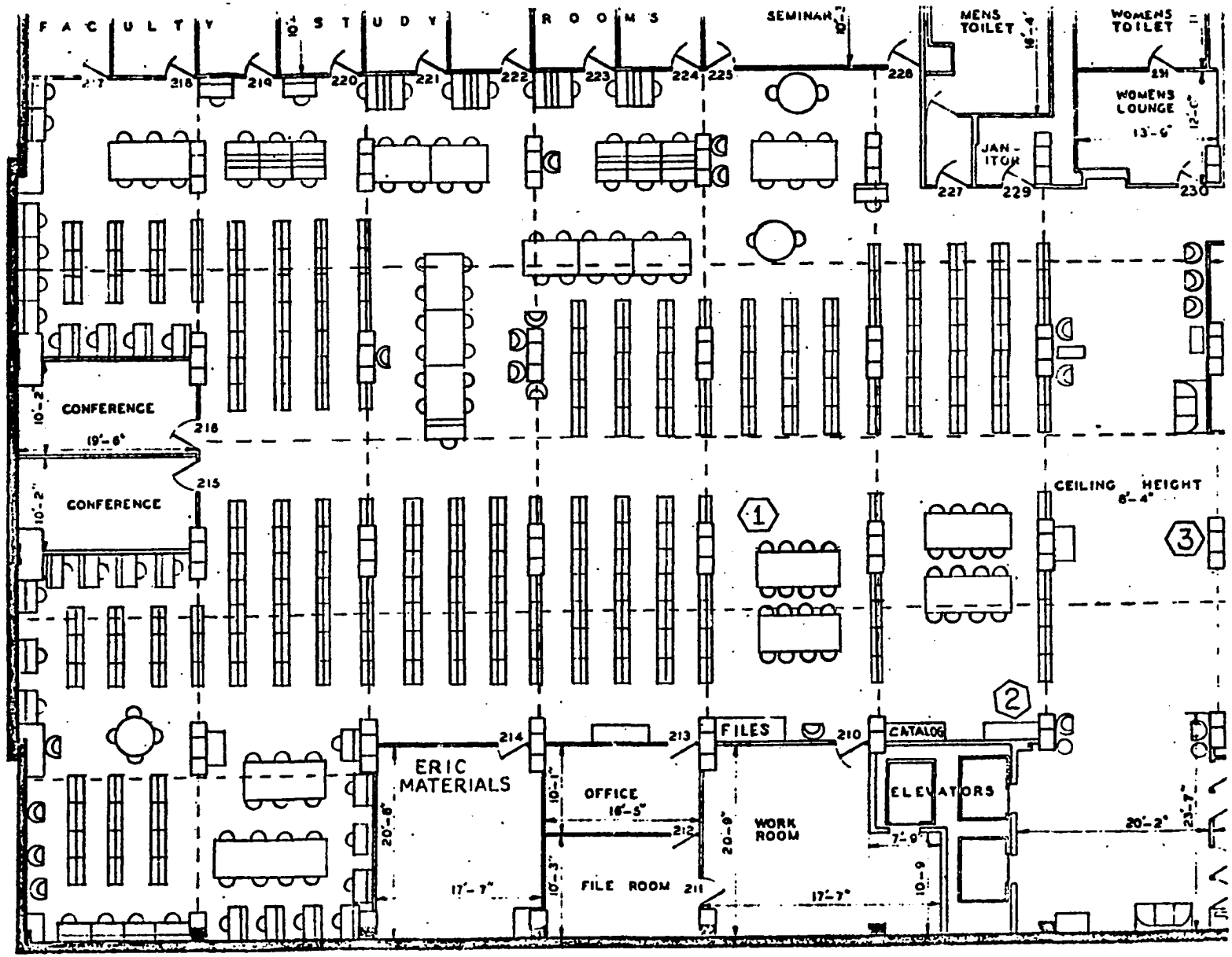


Figure 5. Experimental site: western one-half.

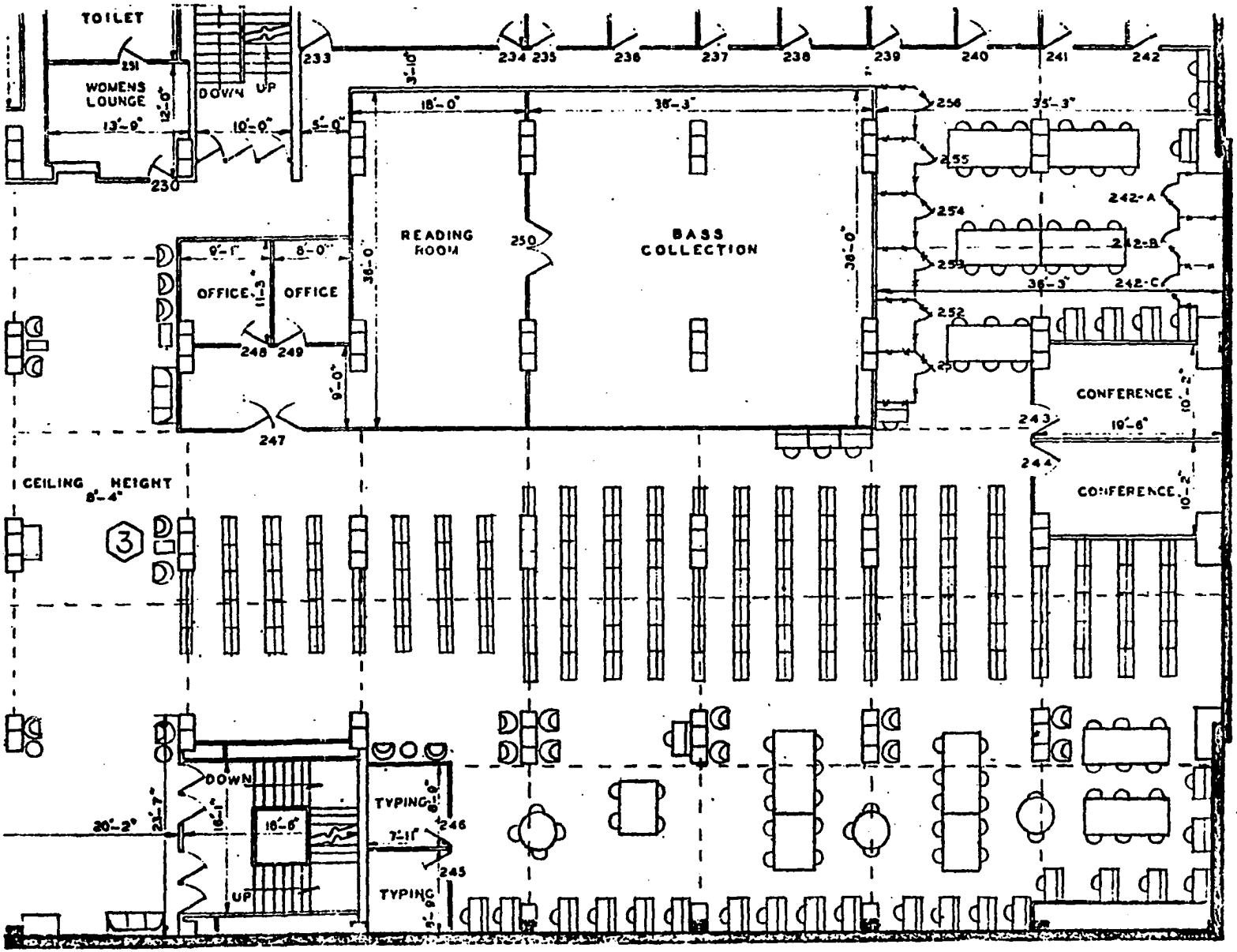


Figure 6. Experimental site: eastern one-half.

similar to the other half, except that the Bass Collection in Business History occupies a large interior office, and there are locked, cage carrels in the northeastern corner.

An important distinction between the two halves of the site is that the western side houses the more recent materials classified in the Library of Congress system, while the eastern side contains older books still in the Dewey Decimal Classification. For this reason, the majority of activity occurs in the western half with the other side serving largely as a study hall.

Faculty studies line the northern wall of the floor, this row being broken in the center by the back stairs and restrooms, flanked by two seminar rooms used, at least weekly, as classrooms.

Photographs presented in Figures 7-11 complete the description of the floor used for the experimental site.

The three experimental locations are illustrated in Figures 12-14. These photographs also serve to describe the desk used in the experiment; the attributes of this facility consisted of a sign reading "Library Assistance" in large black letters on a pale yellow sign board attached to the front of the desk and visible in all three figures. This sign did not photograph well, possibly because the sign board was laminated to protect it during the experiment.

The sign was 11" x 13"; the lettering was two inches high and had an average width of 1½". The Peters and Adams formula for determining letter size at given distances, as

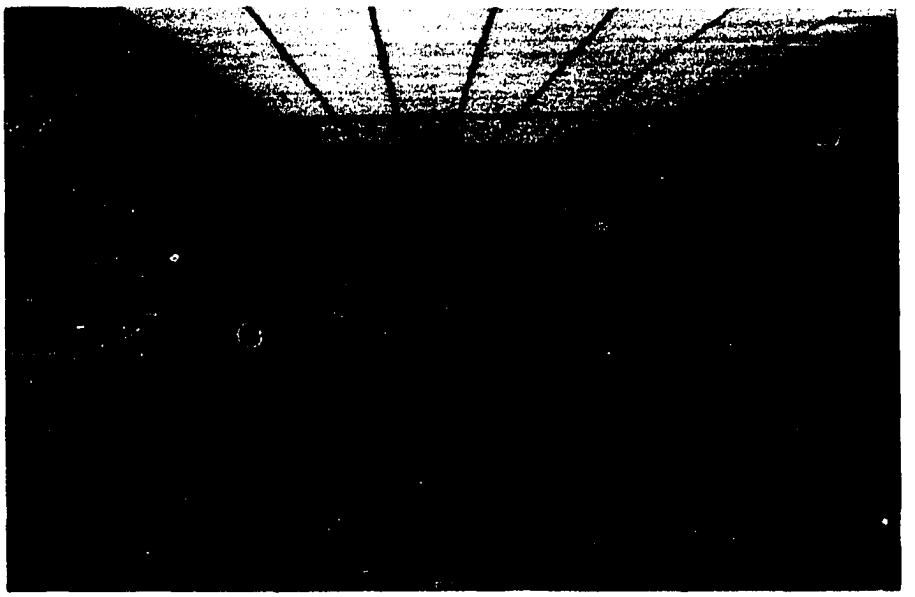


Figure 7. Users filling out survey instruments at the south end of the main aisle.

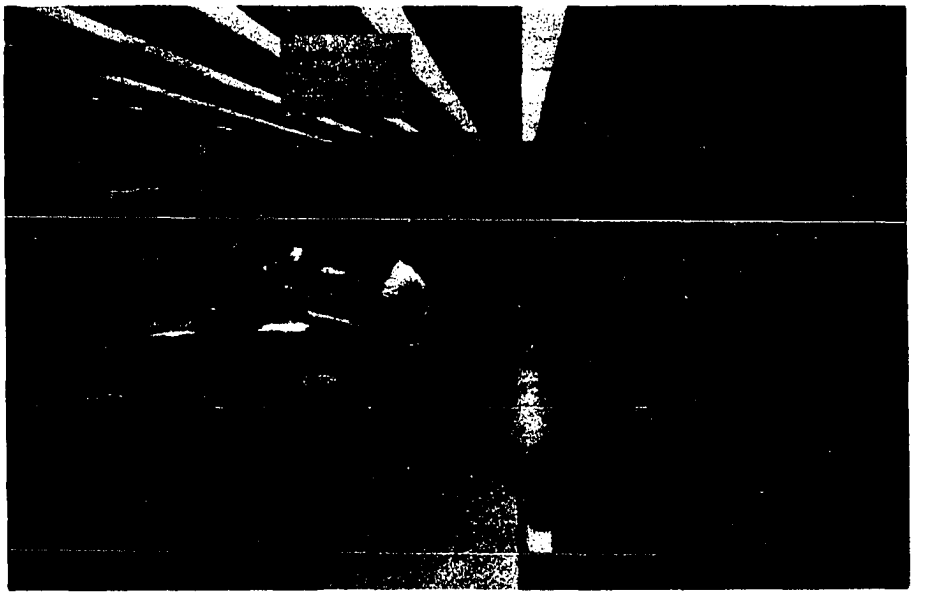


Figure 8. Experimental site: view toward the west in the northwest quadrant.

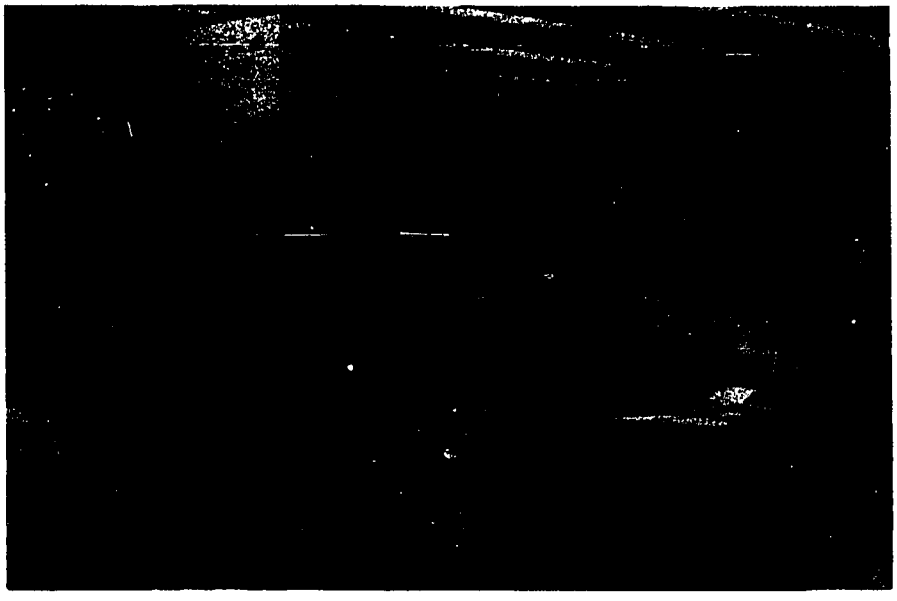


Figure 9. Experimental site: view of the northeast quadrant study area.

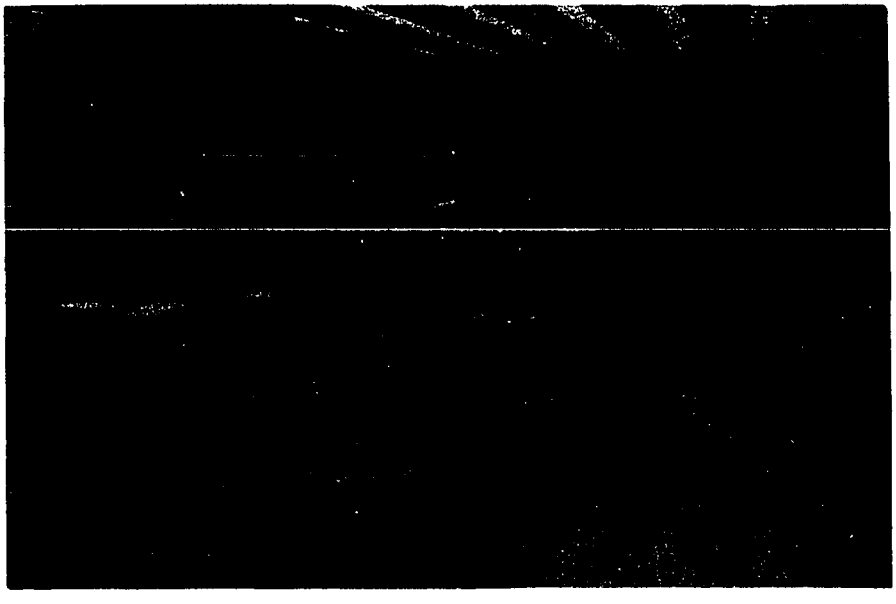


Figure 10. Experimental site: view toward the east of the study facilities in the southeast quadrant.

Figure 11. Experimental site: view of the office from which reference service is normally provided.

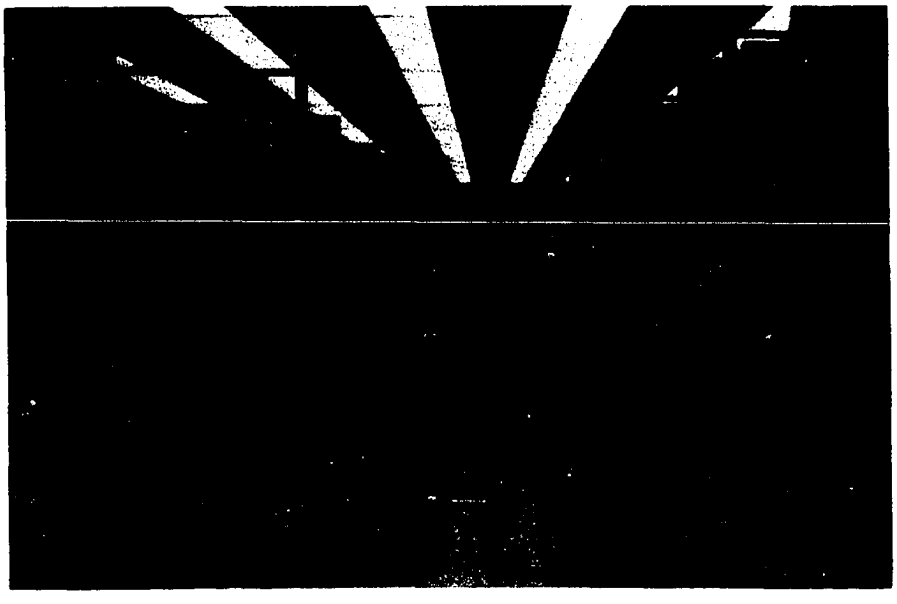


Figure 12. Desk location number one as seen from a point at the center of the floor in the main aisle.

Figure 13. Desk location number two as seen from the entry at the main stairs.

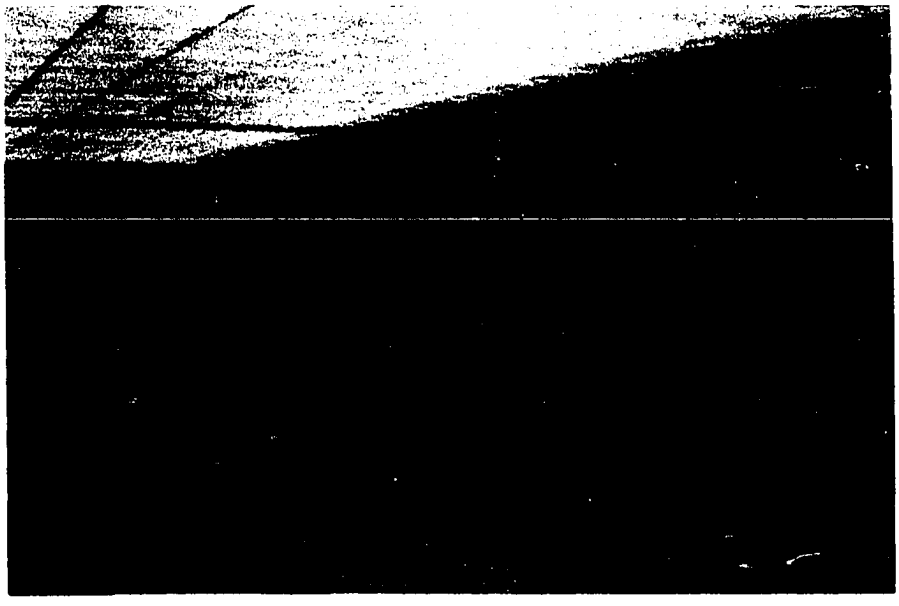


Figure 14. Desk location number three viewed from in front of the elevators.

described by McCormick (1970), was used to evaluate the effectiveness of the sign. The formula is

$$H = 0.0022D + K_1 + K_2$$

where: H = height of the letters in inches

D = viewing distance in inches

K_1 = a correction factor for viewing conditions

K_2 = a correction factor for importance.

In this case, K_1 would be evaluated as 0.06 given the generally favorable reading conditions with good illumination. K_2 can be evaluated as zero since the communication does not involve any emergency conditions. The formula for a viewing distance of 24 feet (288 inches) which is the maximum distance at which the sign would have been seen by entering patrons, yields a letter height of 0.6936 inches, or about 11/16 inches. The lettering on the sign exceeded this by a factor of two, so it should have been quite readable to the entering patrons.

The desk was placed in the appropriate location just before 1:00 p.m. but was not manned until that time. Between experimental periods the desk was stored inconspicuously near the reference office with the sign turned toward the wall.

Table 1 gives the experimental schedule. Phase one took place between April 8 and 25; phase two was scheduled between June 10 and 27, 1974. All trials occurred between 1:00 and 3:00 p.m. Fridays were omitted from the schedule

TABLE 1

THE EXPERIMENTAL SCHEDULE*

Phase	Week	Day			
		M	T	W	TH
1	1	X	1	3	2
	2	3	X	2	1
	3	2	3	1	X
2	1	X	X	1	3
	2	3	1	2	2
	3	1	2	3	X

*Treatments are shown as "1", "2", or "3" indicating the desk positions; an "X" designates a null treatment, or office only.

because of low numbers of users on those days. An "X" in the schedule indicates a null treatment, i.e., no desk was in place, so that the office was the only source of assistance. The numbers in the schedule refer to the desk locations.

The person serving as the reference librarian at the desk was the same for all experimental periods. She was one of the experienced staff members of the second floor. Her illness forced a rescheduling during the second phase, which is evident in Table 1.

The reference librarian was instructed to simulate ordinary service and bring some of her everyday work with her to stay occupied, as long as the material did not

drastically alter the appearance of the desk. She maintained the passive mode of operation; that is, she did not volunteer assistance but waited for the user to request it.

The measures taken during the experimentation are listed below: the use of these measures in computing the dependent and independent variables will be discussed in the section dealing with experimental design.

1. Population characteristics as measured by response of a sample of the general population to a survey instrument
2. Head count of the general population
3. Usage measures at desks and office
4. Environmental measures
   (a) entering traffic patterns
   (b) areal (spatial) distribution of users.

The procedures for obtaining these measures are described immediately below.

1. Population characteristics.

Figure 15 represents the survey instrument which was distributed to a sample of persons as they entered the floor. The experimenter tried to achieve a 100 percent sample during the time that he was not occupied with the floor mapping; this was impossible, however, given multiple entries, interruptions, and questions by respondents. Also, as the majority of the users enter via the main stairs, no attempt was made to sample at the back stairs.

LIBRARY USER SURVEY

1. What is your academic standing:
   ___ Freshman
   ___ Sophomore
   ___ Junior
   ___ Senior
   ___ Graduate
   ___ Faculty
   ___ Other

2. What is your Major: _____

3. When was the last time you were on this floor of the library?

   _____ Time of Day _____

4. How long do you expect to stay on this floor during this visit?

   ___ less than ½ hour
   ___ ½ hour to 1 hour
   ___ 1 hour to 1½ hours
   ___ 1½ hours to 2 hours
   ___ 2 hours to 2½ hours
   ___ 2½ hours to 3 hours
   ___ more than 3 hours

5. Which of the following do you intend to do on this floor during this visit:

   ___ Study only personal material that you brought with you.
   ___ Use library materials only.
   ___ Study personal and library materials.
   ___ Locate library materials to borrow or copy for use elsewhere.
   ___ Other.

6. Have you filled out one of these questionnaires before?

   ___ Yes
   ___ No

Figure 15. Experimental instrument.

2. Head count and traffic patterns.

Since these two measures were both made by the assistant in essentially one process, they will be discussed together here, but are dealt with separately in later sections.

At the start of each experimental period a count of users on the floor was made by the assistant just prior to 1:00; this number became a part of the head count of persons entering the floor between 1:00 and 3:00.

Following the initial count, the Assistant positioned herself at the north end of the main aisle in one of the lounge chairs where both of the entry areas were visible. The counting was performed with a thumb activated wheel counter, or "clicker", and the entering traffic patterns were tallied, initially, on a sheet of paper, later on a diagram of the main aisle. This change was made because during the first few days of the first phase it became apparent that the traffic measures were inadequate. The assistant was measuring at that time only the one path of interest on a given day and this was being normalized over the head count. But the resulting figures did not seem to match the subjective impressions of either the experimenter or the assistant. The task was apparently more difficult than had been expected, and the assistant was obtaining only a sample of the entering population with respect to

this measure. Following this realization, a tally sheet in the form of a schematic diagram of the aisle was prepared so that all paths could be measured every day, and the total on this sheet was used in normalizing the results.

3. Usage measures.

During the trials the librarian at the desk and the staff in the office tallied each interaction in one of the following categories:

A. Directional: this class included all questions relating to location of components and facilities, as well as general library policy and ready reference questions; the latter type of question was rather rare.

B. Tool use: this category dealt with the use of a specific bibliographic tool which the user had already selected.

C. Search strategy: tallied here were questions relating to selection of tools and approaches to a specified problem.

D. Referral: since the initial contact was considered the critical measure, a record was kept of any question that the staff member at one location referred to a person at the other location, i.e., from the office to the desk, or conversely. Referrals were not categorized at the initial point, but were

subtracted from the total use figure at the other.

When the staff members were uncertain as to how to classify a question, they wrote it on the bottom of the sheet, and the experimenter added it to the appropriate tally later.

Repeated use by any one patron was not recorded after the first interaction since the initial contact was the point of interest.

Because of the large number of current issues of periodicals stored in the office, a large part of the staff activity at the location related to servicing these items. Questions dealing with these materials other than "Where is this located?" were excluded as forced usage. Also excluded were questions received at the desk that related to the desk or its placement.

4. Environmental measures.

Traffic patterns were discussed procedurally earlier. The areal distribution of users in the site was mapped on a floor plan adopted from the building blue prints. The experimenter made observations following a standardized circuit of the floor, marking each user on the map in the position observed. One circuit was made, usually, within each 15 minute time period. A circuit required three to eight minutes, depending on the user density. All seated users were mapped, as were all users observed at book shelves; those observed in motion were omitted

unless they reached a destination during the observation.

It should be noted that the mapped positions of some of the tables and chairs are approximate as there was an unexpected and continual amount of minor furniture rearrangement by users, custodians and library staff. The effect was not found to be of major importance (as will be seen in the results chapter) but the lounge furniture in the main aisle smaller than the couches might vary in position by as much as four or five feet from one day to the next, and the orientation was often changed as users moved chairs into conversational positions. The coffee tables in the main aisle should be considered as floating. The other most apparent daily variation was in the number of chairs located at the round tables which were six in number until the middle of the second week of the second phase when the table in the southwestern quadrant was permanently removed from the site. It is also of interest that although the carrels are assigned to specific users, it appeared to the experimenter that less than a fourth of them were occupied by the same persons on any regular basis. Those on the eastern side of the floor were seldom used by anyone.

To simplify the map computations a grid was overlaid. The module size of 18 feet by 18 feet provided a reasonably good fit, after some minor adjustments were made to allow for partitions, etc. This size module corresponds

to the lateral spacing of the columns, which is 18 feet on center. Figures 5 and 6 show this grid.

Experimental Design and Analysis

Since the experiment was an exploratory one, a number of variables of uncertain value (and in some cases, alternative methods of measurement) were proposed as candidates for the model. The model chosen was the general linear hypothesis of full rank, a first order regression model with k independent variables which takes the form (Graybill, 1961):

$$y_i = \sum_j \sum_i B_j x_{ji} + e_{ji}$$

In this instance

y_i = the response to the stimulus, service usage at the desk on the ith day of experimentation, normalized by the head count.

B_j = the jth coefficient of regression.

x_{ji} = the ith measurement of the jth independent variable.

e_{ji} = the error of the i^{th} measurement of the j^{th} independent variable.

$i = 1, 2, \ldots, 18$

$j = 1, 2, \ldots, k$

The model was run on a forward selection regression computer program. The forward selection procedure is described by Smith and Draper (1967). They state that the forward selection procedure "avoids working with more X's than are necessary while improving the equation at every state." It has a drawback in that it fails to eliminate variables which fall below the minimum acceptable level of significance

following the introduction of one or more additional variables. This drawback is eliminated in the stepwise regression procedure which is otherwise the same as that for forward selection. The forward selection process does not guarantee an optimal fit; Smith and Draper recommend several "forced" runs with different combinations of the apparently "best" independent variables and the exercise of judgement on the part of the experimenter when using such approaches in an attempt to develop the most economical model. Although the STATPAC program package contains stepwise and backward elimination programs, forward selection was used for this study because of certain program options that were available only for this procedure.

The criterion variable and candidates for the independent variables are described below.

The Criterion Variable

The criterion variable, y_i, is a measure of usage, or response, at the experimental desk. A "use" was defined as any information-transferring interaction initiated voluntarily by a patron, with the restrictions discussed earlier under experimental procedures.

The variable y_i was computed by normalizing the daily tally of use over the daily head count in order to adjust for the fluctuations in general population size from day to day, and the proportion was expressed as a percentage for convenience.

The head count was not the original choice for normalizing factor, but reasons for its use will be explained in Chapter VII.

The Desk Positions

The three desk locations were chosen after examination of the preliminary data sampling, in an attempt to increase the range of values of certain of the candidate independent variables. Position One was near the index tables, a position of fairly high visibility to the users of the reference tools, but in an aisle with light traffic; also, the point of minimum aggregate travel which was defined and discussed in Chapter V fell in the same module during the preliminary sampling. Position Two was near the greatest traffic flow, in a position of good visibility to the other module of reference tools and index tables, but some distance from the point of minimum aggregate travel. Position Three was characterized by low visibility from work stations, medium traffic flow and was located the furthest from the point of minimum aggregate travel. These choices of positions were, of course, constrained by the previously existing floor layout and other practical considerations, such as the need for the reference librarian to be near the tools she might need in assisting patrons.

The desk positions were entered in the model as blocking variables. Inasmuch as these were qualitative levels, they were evaluated as two binary variables with the

values zero or one. That is, position one was coded as "0,1", position two as "1,0" and position three as "0,0".

Variables of Areal Distribution of Population

The first variable derived from the mapping of spatial distribution was a cost factor involving the amount of aggregate travel from all points within the site to the service point. The deviation from the point of minimum aggregate travel was computed in terms of actual travel distances on the floor grid. The assumption that uncertainty is equally likely at any point was invoked so that the distribution of patrons was considered as synonymous with the distribution of need for the service. From the distribution of users the PMAT was computed and the aggregate travel to this point served as the zero point against which aggregate travel to the actual service location was compared.

As discussed earlier, the median of the areal distribution under the conditions of travel applying on the site should coincide with the PMAT. The median was easily determined: a line was drawn on a horizontal axis so that one-half of the population lay on either side of the line. This step was repeated on the vertical axis, and the intersection of the two lines located the median.

The measure of deviation from the PMAT was expressed as a percentage increase in the aggregate amount of travel. First the amount of travel as measured by the sum of the least number of cell sides between every cell and the cell

containing the PMAT was found; then, for each alternate service point a similar daily measure was computed. The variable was evaluated as follows:

$$C_i = \frac{\sum_{km}\sum S_{km_i} T'_{km_i} - S_{km_i} T_{km_i}}{\sum_{k}\sum_{m} S_{km_i} T_{km_i}} (100)$$

$$i = 1, 2, \ldots, 18$$

$$k = 1, 2, \ldots, 5$$

$$m = 1, 2, \ldots, 13$$

where: C_i = the percentage difference in aggregate travel for the ith experimental period.

S_{km_i} = the number of users located in the cell having grid coordinates km.

T_{km_i} = travel distance from $cell_{km}$ to the PMAT.

T'_{km_i} = travel distance from $cell_{km}$ to the cell containing the experimental service point.

The possible influence of visibility and perceptual readiness on service use was discussed earlier. The visibility of the service could be considered in two ways: (1) as visibility from a percentage of the floor area, or (2) as the percentage of population who have a direct line of sight from their (static) work stations to the service.

The first measure would be satisfactory if the users were evenly distributed within the total area. However, the seating facilities are not evenly distributed, and the findings of proxemic research indicate that an even distribution of users is unlikely in any case. For these reasons

the second measure was used.

The field of vision for each service was empirically determined; the same mapping used for the other areal measures was employed to determine the proportions of patrons within the field of vision on a daily basis. The user's vision was considered dynamically; that is, if he was within the field of vision of a given service, the probability of his seeing the service when he was perceptually ready was assumed to be equal to one, regardless of the orientation of his work station in relation to the service point.

Since this measure was based on the mapping which was independent of the head count, the total count of users mapped was used as the normalizing element. The proportions were expressed as percentages for convenience.

Another approach to the cost factor was undertaken with a variable called proximate density. Again the mapping grid was used in computing the values; in this case the number of persons within grid zones around the service were found. The zones were defined as the grid modules or cells equidistant from the cell containing the service, so that a series of square, concentric zones surrounded the central cell.

Two approaches were taken to the scoring:

(1) In the first instance the mapping observations were weighted for distance from the service desk. The procedure for computing the daily values of this variable

was as follows:

(a) The observations were tallied for each module.

(b) The tallies were converted to zone scores; that is, all observations from modules at a given distance from the desk were summed.

(c) The zone tallies were converted to percentages of the total daily observations.

(d) Each zone percentage was multiplied by a weighting factor which ranged from 0-9; i.e., the percentage of observations noted in the module containing the service point was taken times nine, in the contiguous modules times 8, etc., until in the furthest zone the weighting factor dropped to zero.

(e) All weighted zone percentages were summed to be the daily score for this variable.

(2) The second type of measure used the same type of site zoning as the first. The scores were computed as follows:

(a) the percentages of users per zone were found, then

(b) a cumulative percentage was figured for each zone working outward from the module containing the service point. The score for each zone was given by:

$p_{zi} = s_{zi} + s_{(z-1)i}$ where s_z = percentage of total population observed in zone z; z = 2-5; and i = 1,2, ..., 18.

The rationale in this case was that a maximal area of source of use might be defined at a given distance; that is, the patrons located at the extreme ends of the site

might be largely study hall users or a certain distance might define the maximum area of cost indifference.

The first zone, the module containing the service point, had such low values that it was dropped; above the fifth zone, the values became so similar that they were also eliminated. Thus, only the four cumulative zones measures, 2--5, were considered as candidate variables.

The floor density factor, also derived from the mapping of population, attempted to take into account the daily variation in the length of stay or intensity of use. It was hoped that this would be sensitive in some ways to fluctuations in the use patterns. It was computed two ways: (1) within the two phases, and (2) across both phases. The formulas were:

within phase $$d_{ij} = 1 + \frac{\bar{o}_j - M_j}{M_j}$$

across phases $$d_{ij} = 1 + \frac{\bar{o}_{ij} - M}{M}$$

where: d_{ij} = the factor for the ith day of experimentation of the jth phase

o_{ij} = total observations on the ith day of the jth phase

$\bar{o}_{ij}$ = the average number of observations per mapping circuit on the ith day of the jth phase

M_j = the average number of observations per mapping circuit for the jth phase

M = the average number of observations per mapping circuit for both phases, or:

$$\frac{\sum\sum o_{ij}}{C}$$ where C = total number of mapping circuits.

$i = 1,2, \ldots, 12$

$j = 1,2$

Traffic Patterns

The variable of traffic focus was evaluated simply as the percentage of users taking a route into the area which would result in their passing within 18 feet (one module) of the service location so that they faced it in a head-on manner. Only the initial entering movement was considered; all later perambulations were ignored. The one module distance was taken, rather arbitrarily, as a zone of cost indifference if the entering user had need of assistance at that time, and, also arbitrarily, as a measure of maximum distance for clear perception of the service point.

Figure 16 is a schematic representation of the main aisle and alternate aisles into which patrons could branch after entering the site. The numbers in circles are the arbitrarily assigned designations for the six side aisles; the desk positions are shown in triangles.

Experimental Controls

Sommer and Becker (1971) have stated the case for investigation of environmental effects on behavior:

> It is clear that psychologists must deal with organisms-in-environments rather than look at organisms or environments separately. Barker correctly observed that there is more resemblance between any two men sitting in a barber's chair than between either man in the barber's chair and the way he acts at home.

Prohansky (1972) gives a basic methodological viewpoint: "We have . . . stated a fundamental methodological commitment of environmental psychology: the need to study

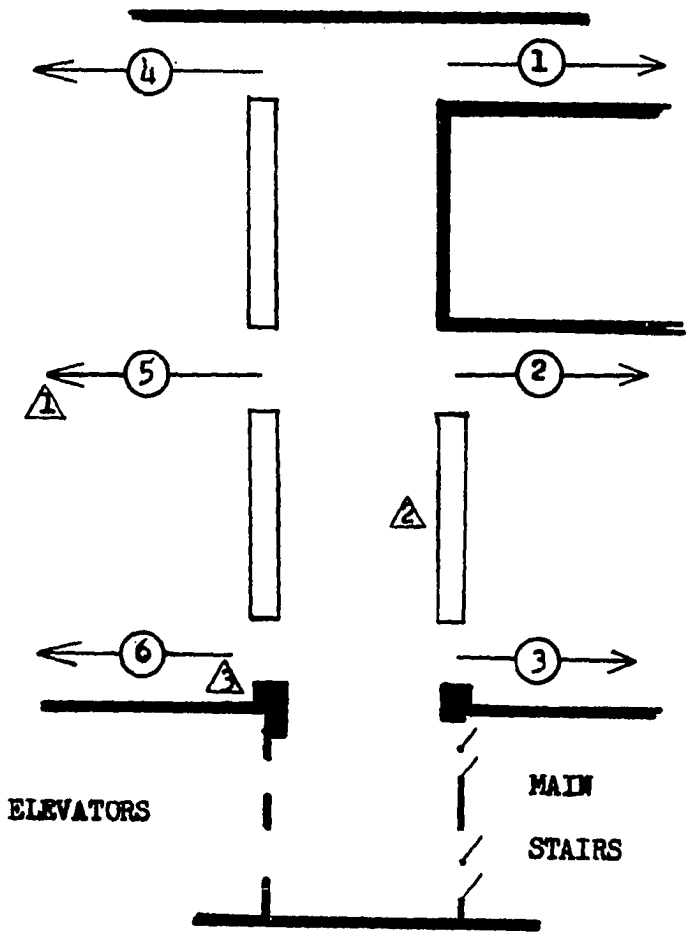


Figure 16. Schematic diagram of alternate entering pathways.

the relationships between individuals and their physical settings in ways that maintain the integrity of both and the activities or events that relate them to each other." In his paper Prohansky points out many of the problems involved in such experimentation, although in a rather general manner. Uhl (1961) discussed "field experimentation" in marketing where the problems are similar to those encountered in environmental research in that "the on-going turn of events is not altered, but is only measured--and hopefully, not disturbed."

The following discussion of the problems of experimental designs in environmental research is based on Uhl's article and a more extensive treatise by Campbell (1963) dealing with experimental design in education research. Campbell's test unit (Uhl's terminology) is the individual while Uhl is concerned with marketing environments as the unit, so together they provide good coverage of a difficult topic.

Campbell designates research where the experimenter lacks control over "the scheduling of data collection (e.g., the <u>where</u> and to <u>whom</u> of measurement)" as quasi-experiments. He encourages the researcher to use such designs where required but with the understanding of "which specific variables his particular design fails to control." Especially where control groups are lacking he states, "one must, in interpreting the results consider in detail the likelihood

of uncontrolled factors accounting for the results."

Lacking control groups, pretesting and posttesting is often used, either on the same group or a matched group. In the experiment performed for this study, the experimenter lacked control over the subjects, and the existing reference service was quite different from the experimental stimuli. The existing service, that is, does not provide a pretest because of the lack of control over variables involving proxemics, habit patterns, prior knowledge, etc. Another point regarding the existing service should be made: since the office provided service continually, the days on which no desk was used did not constitute a null treatment in the usual sense of this concept.

One of the underlying assumptions of this study was that the population of users would be statistically stable with regard to some characteristics through both of the phases of experimentation, and would be statistically stable for other characteristics within each phase. If the first were true, then the daily populations could be considered as matched; in the second case, if it could be shown that two populations responded in the same manner to the stimuli, the generality of the results would be enhanced. Tests were performed on the various population measures to determine if the expectations were valid. These will be discussed in the results chapter, where the problem of matched groups will also be taken up again.

The internal validity of an experimental design is defined by Campbell as "the basic minimum without which any experiment is uninterpretable; did in fact the experimental treatments make a difference in this specific experimental instance?" The following discussion of variables covers a partial list of those that Campbell designates as important to internal validity.

History, or events occurring between measurements in addition to the experimental treatments, can produce changes in attitudes, demand, etc. Control of these events occurring outside of the library environment is the weakest point in the experiment undertaken. No measure or control was attempted on possible motivating agents such as class assignments, impending quizzes, or other demand producing events. By presenting the stimuli on several occasions, it is hoped that the likelihood of coincidence of extraneous events was reduced.

When dealing with one group the testing effect is likely to become a problem, that is, the group becomes aware of the testing and/or may be made more sensitive to the test by a prior one. As will be seen in the results, the stimuli were being presented to a large group of regular users as well as the occasional users of the library. Subjectively, the experimenter feels that few persons regularly on the floor made a connection between the experimenter's presence with the survey instruments and the experimental stimuli. When

questioned about the research, the answer "It's for my dissertation," usually sufficed; when pressed further an offhand remark, "There's an experimental stimulus on the floor and I need to know who is here in order to relate it to the response," was given, even on null treatment days. (One user asked "It was awfully noisy up here yesterday; was that your stimulus?")

The experimental assistant, however, was identified by many of the regular users as related to the administration of instruments taking place at the other end of the hall. One regular user began entering via the rear stairs to avoid the questionnaire, and on each entry he made a clicking sound with his tongue as he passed the assistant, then winked or smiled at her.

Related to the testing effect in this case is what Campbell calls "maturation" or time related processes occurring within the subjects. Specifically, there is some evidence, discussed in the results chapter, that the subjects became more aware of the desks' availability through time which caused a shift from office use to desk use. This, of course, complicates the interpretation of the results, although the interception of usage was not statistically significant for the period of experimentation.

Instrumentation or calibration is partially controlled for the major measure of usage in that any contact initiated by a user was simply counted as one use, and in the matter

of discounting multiple uses by the same subject on the same day, the short experimental periods did not tax the memory of the reference librarian or office staff. The measure of type of use, of secondary interest, is probably less accurate.

The problem of calibration is less certain in the matter of normalizing the use tally. This will be discussed in the results section in conjunction with the response to the intent of use question on the instrument, and also with regard to the floor density factor, the latter of which was intended as a population calibration factor to adjust for intensity of use on a given day.

The external validity refers to the generality of results. In the experiment under discussion probably the most important factor affecting external validity is the one that Uhl referred to as the problem of test unit selection. His test unit consists of either subjects, stores or markets. The store unit is analogous to the library environment and the library users to a market group. Although the market may be considered as representative for a given store unit, a different store will draw from a different market, and any two stores have individual characteristics which may or may not be representative of the universe of stores which interact with the markets. In this case, the best that can be said is that this study is exploratory within one environment; an attempt had been made to ensure internal validity, but

the results may not be representative and, care must be exercised in extending them to other libraries.

For example, visibility of any stimulus in the experimental site is extremely low; the floors were crowded and the stacks were arranged to block vision. In this case a measure of spatial centrality would be purely a cost measure; in a more open environment the central point might provide the greatest visibility over the largest area. The author undertook this research with the intuitive notion that the experimental site was not "that" different from other academic libraries of comparable size, and the results, while not entirely generalizable, may, at least, point the way for further research by providing a viewpoint and conceptual model.

CHAPTER VII

RESULTS AND ANALYSIS

General Statement

In the previous chapter the problems of controls on population in a field experiment were discussed. Due to the lack of controls and/or prior knowledge of the population make-up it was necessary in undertaking this research to attempt some minimal measures of the population on a daily basis. The original plan had been to make these measurements prior to the experiment, and then to extrapolate from them for the experimental period. The pretest period, however, revealed that the day to day variation on several points was so great that no meaningful extrapolation could be made. This led to a daily sampling of the population--an unavoidable environmental disturbance.

Unfortunately, the pre-test was not extensive enough to demonstrate several defects in the instrument and methodology. These will be discussed at appropriate points in this chapter.

The population characteristics are discussed first below in order to lay the foundation for the discussion of the other results. The measures obtained from the survey

instrument are analyzed in terms of similarity within phase and across phases. It is also attempted to identify which population segments contributed the most usage of the service; and the possible effects of re-exposure to the stimulus is investigated. Various aspects of the population characteristics will be mentioned in different contexts in the later sections.

In the second section of this chapter the results of the daily head count, or tally of entering users is reported. This data is utilized in the third section in conjunction with the usage measures and, again, as a normalizing factor for the criterion measure of the regression model in the fourth section.

The usage measures are discussed in the third section. Usage is shown to be a function of the size of the population on a given day. The use at the experimental desk is compared to use at the office, and it is shown that use of the two types of facilities was almost completely independent. That is, during the experiment neither the desk nor the office exerted any significant effect on the other. This leads to the conclusion that the experimental desk created "new" usage, or use that would not have occurred otherwise. It is also reported that there was no statistically significant difference between the type of use experienced at the desk and office.

The fourth and last section covers the environmental

variables individually and then reports the attempt to use them as independent variables in a regression model to predict service usage. Visibility of the service appears to have exerted an effect on use in one context--that of tool related questions--however, it did not prove a strong candidate for the regression model. The within phase measures of floor density proved somewhat valuable in the prediction equation. Traffic focus had the highest individual correlation with use of the variables, although problems of measurement make its contribution to the model somewhat uncertain. The deviation of the service point from the point of minimum aggregate travel was found to correlate inversely from its supposed relationship with usage, and it was dropped from the set of candidate variables. Of the proximate density measures only the fifth cumulative zone measures proved worthwhile; although its correlation with the criterion variable was slight, it was useful in the combination of variables chosen for the model.

The model was fitted to the usage data by means of a forward selection regression computer program. The best combination of variables allowed the model to predict only fifty percent of the daily variation in usage, and the sum of squares attributed to the regression was only borderline significant. For these reasons the model was judged to have failed as an adequate predictor of service use.

The statistical analyses reported in this chapter

were performed largely on two computer program systems. The results in the sections dealing with head count and usage measures were run on the University of Oklahoma's ITF conversational statistical package (University of Oklahoma Merrick Computer Center, 1973). For results dealing with population characteristics and environmental variables, including the overall regression model, Northeast Louisiana University's STATPAC programs were employed. This program package utilizes several of IBM's scientific subroutines and was modified for local use primarily by William Etheredge and James Webb. The STATPAC programs are "a modified version of the 'Statistical Monitor" authored and programmed by Dr. Albert E. Drake and Mr. Edward Streit, respectively, at the University of Alabama." (Etheredge and Webb, 1974).

In all cases, the simplest model, i.e., a linear model, was desired for economy. However, in several cases when linear regression did not provide a good fit to the data, curvilinear regression was also attempted; however, in the majority of instances, the fit was even less acceptable. Since in these cases both approaches yielded insignificant results, only the linear case is discussed. The same applies to transformations of the data by logarithms, roots, etc.

The chi square tests and other nonparametric tests were computed, for the most part, manually.

Population Characteristics

The population characteristics as measured by the survey instrument were of interest for several reasons. Most importantly, since the population was not subject to controls it seemed desirable to measure as much as possible the varying proportions of types of users. This was to test in some degree the assumption that the daily populations within each phase would be matched.

The differences between the populations of the two phases were important to the external validity of the experiment in that if it could be shown that two groups with different make-ups responded similarly to the stimuli within a specified environment the results would be more generally applicable than if they were based on only one population.

Of secondary interest was an attempt to ascertain the sources of reference usage among segments of the population.

The experiment was conducted within a limited time frame; replications were necessary due to the lack of controls on external motivation of users. However, this opened the possibility of effects due to reexposure to the stimulus since the reference office was, necessarily, maintained in operation. Ideally, the desks would have been placed in each position for a semester or more to reduce the novelty, and, presumably, the shift of use from office to desk would have leveled out at some point. Since this was not feasible, the possible effects of reexposure were examined.

The measurement of population characteristics suffered from problems with the instrument, as will be seen in the discussions dealing with individual questions. More extensive pre-testing would have brought these to light and, presumably, have given more meaningful experimental results.

It should be noted that not all respondents replied to all questions, so the sizes of the samples vary somewhat in the tables of data.

The discussion of population characteristics follows the sequence of the survey instrument questions.

Class Standing

The responses to the first question are shown in Table 2. Table 3 displays the results of a chi square test comparing the phase subtotals; the test statistic had a value of 154.86 with six degrees of freedom which is more than sufficient to reject the null hypothesis that the two populations were similar in make-up on this characteristic.

Daily variation exhibited less marked fluctuations within the phases; to test this the freshman and sophomore categories were combined and the faculty and other categories were dropped in order to perform the chi square tests, but, while the values of the two test statistics were high they were not sufficient to reject the null hypothesis that the daily samples were drawn from the same population at an alpha level of 0.05.

TABLE 2

ACADEMIC STATUS: RESPONSE TO DAILY SURVEY OF USERS ENTERING SITE

Date	Freshman	Sophomore	Junior	Senior	Graduate	Faculty	Other	Sample
April								
8	10	13	10	13	29	2	0	77
9	4	9	10	13	9	3	2	50
10	7	8	8	16	20	0	0	59
11	8	4	12	12	23	1	2	62
15	3	9	18	19	22	1	3	75
16	9	8	8	10	21	2	1	59
17	4	11	8	17	23	1	0	64
18	7	13	11	10	22	6	2	71
22	6	9	7	19	22	3	0	66
22	4	6	12	24	14	2	0	62
24	7	3	16	14	33	1	0	74
25	5	7	12	9	19	3	2	57
Phase 1 Summary	74	100	132	176	257	25	12	781
June								
10	1	3	2	8	35	3	3	55
11	0	3	2	3	21	5	4	38
12	1	4	1	7	37	2	2	54
13	1	4	4	9	27	2	2	49
17	2	5	6	4	29	2	0	48
18	3	4	3	8	22	1	2	43
19	1	3	1	3	26	5	4	43
20	1	0	6	13	23	0	2	45
24	1	0	4	7	39	4	2	57
25	2	1	3	10	41	2	3	62
26	0	3	5	2	30	2	3	45
27	2	3	4	10	26	2	3	50
Phase 2 Summary	15	33	41	84	356	30	30	589
Total	89	133	173	260	613	55	42	N=1370

TABLE 3

SUMMARY DATA FOR CLASS STANDING CHI SQUARE TEST; CELLS SHOW (a) TALLY, (b) EXPECTED, AND (c) CHI SQUARE CONTRIBUTION

	Class							Totals
	Freshman	Sophomore	Junior	Senior	Graduate	Faculty	Other	
Phase 1								
a	74	100	132	176	257	25	12	781
b	50.74	75.82	98.62	148.22	349.45	31.35	23.94	
c	10.66	7.71	11.30	5.21	24.46	1.29	5.96	
Phase 2								
a	15	33	41	84	356	30	30	589
b	38.26	57.18	74.38	111.78	263.55	23.65	18.06	
c	14.14	10.23	14.98	6.90	32.43	1.70	7.89	
Total	89	133	173	260	613	55	42	1370

chi square = 154.86
df = 6

In order to correlate the class categories with the use figures, (a) the daily counts of responses in each category were converted to proportions by normalizing them over the daily number of respondents; (b) these proportions were multiplied by the daily head counts, or total population. This provided an estimate of the numbers of persons in each category in the general population. Again, the faculty and other categories were omitted due to low numbers of responses. The results of the individual correlations are shown in Table 4. An examination of these relationships suggests that the seniors may account for a large part of the overall usage, but the desks may have attracted the less knowledgeable freshmen to a greater extent than the office. The graduates correlated insignificantly: this was expected since the largest number of the high frequency users appeared to be graduates with carrell assignments who used the floor as a study hall.

Major Field of Study

A detailed analysis of the responses to this question was not undertaken because of the low number of responses in any one category and the difficulty in interpreting some majors for combining into larger interest groups. Some generalizations are feasible, however.

The largest single major specified was library science. This category represented between six and ten percent of the population on any given day. The library science majors, almost without exception, were among the regular

TABLE 4

CORRELATIONS OF ESTIMATED NUMBER OF USERS IN SPECIFIED CLASSES WITH (A) TOTAL USAGE, (B) USE AT THE OFFICE AND (C) USE AT THE DESK POSITIONS

Class	Correlation Coefficients		
	Total Use	Use at Office	Use at Desks
Freshman	0.39	0.51*	0.65*
Sophomore	0.42*	0.47*	0.48*
Junior	0.37	0.38	0.31
Senior	0.65*	0.41*	0.53*
Graduate	-0.06	-0.15	0.06

*These correlations were significantly different from zero at an alpha level of 0.05.

daily users of the floor. Their presence probably served to inflate the estimate of potential users based on the intent of use question for, while they were media users, they were largely capable of serving themselves with little interaction, except of a social nature, with the reference staff.

The largest combined group of reasonably clear cut majors were in the social sciences with economics, psychology, sociology and social work being the most represented; this group was usually above twenty percent. Education and related fields represented between fifteen and twenty percent as the second largest grouping, although some interpretation was required in this case in order to combine responses.

The remainder of the reported majors were spread across the board and included all of the business areas and most of the physical sciences as well as the humanities.

Last Time in the Site

Responses to this question are shown in Table 5, and the results of a chi square test comparing the two phases are shown in Table 6. The value of the chi square test statistic was 46.13 with six degrees of freedom which is significant and allows for the rejection of the hypothesis that the two populations were similar in terms of frequency of use. A large part of the chi square contribution was from the "never" category, which would be expected to be higher in the summer session. Related to this is the fact that the first phase of experimentation occurred during

TABLE 5

RESPONSE TO QUESTION REGARDING LAST TIME AT THE EXPERIMENTAL SITE

Phase	Day	Response						
		Same Day	Yester-day	Within 1 wk.	Within 1 mo.	Within 6 mo.	More Than 6 mo.	Never
1	1	13	14	23	13	2	1	3
	2	6	19	7	6	4	2	1
	3	12	21	15	6	2	0	1
	4	9	19	16	7	1	2	1
	5	12	11	41	4	3	1	1
	6	14	14	19	6	1	2	2
	7	11	19	24	7	2	1	0
	8	14	21	22	4	6	2	0
	9	11	11	32	8	1	1	0
	10	3	27	15	13	2	0	2
	11	18	17	24	10	3	0	1
	12	7	19	16	8	3	2	1
Subtotal		130	212	254	92	30	14	13
Per-centage		17.4	28.5	34.1	12.4	4.0	1.9	1.7
Cumula-tive Per-centage		17.4	45.9	80.0	92.4	96.4	98.3	100
2	1	15	5	17	8	2	2	3
	2	18	7	5	3	0	1	4
	3	15	20	7	3	1	2	4
	4	15	16	7	2	4	2	3
	5	9	5	19	5	1	7	1
	6	12	11	8	3	2	1	6
	7	12	13	6	6	4	1	0
	8	7	13	12	2	4	1	4
	9	10	6	33	2	2	2	2
	10	11	20	18	6	1	2	2
	11	11	19	9	2	0	1	2
	12	8	16	12	4	0	1	7
Subtotal		143	151	153	46	21	23	38
Per-centage		24.9	26.3	26.6	8.0	3.6	4.0	6.6
Cumula-tive Per-centage		24.9	51.2	77.8	85.8	89.4	93.4	100
TOTAL		273	363	407	138	51	37	51

TABLE 6

RESPONSE TO "LAST TIME ON THIS FLOOR" QUESTION BY PHASES WITH CHI SQUARE TEST DATA: (A) OBSERVED, (B) EXPECTED, AND (C) CHI SQUARE CONTRIBUTION

Phase		Category of Response							Observed Totals
		1	2	3	4	5	6	7	
1	A	130	212	254	92	30	14	13	745
	B	154.08	204.88	229.71	77.89	28.78	20.88	28.78	
	C	3.76	0.25	2.57	2.56	0.05	2.27	8.65	
2	A	143	151	153	46	21	23	38	575
	B	118.92	158.13	177.29	60.11	22.23	16.12	22.23	
	C	4.86	0.32	3.33	3.31	0.07	2.94	11.19	
Observed Totals		273	363	407	138	51	37	51	1320

the final weeks of the regular spring semester, and most students could have been expected to have been exposed to the library during the earlier portions of the academic year. The overall reason for the disparity between the phases is probably due to a greater intensity of use during the summer because of the shorter time span and the larger number of graduate students.

A chi square test was also performed on the daily data within each phase. In order to perform the test the data was combined into five categories for the first phase and four for the second to avoid the restriction on number of expected values less than or equal to 5. The combined classes were in both cases the right-most columns where the numbers of responses were low. In each case the null hypothesis: that the make-up of the population was proportional on all days within the phase was rejected. The values of the test statistics were 74.53 and 103.25, respectively.

Although this survey was not directly comparable to the one performed by Harrelson (1972), his figures of nearly 80 percent for users who claim to be in the library at least once per week appears to be confirmed generally. It seems that the majority of students simply do not use library facilities, but those who do, use them frequently.

Individual correlations were performed for the categories and desk, office and total usage. These are shown in Table 7. The data was manipulated in the same manner as was used for the correlations of use and class standing. An

TABLE 7

CORRELATIONS OF ESTIMATED NUMBERS OF USERS IN LAST-TIME-ON-SITE CATEGORIES WITH TOTAL, OFFICE AND DESK USE

Category	Correlations		
	Total Use	Office Use	Desk Use
Same Day or Yesterday	0.36	0.40	0.27
Within One Week	0.40	0.27	0.53*
Within One Month	0.19	0.41*	0.48*
Within Six Months	0.21	0.08	-0.03
More than Six Months	0.10	0.17	0.08
Never	-0.29	0.33	-0.33

*These correlations were significantly different from zero at an alpha level of 0.05.

examination of the correlations indicates that the use of the reference service appears to come from the fairly regular users rather than the infrequent users.

Length of Stay

The response to this item on the instrument is summarized in Table 8 . Almost one-third of the users indicated that they intended staying less than one-half hour, making this the modal value. A weighted average was computed using the midpoints of the categories; that is, the count of 442 persons responding to the first category was multiplied by 0.25, the count in the second category by 0.75, etc.; the last category being multiplied by 3.5 hours. The sum of the weighted counts was 1789; this was divided by the total sample, 1358, giving an estimated average duration of visits of 1.32 hours.

A chi square test was performed using the phase subtotals with the null hypothesis that the proportions in the various categories were similar for both phases. The test gave a value of chi square equal to 7.88 with 6 degrees of freedom which is not sufficient to reject the null hypothesis. From this result it is concluded that the amount of within phase variation was also not significant.

Table 9 presents correlations of usage with the estimated numbers of persons in the general population (figured as for the other previous correlations) who would fall into the various response categories. The pattern does

TABLE 8

RESPONSE TO QUESTION REGARDING LENGTH OF STAY

Phase	Response Category							
	Less Than ½ Hr.	½ to One Hour	1 to 1½ Hours	1½ to 2 Hr.	2 to 2½ Hours	2½ to 3 Hours	More Than 3 Hr.	Totals
One	29	12	8	7	7	7	7	77
	21	9	5	2	4	7	1	49
	18	10	9	4	7	7	5	60
	15	9	12	5	6	6	9	62
	21	18	7	6	9	4	10	75
	16	12	8	10	4	4	4	58
	15	9	11	9	7	5	8	55
	27	14	7	6	8	3	5	70
	16	17	9	10	3	4	6	65
	27	8	9	6	4	2	6	62
	19	15	12	7	9	4	8	74
	16	13	10	7	6	3	3	58
Two	18	13	5	6	4	3	6	55
	20	4	4	2	1	1	6	38
	14	11	5	2	3	11	8	54
	19	1	10	4	1	5	9	49
	20	7	6	3	1	5	6	48
	11	8	6	4	5	6	3	43
	13	10	4	5	5	2	4	43
	16	4	8	4	4	5	4	45
	18	15	9	1	5	6	3	57
	22	11	3	10	11	3	2	62
	15	7	4	2	7	8	2	45
	16	8	6	5	7	5	3	50
Totals	442	240	177	127	128	116	128	1358
Percentages	32.6	17.7	13.0	9.4	9.4	8.5	9.4	100%
Cumulative Percentages	32.6	50.3	63.3	72.7	82.1	90.6	100	

TABLE 9

CORRELATIONS OF ESTIMATED NUMBERS OF USERS IN LENGTH-OF-STAY CATEGORIES WITH TOTAL, OFFICE AND DESK USE

Category	Correlations		
	Total Use	Office Use	Desk Use
Less than ½ Hour	0.27	0.46 *	0.18
½ to One Hour	0.37	0.28	0.52*
1 to 1½ Hours	0.42*	0.25	0.43
1½ to 2 Hours	0.18	0.11	0.58*
2 to 2½ Hours	0.26	0.11	0.27
2½ to 3 Hours	0.44*	0.36	0.13
More than 3 Hours	0.36	0.25	0.25

*These correlations were significantly different from zero at an alpha level of 0.05.

not seem clearcut, but it may be that users who intend to stay less than one-half hour used the service at the office out of habit while desk use came from those who were on the floor for a longer time and, presumably, moved about more, thus, increasing their chance for exposure to the desk and increasing the opportunity for interception by the desk before reaching the office.

Intent

Response to this question (shown in Table 10) was disappointing, at least in terms of the anticipated use of the data. The original purpose was to achieve greater accuracy in normalizing the usage data by narrowing the head count to only those presumed potential users of the service. The intent measures were not used in any fashion for reasons that will become clear below.

Table 11 presents the correlation coefficients of the five intent categories in relation to total usage and usage occurring at the desks and office. These were based on estimated numbers of persons in the categories as was done for the other population characteristics. Two factors immediately make the correlations suspect; the first and last categories were presumed to be counter-indicative of usage, however, both have positive correlations with the use counts.

The originally intended combination of the three middle intent groups was performed to arrive at an estimated potential user population. The correlation of these

TABLE 10

INTENT OF USERS FROM RESPONSES TO SURVEY INSTRUMENT

Date	Use Only Personal Material	Use Only Library Material	Personal and Libr. Material	Locate Library Material	Other	Total
April						
8	16	18	16	12	15	77
9	14	12	5	12	7	50
10	15	13	18	7	7	60
11	17	21	9	10	5	62
15	14	24	15	14	8	75
16	11	16	13	16	3	59
17	14	20	12	13	3	62
18	13	23	9	16	10	71
22	8	28	12	11	6	65
23	11	19	9	15	8	62
24	16	22	17	12	7	74
25	10	18	12	14	4	58
June						
10	7	17	11	12	8	55
11	7	6	8	12	5	38
12	6	16	14	15	3	54
13	6	18	9	5	10	48
17	3	15	11	13	6	48
18	7	12	15	6	3	43
19	7	10	10	15	1	43
20	7	11	7	13	7	45
24	3	10	18	21	5	57
25	10	21	12	8	11	62
26	4	14	12	12	3	45
27	10	11	12	10	7	50
Total	239	395	286	294	152	1363

TABLE 11

CORRELATIONS: ESTIMATED NUMBER OF USERS IN INTENT CATEGORIES WITH TOTAL, OFFICE AND DESK USAGE

Intent Category	Correlations		
	Total Use	Office Use	Desk Use
Use Only Personal Material	0.48*	0.49*	0.34
Use Only Library Material	0.53*	0.29	0.54*
Personal and Library Material	0.26	0.17	0.41
Locate Library Material	0.14	0.26	0.14
Other	0.21	0.46*	0.18

*These correlations were significantly different from zero at an alpha level of 0.05.

figures and the use figures was 0.458, considering total usage, and 0.592 if desk use was the correlate. These correlations are not as good as the one obtained from correlating usage with the simple head count. Since this is the case, the head count would remove more extraneous variation from the criterion variable in the normalization process than would the estimated potential service user population.

A chi square test on the five intent categories on a daily basis for the 24 days of experimentation proved insignificant at the 0.05 level. The declared intent of the users is, within the constraints of the questionnaire, apparently relatively constant.

The accuracy of the declared intent, however, is suspect. For example, on several occasions users checked one of the media use categories, but they were observed to go directly to the restrooms, following which they exited the site. Another source of error in this measure was probably introduced by students traveling from floor to floor to gather materials to be used on a floor other than the site; the impression of the experimenter is that there were many users who checked an intent category that applied to an overall purpose in visiting the library, but not specifically to the second floor.

Another problem in this area is that while the graduate students were media users and their intent would qualify them as potential users of the service, their experience in

using the library enabled them to serve themselves with less assistance.

An overall assessment of the response to this question must lead to the conclusion that the instrumentation failed in measuring the intent of the user population, and, by extension, failed to identify potential users of the service. As the head count appeared to be a more reliable predictor, and the accuracy of that measure was less dubious, it was decided to normalize the criterion variable by the total population size.

Reexposure

The sixth question on the survey instrument--"Have you filled out one of these questionnaires before?"--was to gather a rough indication of the possibility of reexposure to the stimulus. However, since the trial period immediately preceded the first phase of experimentation, the first day of phase one shows a 9 percent affirmative response to this question as is seen in Table 12.

There was some indication of a maturation of response in use of the desks. Table 13 presents the percentage of total daily use at the desk (as opposed to the office) for the 18 days during which the desk was in one of the three positions. A general tendency to increase can be seen in four of the six data subsets of location within phase and also in the weekly averages for both phases. A correlation of the estimated number of persons who had been reexposed

TABLE 12

RESPONSE TO QUESTION NUMBER SIX ON INSTRUMENT RELATING TO POSSIBLE REEXPOSURE TO EXPERIMENTAL STIMULUS

Phase	Response		Total	Percentage Positive
	Yes	No		
1	7	69	76	9.2
	8	41	49	19.5
	13	47	60	21.7
	12	50	62	19.4
	14	60	74	18.9
	15	44	59	25.4
	19	45	64	29.7
	17	54	71	23.9
	20	45	65	30.8
	15	47	62	24.2
	21	53	74	28.4
	17	41	58	29.3
2	9	46	55	16.4
	7	31	38	22.6
	16	38	54	29.6
	15	34	49	44.1
	15	32	47	31.9
	13	30	43	30.2
	15	28	43	34.9
	18	27	45	40.0
	26	31	57	45.6
	20	42	62	32.3
	22	23	45	48.9
	19	31	50	38.0

TABLE 13

PERCENTAGE OF TOTAL DAILY USAGE OCCURRING AT DESKS

Phase	Desk Location			Average Weekly Percentage
	1	2	3	
1	50.0	59.1	65.6	58.2
	55.9	73.5	52.8	60.7
	61.2	73.9	51.6	62.2
2	42.9	95.0	56.3	64.7
	69.2	61.1	64.9	65.1
	76.5	90.5	71.4	79.5

to the desk with the tally of desk use yielded a coefficient of correlation of only 0.18 which is not significantly different from zero. The converse segment of the population, the estimated number of those who had presumably not been previously exposed to the desk correlated at 0.56; this correlation is significant at an alpha level of 0.05. If there was an actual tendency for desk use to increase with time, the only apparent explanation would be increased awareness due to reexposure. The problem with the correlations is most likely due to contamination of the reexposure data by the number of frequent study hall type users; unfortunately, given the imprecision of the intent measures there is no means to test this assumption.

Summary

With regard to the question of similarity of population make-up between the two phases of experimentation, both the measures of class standing and the last time on the floor of the library showed high divergence between the spring phase and the summer phase. The measures relating to patterns of use, that is, the anticipated length of stay and the intent of use, showed no appreciable difference, but the latter measure is probably meaningless in terms of actually determining intent of use.

It is concluded that the phase populations were different in make-up, but that the patterns of use measured broadly were essentially similar.

Within phases the populations showed little divergence except with regard to the last time on the site. Since this

related to the timing of the sampling, it was concluded that the day-to-day populations within each phase could be considered to be matched groups within reasonable limits.

Sources of usage are not clear cut. The composite picture of a likely user of the service would be a freshman or sophomore who is in the library at least weekly to monthly. No simple generalizations appear feasible with regard to the other measures.

Reexposure to the stimulus seemed to increase the use of the service, however, contamination of the data probably acted to obscure this in the correlation of reexposed population with use counts. Any time trends of this nature would be expected to be more clearly seen with longer term experiments.

Head Count

Table 14 presents the daily head counts in chronological sequence for the two phases of experimentation. The average size of the population entering the site during the spring semester was nearly twice the number of people entering during the summer session.

A chi square test performed on the head count data as it is arranged in Table 14 gave a value of 31.96 with 15 degrees of freedom; this is significant at the alpha level of 0.01 and sufficient to reject the null hypothesis that the number of users on experimental days was proportional for both phases. Next, each phase was similarly tested

TABLE 14

HEAD COUNT OF GENERAL POPULATION ENTERING EXPERIMENTAL SITE FOR ALL TRIAL PERIODS

Phase	Week	Day				Phase Total	Phase Mean
		Mon	Tues	Wed	Thu		
1	1	335	249	292	276	3198	266.5
	2	278	227	287	260		
	3	265	228	237	264		
2	1	161	125	178	159	1817	151.4
	2	149	172	170	128		
	3	147	156	131	141		

separately. The spring measures did not vary significantly, but the three summer session weeks gave a test statistic with a value of 17.16 with 6 degrees of freedom, which is significant at an alpha equal to 0.01. That is, the summer session population use patterns differed from those of the spring semester, and there was no consistency from week to week within the summer session.

Usage Measures

Table 15 presents all usage values obtained for all locations in the chronological sequence of experimentation. It is interesting to note that the maximum usage on any day in the office was 22 questions; use at the desks equalled or exceeded this amount on six different occasions.

The desk usage accounted for almost 54 percent of all use during the 24 days of experimentation. On days when the desk was in place, 63.4 percent of the questions were asked at the desk, and only 36.6 percent in the office. When the office did not have competition from a desk location, the average number of interactions was 17.2 per day. The average amount of desk use was 19.6 questions per day, even with the constant competition of the office service.

This section will consider (a) use of the reference service as a function of the size of the population, (b) the effect of the experimental desks on total usage, and (c) the type of use received at the four points.

TABLE 15

ALL REFERENCE USAGE AT ALL LOCATIONS DURING EXPERIMENTAL PERIOD IN CHRONOLOGICAL SEQUENCE

Phase	Phase Location ("0"=Office Only)	Reference Usage								Total Daily Usage
		Desk				Office				
		Type*			Total**	Type*			Total**	
		1	2	3		1	2	3		
	0	-	-	-	-	20	0	2	22	22
	1	16	2	0	18	14	0	4	18	36
	3	27	1	4	31	13	1	1	16	47
	2	17	4	7	26	13	0	3	18	44
	3	18	1	2	19	11	1	2	17	36
1	0	-	-	-	-	14	1	2	17	17
	2	21	1	3	25	4	0	5	9	34
	1	20	0	1	19	6	0	7	15	34
	2	29	2	3	34	10	0	2	12	46
	3	17	0	2	16	12	0	0	15	31
	1	14	1	2	16	2	0	5	10	26
	0	-	-	-	-	12	3	2	17	17
	0	-	-	-	-	7	2	3	12	12
	0	-	-	-	-	12	1	1	14	14
	1	12	2	1	15	13	4	3	20	35
	3	6	0	3	9	6	0	1	7	16
	3	23	0	1	24	11	2	0	13	37
2	1	14	1	3	18	5	0	2	8	26
	2	16	1	2	19	1	0	0	1	20
	2	21	0	2	22	13	0	1	14	36
	1	8	0	5	13	4	0	0	4	17
	2	18	1	0	19	3	0	0	3	21
	3	9	1	0	10	4	0	0	4	14
	0	-	-	-	-	17	4	0	21	21
Totals		306	18	41	353	229	19	46	307	659

*The types are: (1) directional, (2) tool use, and (3) search strategy.

**These subtotals include referrals to the other location and are adjusted for referrals from the other location, so the figures for type of use do not always sum to total desk or office use.

Use as a Function of Head Count

The amount of use occurring on any given day would be expected to be a function of the number of people on the floor during the experimental period. Figures 17-20 are plots of use data for the total site, office only and desk locations, and total daily use on days when the desks were in use.

Table 16 presents a summary of the results of analysis of the regressions shown individually in Tables 17-20. All four proved significant at an alpha level of 0.05.

If equal demand for the service can be assumed for all experimental periods, then the combination of desk and office would seem to be the most effective in attracting use. On the other hand, daily fluctuation in demand (need for assistance) could be considered as a factor likely to contribute to the error of the regression on head count. If this is true, then the use of the office and that of the desk should display a high degree of correlation; that is, use at the two points should vary in the same direction from the head count regression prediction on any given day. This was looked into briefly: the residuals from the two regressions of desk use and office use on head count were arranged in chronological order for the 18 days of experimentation when the desk was in use (shown in Table 21) and a Spearman rank correlation was computed. The coefficient

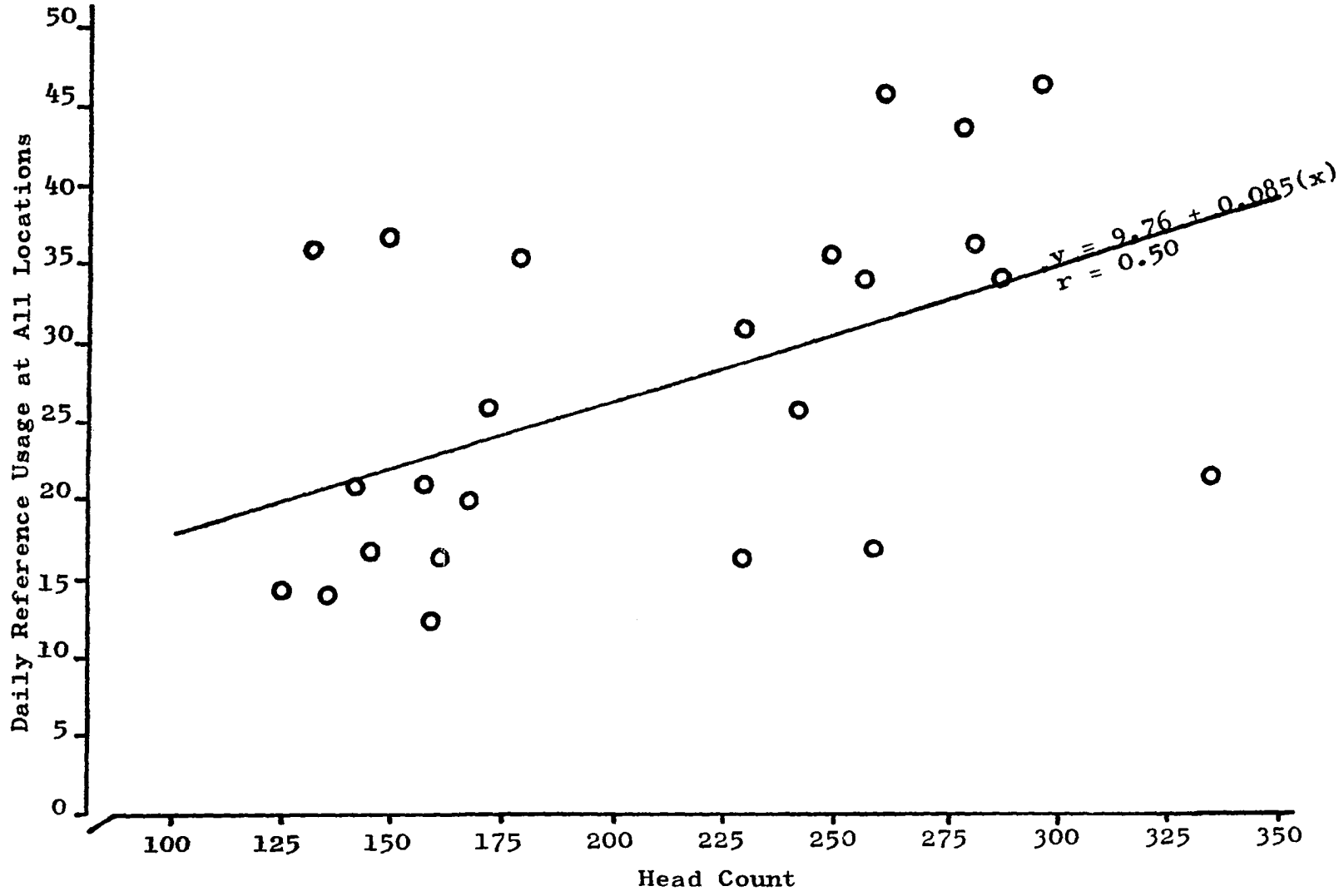


Figure 17. Total daily reference use at all locations plotted on daily head count.

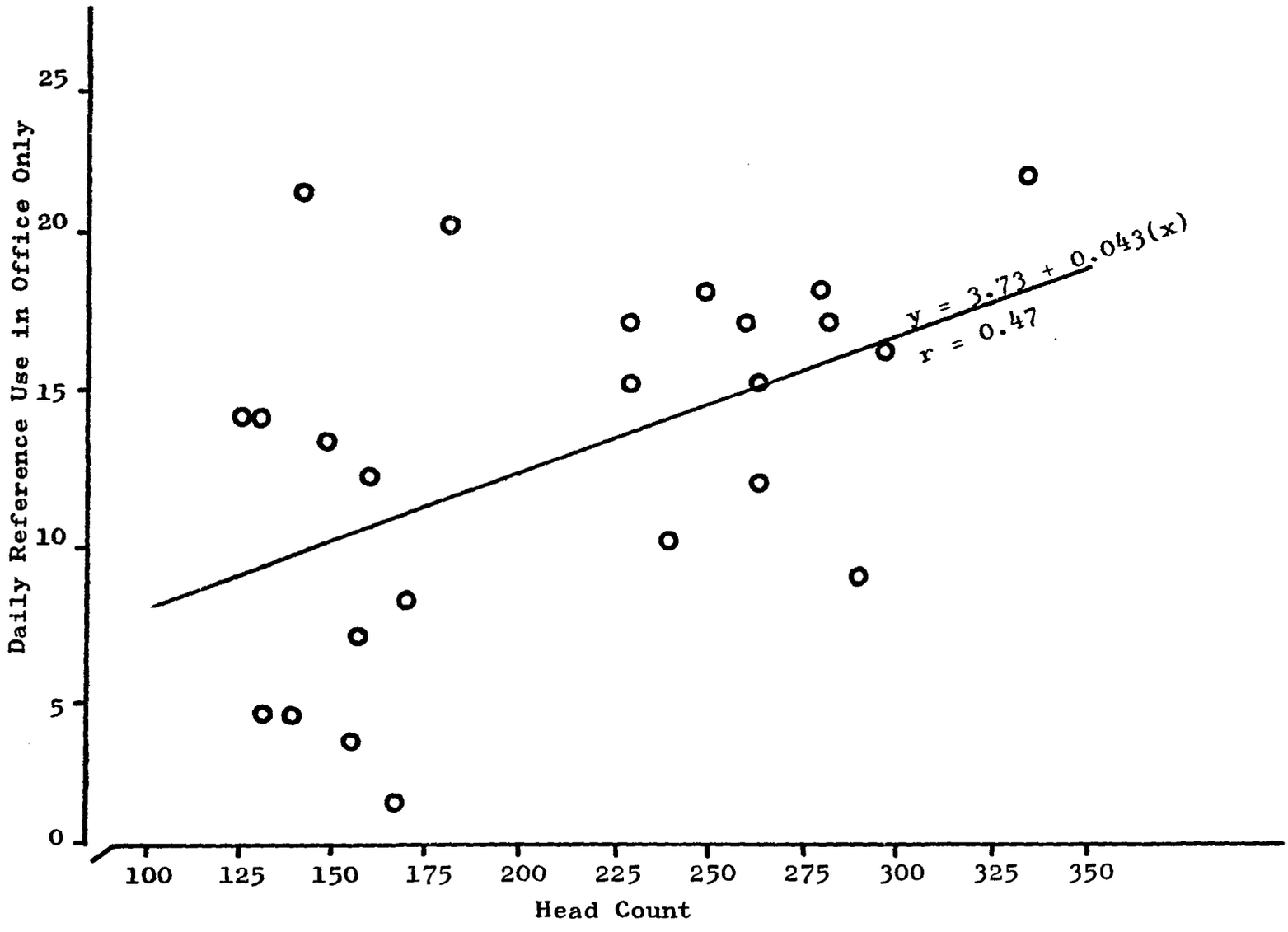


Figure 18. Daily reference use in office only plotted on daily head count.

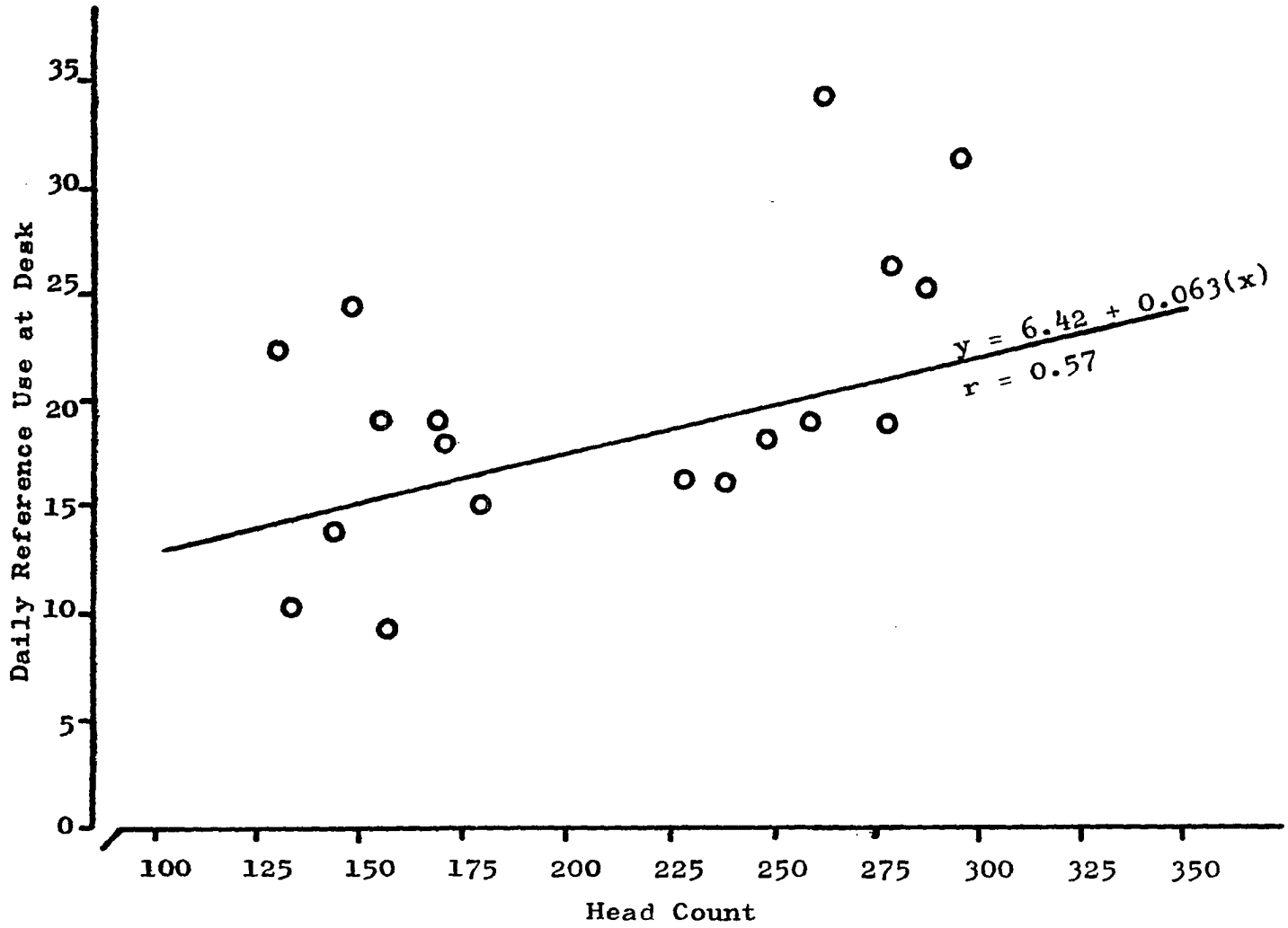


Figure 19. Daily reference use at experimental locations plotted on head count.

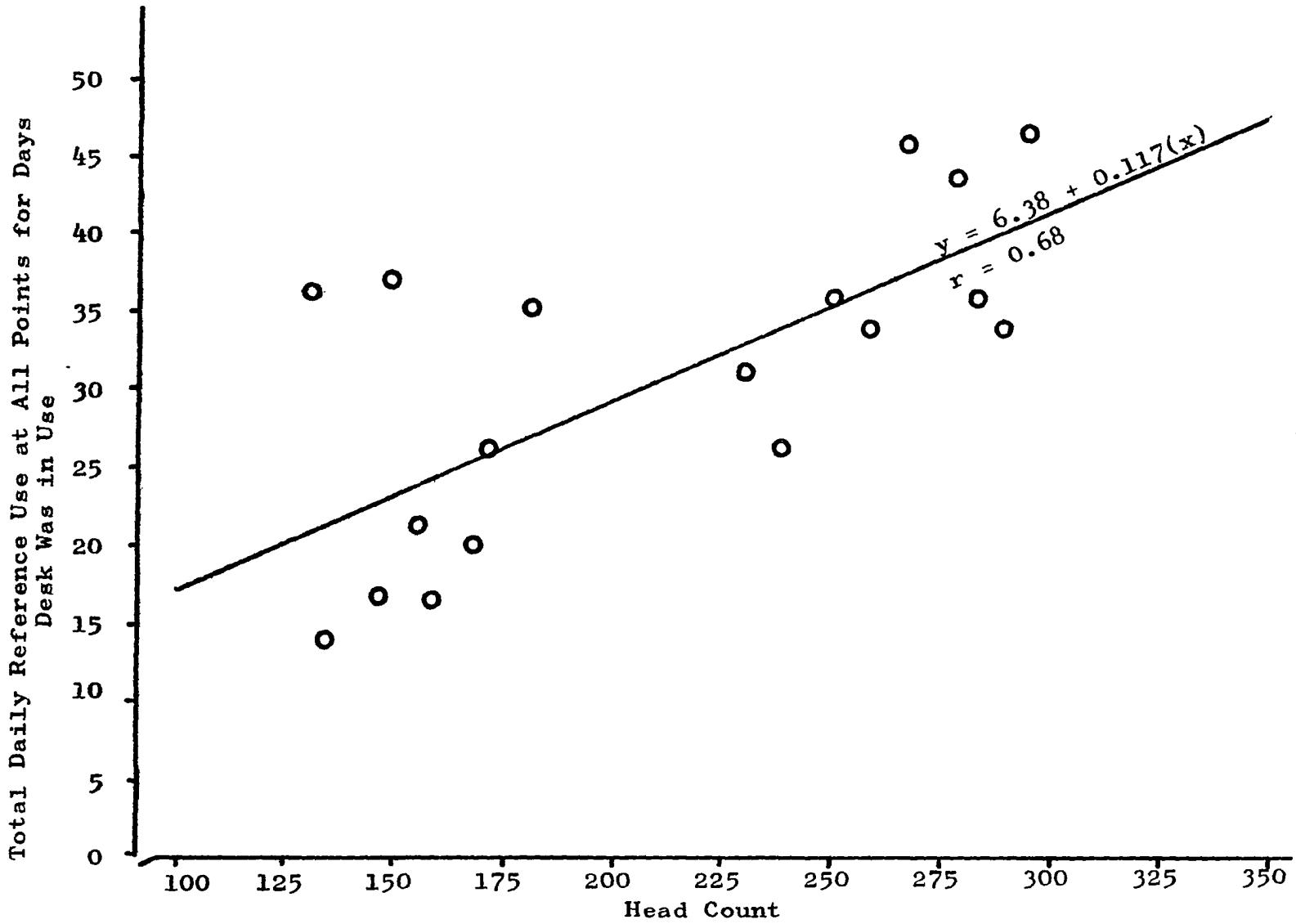


Figure 20. Total daily reference usage on 18 days when desks were in use.

TABLE 16

SUMMARY OF RESULTS OF USAGE REGRESSIONS ON HEAD COUNTS

Regression on Head Count of:	ANOVA Results Shown In:	Coefficient of Correlation	Regression Equation
Total use at all points (24 days)	Table 17	0.50*	$y = 9.76 + 0.085(x)$
Office use only (24 days)	Table 18	0.47*	$y = 3.73 + 0.043(x)$
Desk use only (18 days)	Table 19	0.57*	$y = 6.42 + 0.063(x)$
Total use on days when desks were in place (18 days)	Table 20	0.68*	$y = 6.38 + 0.117(x)$

*All these regressions are significant at an alpha level of 0.05.

TABLE 17

ANOVA TABLE: REGRESSION OF TOTAL REFERENCE USE ON HEAD COUNT

Source	DF	SS	MS	F	$F_{0.05}$
Regression	1	668.280	668.280	7.244	4.30
Deviation	22	2029.680	92.258		
Total	23	2697.960			

TABLE 18

ANOVA TABLE: REGRESSION OF REFERENCE USAGE AT THE OFFICE ONLY ON DAILY HEAD COUNT

Source	DF	SS	MS	F	$F_{0.05}$
Regression	1	175.089	175.089	6.125	4.30
Deviation	22	628.867	28.585		
Total	23	803.956			

TABLE 19

ANOVA TABLE: REGRESSION OF REFERENCE USAGE AT THE EXPERIMENTAL DESKS ONLY ON DAILY HEAD COUNTS

Source	DF	SS	MS	F	$F_{0.05}$
Regression	1	238.827	238.827	7.713	4.49
Deviation	16	495.449	30.966		
Total	17	734.276			

TABLE 20

ANOVA TABLE: REGRESSION OF TOTAL USAGE AT ALL LOCATIONS DURING THE 18 DAYS OF EXPERIMENTATION ON DAILY HEAD COUNT

Source	DF	SS	MS	F	$F_{0.05}$
Regression	1	824.310	824.310	13.862	4.49
Deviation	16	951.466	59.467		
Total	17	1775.776			

TABLE 21

RESIDUALS OF USAGE REGRESSIONS ON HEAD COUNTS
FOR OFFICE AND DESK POSITIONS
ARRANGED CHRONOLOGICALLY

Office	Desk
3.5	-4.1
-4.0	6.2
2.3	2.2
1.2	-5.0
-7.2	5.0
-0.04	-3.8
-3.2	11.0
1.4	-4.8
-4.0	-5.4
8.6	-2.7
-3.6	-7.5
2.8	8.2
-3.1	7.0
-10.1	1.9
4.7	7.5
-6.1	-2.7
-7.5	2.7
-5.4	-4.7

of correlation was 0.096, which is equivalent to zero, indicating total independence of the two variables. Thus, daily variation in demand for reference service does not appear to be a factor in the amount of use, indeed, the variation appears to have different underlying factors for each of the two types of location, office and desk, unless it can be shown that the desks influenced the use at the office in such a way as to counter the effects of demand. This is the topic of the next subsection.

Effects of the Desk on Usage

To determine the effect of the experimental desks on the use experienced at the office the data in Table 22--use at the office only arranged by treatment level--was subjected to an analysis of variance. This data was computed from the use tallies; since the daily populations were of unequal sizes, the daily tally was normalized over the head count and expressed as a percentage for convenience. The treatment levels represent the experimental desk locations 1-3; the zero level indicates a null treatment, or a day when no desk was in use.

The results of the ANOVA are shown in Table 23. None of the F values were significant at an alpha level of 0.05. This would indicate that the amount of use at the office was not significantly different given any of the treatments, although the mean values for the desk treatments are somewhat lower. A relaxation of the alpha level to 0.10

TABLE 22

USE AT THE OFFICE ONLY ARRANGED BY TREATMENT LEVEL, NORMALIZED BY HEAD COUNT AND EXPRESSED AS A PERCENTAGE

	Treatment				Means
	0	1	2	3	
Phase 1	6.6	7.2	6.5	5.5	
	7.5	5.8	3.1	6.1	5.8
	6.4	4.2	4.5	6.6	
Phase 2	7.5	11.2	0.6	4.4	
	11.2	4.7	10.9	8.7	6.8
	14.9	2.7	1.9	3.1	
Means	9.0	6.0	4.6	5.7	6.3

TABLE 23

ANOVA TABLE: EFFECT OF TREATMENTS ON USE AT OFFICE ONLY

Source	df	SS	MS	F	$F_{0.05}$
Treatment	3	65.623	21.874	2.207*	3.24
Phase	1	5.607	5.607	0.556	
T x P	3	23.205	7.735	0.781	
Error	16	158.559	9.910		
Total	23	252.993			

*This is still insignificant if alpha is relaxed at 0.10.

still did not show any significant change. It may be concluded, then, that the desks were not significantly interceptive of use,[1] and, more importantly, that the use at the desks was largely "new" use, or use that would not have occurred if the desks had not been operated. The interpretation of the results made previously that use of the office and desks stemmed from different or independent factors, appears to be valid.

The data in Table 24, the total daily use arranged by treatment level, was tested to determine if the amount of "new" use was significant. The results of the ANOVA are summarized in Table 25. These F values proved insignificant at an alpha level of 0.05; in this case the alpha level was relaxed to 0.10 in order to favor the library user by reducing the false acceptance of the null hypothesis that the desks made no difference in the amount of use, versus the alternate, that a greater proportion of the need for service was satisfied. At the alpha level of 0.10, the null hypothesis was rejected, and the amount of "new" use was considered to be significant.

Type of Use

A chi square test was used to compare the type of use experienced at the office and desks, that is, the type of question asked by patrons. The three categories of questions were described in Chapter VI. The summary distributions

---

[1] That is, they were not significantly interceptive during the experimental period. Indications of a time trend were discussed in conjunction with re-exposure to the stimulus in the previous section covering population characteristics.

TABLE 24

TOTAL USE AT BOTH OFFICE AND DESKS NORMALIZED BY HEAD COUNT, EXPRESSED AS PERCENTAGES

	Treatment				Means
	0	1	2	3	
Phase 1	6.6	14.5	15.9	16.1	
	7.5	13.1	11.9	13.0	12.3
	6.4	11.0	17.4	13.6	
Phase 2	7.5	19.7	11.8	10.1	
	11.2	15.1	28.1	24.8	14.9
	14.9	11.6	13.5	10.7	
Means	9.0	14.2	16.4	14.7	13.6

TABLE 25

ANOVA TABLE: EFFECT OF TREATMENT ON TOTAL DAILY USE AT BOTH LOCATIONS

Source	DF	SS	MS	F	$F_{0.10}$
Treatment	3	183.625	61.208	2.525	2.46
Phase	1	42.684	42.684	1.761	
T x P	3	8.664	2.888	0.119	
Error	16	387.852	24.241		
Total	23	622.824			

of type of use at the four locations were compiled from the data in Table 15; these figures are shown in Table 26.

The test yielded a value of chi square at 5.69 with six degrees of freedom which is not sufficient to reject the null hypothesis that the four distributions were proportional. Thus, it is concluded that the four locations received essentially the same amounts of the three types of questions. An examination of the chi square contribution from each cell indicates that the office received a somewhat disproportionately higher amount of search questions and that location three fell short of the others in the category of tool related questions. In the first instance, the office may have attracted more search questions because of habit, or possibly because an office seems more appropriate as a location to discuss a rather complicated need than a free standing desk. In the second case, it should be noted that while desk location three was only slightly more removed from the bibliographic tools than any of the other two desks or the office, it was more visually isolated than the other points; thus, visibility seems to have been an influence on this type of use. This point will be further discussed in conjunction with the variable of proximate density in the next section dealing with environmental variables.

TABLE 26

SUMMARY OF USE BY TYPE FOR THE FOUR LOCATIONS

Location	Type of Use			Total Use
	1	2	3	
Office	229	19	46	294
Desk 1	84	6	12	102
Desk 2	122	9	17	148
Desk 3	100	3	12	115
Totals	535	37	87	659

Environmental Variables and Prediction Model

The following discussion covers, first, the candidate variables and their measurement, then, the selection of variables for the most economical* prediction model. The latter portion was performed, as previously noted, by use of a forward selection regression computer program.

Table 27 presents a correlation matrix for the environmental variables and the criterion variable. The variable of deviation from PMAT is included although it was not considered as a candidate variable for the prediction model for reasons which are given later in this section.

Criterion Variable

It was originally intended to reduce some of the variation in the Y_i by utilizing an estimate of the size of the media using (i.e., potential service using) population for the normalizing factor. This would have reduced the effect of fluctuations in the proportion of study hall users, yielding a more accurate response value. However, the intent measures from which estimates of the population segments were to have been derived, did not give as good a correlation with use as did the simple head count. The latter measure was used, therefore, as the normalizing factor to reduce apparent shifts in response that were simply functions of population size.

The criterion variable was computed as:

*I.e., economical in terms of the number of independent variables required to adequately predict the response.

TABLE 27

CORRELATION MATRIX FOR ENVIRONMENTAL VARIABLES AND USAGE (y_i)

Variable	1	2	3	4	5	6	7	8	9	10	11
1 y_i	1.000										
2 Visibility v_i	0.351	1.000									
3 Floor Density (Across Phases) f_{1i}	-0.112	0.208	1.000								
4 Floor Density (Within Phases) f_{2i}	0.298	0.186	0.620*	1.000							
5 Focus t_i	0.404	0.292	-0.338	-0.136	1.000						
6 Deviation from PMAT	0.699*	0.026	-0.121	0.107	0.420	1.000					
7 Proximate Density (total area) p_{ti}	0.233	0.511*	-0.089	0.406	0.056	0.013	1.000				
8 Proximate Density p_{2i}	0.232	0.555*	0.304	0.378	-0.212	-0.373	0.696*	1.000			
9 Proximate Density p_{3i}	-0.238	0.112	-0.030	0.125	-0.514*	-0.536*	0.640*	0.706*	1.000		
10 Proximate Density p_{4i}	0.070	0.287	-0.069	0.341	-0.282	-0.315	0.833*	0.718*	0.845*	1.000	
11 Proximate Density p_{5i}	0.091	0.346	0.014	0.272	-0.387	-0.282	0.782*	0.745*	0.896*	0.924*	1.000

* These correlations were significantly different from zero at an alpha level of 0.05.

$$y_i = \frac{u_i}{h_i} (100)$$

where: u_i = the use tally for the ith day

h_i = head count for the ith day

i = 1, 2, ..., 18

The data used in the computation of y_i are available in Tables 14 and 15; the values of y_i are shown in Table 34.

Desk Positions

The model was run with and without the binary variables for desk position. The correlations of these variables and the other variables are given in Table 28.

The dummy variables were considered as blocking variables; that is to account for variation due to desk position which was unrelated to the specific measures represented by the other variables. However, a test for significance of the sum of squares accounted for by these variables was performed in order to satisfy the first objective of this study, which was to demonstrate that the service usage could be changed by moving the service.

An attempt was made to determine the effect, if any, of the desk position on the areal distribution of users, independently of the general regression model. The floor maps were divided into six sectors or zones of unequal size based roughly on natural boundaries or defining areas where the types of use were similar. The numbers of users in each sector were then tallied on a daily basis from the mapping.

TABLE 28

CORRELATIONS OF D_i WITH OTHER VARIABLES IN GENERAL MODEL

Variable	Correlations	
	d_1	d_2
y_i	-0.3425	0.5030*
Visibility (v_i)	-0.0305	0.6104*
Floor Density (f_{2i})	0.1941	0.4659*
Focus (t_i)	-0.6419*	0.4972*
Proximate Density (p_{ti})	0.4620	0.1598
Proximate Density (p_{Ei})	0.7496*	-0.1137
d_1 Desk Position	1.0000	-0.5000*
d_2 Desk Position	-0.5000*	1.0000

*These correlations are significantly different than zero at an alpha level of 0.05.

As a first step the null treatment days were compared by means of a chi square test. The value of the test statistic was 109.16 with 25 degrees of freedom. This indicates that the probability that the samples came from the same distribution was less than 0.001. No further investigation was made for any effect created by the desks would be inseparable from the considerable daily variation.

Deviation from the Point of Minimum Aggregate Travel

The PMAT was located daily by use of the areal mapping. It fell most often in the map module with the coordinates 3,5. Table 29 gives the occurrence by cell coordinates by phases. The summer session demonstrated somewhat more variation than the spring semester, presumably because of the lower population density and the concommitant greater choice of seating available. The module with the coordinates 3,5 was the same cell within which desk position number one was located.

This variable displayed the highest correlation of all of the environmental variables with the criterion variable ($r = 0.6987$)*. However, the relationship was in the wrong direction in that deviation from PMAT indicates an increase in cost of access to the service for the total population. Given the direction of correlation, this would indicate that the further the desk was from PMAT the more use could be expected. The move away from PMAT probably corresponds to a move toward better exposure of the facility;

*This is significantly different from zero with an alpha level of 0.05.

TABLE 29

FREQUENCY OF OCCURRENCE OF PMAT BY MODULE COORDINATES BY PHASE OF EXPERIMENTATION

Phase	Module Coordinates				
	(2,4)	(2,5)	(3,4)	(3,5)	(3,6)
1	-	-	3	8	1
2	2	1	3	4	2
Totals	2	1	6	12	3

in the experimental site, the move clearly related to increased focus. The method of measurement of this variable does not permit any definite interpretations, however, and the correlation with usage must be considered as coincidental.

This variable was dropped due to the uncertain interpretation. The values appear in the variable matrix relating to the model, Table 34, but it was not used in any runs of the model.

Visibility

Values for the variable of visibility and the measures used in computing it are given in Table 30. Since the field of vision for desk position number three was confined almost entirely to the main aisle, the values for this position were quite low. The patrons using the lounge furniture in the main aisle appeared to be largely study hall users wanting some place to sit and read between classes, or pairs of students wanting to talk. Both of the other positions were visible to at least a part of the patrons using the reference materials in the two bays in front of the office.

The correlation of visibility with normalized usage was 0.3514*. The concept of this variable in this particular environment is similar to that of proximate density, in the cumulative type of measurement, and the correlations can be seen in Table 27. Visibility is most highly related to the

*This is not significantly different from zero at an alpha level of 0.05.

TABLE 30

VISIBILITY: MEASURES AND COMPUTED VALUES OF THE VARIABLE

Phase	Desk	Users in FOV	Map Ct.	V_i
	1	26	298	8.72
	3	2	362	0.55
	2	22	357	6.16
	3	11	311	3.54
1	2	38	297	12.79
	1	31	294	10.54
	2	62	373	16.62
	3	0	329	0.00
	1	16	359	4.46
	1	16	276	5.79
	3	0	239	0.00
	3	19	251	7.54
	1	11	275	4.00
2	2	27	293	9.22
	2	20	292	6.85
	1	16	323	4.95
	2	28	281	9.96
	3	16	229	6.99

cumulative measurement for the second zone where the inclusive area would be most similar to the field of vision. Surprisingly, it is nearly as highly related to the overall, weighted measure of proximate density; but no apparent reasons can be offered.

Proximate Density

For the purposes of discussion, the two types of measures of this variable will be designated as follows:

p_{ti} = the overall, weighted measure, or total area measure

p_{zi} = will be used to indicate the cumulative, zone measures with z = 2, 3, 4, 5 to indicate a specific zone of measurement.

The values of all these measures appear in Table 34.

With the failure of the deviation from PMAT variable the weighted version of proximate density (p_{ti}) is the only variable remaining that attempts to consider the cost of approach to the service point for the entire area. The correlation of this variable with the criterion measure is only 0.233. This would not be significant at the sample size of the experiment. This form of the variable was seldom selected during runs of the model.

The second version of this variable, p_{zi}, was an afterthought, conceived while analyzing the data after it appeared that p_{ti} had failed to explain a meaningful amount of usage of the service and that deviation from PMAT had

failed to be relevant. It was thought that the values of the correlations for the successive cumulative measures would correlate positively, probably rising as the zones increased in distance to a peak value, then fall off as distance increased; this would define a maximum distance of cost indifference. Since this was not the case, a reevaluation of p_{zi} is called for.

The primary[2] zone, p_{2i}, including the module containing the service desk and contiguous modules was not significantly correlated to y_i. It displayed a higher degree of colinearity with v_i, which is not surprising, considering that the zone involved is similar to the field of vision of the service.

The first three levels of p_{zi} (i.e., p_{2i}, p_{3i} and p_{4i}) seldom entered into the selected sets of independent variables during initial runs of the forward selection regression model and were eliminated early in the trials. The fourth level, p_{5i}, despite its insignificant individual correlation with y_i, made a good showing in combination with other variables, and is included in the final set.

The value and validity of this variable, however, are challenged by the lack of the expected pattern. The following considerations are offered.

---

[2] p_{2i} is considered "primary" since p_{1i} was not considered for the model; the reason for this was given in the discussion of the variable in Chapter VI.

To evaluate the measure p_{5i}, the reader should again refer to the floor maps shown in Figures 5-6. The area encompassed by the fifth cumulative zone covers more than one half of the area of the site and includes most of the shelves and active study areas, i.e., as previously noted, the experimenter's impression was that by and large the extreme ends of the site and most of the eastern half of the site were occupied by study hall users. The area defined by the fifth zone should contain the majority of facilities which generate uncertainty; however, since it is so large, it is also rather amorphous. The interpretation of its meaning in the regression model is that it roughly defined a maximum area of activity within which service use is generated, although it is distorted by inclusion of aisles and office areas.

Floor Density

The floor density, or population density in the site, was computed in two ways: (1) as a measure of deviation of daily population from the mean of the entire period of experimentation (f_{1i}), and, (2) as a measure of daily deviation within each phase (f_{2i}). The second measure was prompted by the differences observed in the total sizes of daily populations between the two phases. All twenty-four days of measurement were included in the computations of the means, although only the eighteen values relating to days of desk

experimentation were used in the model.

The measures used to compute the daily values and the values of the variables are shown in Table 31.

The across phase variable correlated insignificantly with y_i. Since this measure of the variable gave a poor showing in all runs of the model, it was dropped early in the evaluation of results.

The within phase variable yielded an $r = 0.298$. Although this is not significantly different from zero, the variable was selected as useful in combination.

Traffic Focus

Table 32 displays the percentages of users who branched into each of the six aisles. Traffic focus was defined so that the percentage of users who, for example, turned into aisle number six on a day when desk location number two was in use would serve as the value of this variable. The table reflects the change in method of tallying which occurred on the sixth day. Center aisle measurements were taken in addition to the others only on days when the desk was in position number three.

It is readily apparent from the average percentages at the bottom of Table 32 and by consulting Figure 20, that the majority of users turned into the western half of the site.

A chi square test was performed on the count data for the 18 days on which counts were made for all six aisles.

TABLE 31

MEASURES AND VALUES OF THE FLOOR DENSITY VARIABLES

Phase	Number of Observations	Number of Observation Circuits	$\bar{O}_{ji}$	f_{1i} (Across Phases)	f_{2i} (Within Phases)
1	394	8	49.25	-	-
	298	7	42.57	1.11	0.99
	362	8	45.25	1.18	1.06
	357	7	51.00	1.33	1.19
	311	8	38.90	1.02	0.91
	251	7	35.86	-	-
	297	7	42.43	1.11	0.99
	294	7	42.00	1.10	0.98
	373	8	46.63	1.22	1.09
	329	8	41.13	1.07	0.96
	359	8	44.88	1.17	1.05
	273	8	34.13	-	-
Subtotals	3898	91	$M_1 = 42.84$		
2	210	8	26.25	-	-
	264	8	33.00	-	-
	276	8	34.50	0.90	1.02
	239	8	29.88	0.78	0.89
	252	8	31.50	0.82	0.93
	275	8	34.38	0.90	1.02
	293	8	36.63	0.96	1.08
	292	8	36.50	0.95	1.08
	323	8	40.38	1.05	1.20
	281	8	35.13	0.92	1.04
	229	8	28.63	0.75	0.85
	309	8	38.63	-	-
Subtotals	3243	96	$M_2 = 33.78$		
Totals	7141	187	$M = 38.19$		

TABLE 32

DAILY PERCENTAGES OF USERS TRAVELLING INTO AISLES ONE TO SIX AFTER ENTERING THE SITE OR TRAVERSING THE MAIN AISLE ON DAYS WHEN LOCATION 3 WAS IN USE

Path	1	2	3	Center	4	5	6
April							
8	-	-	-	-	-	-	-
9	-	-	-	-	-	6.02*	-
10	-	-	-	22.95*	-	-	-
11	-	-	-	-	-	-	15.58*
15	-	-	-	15.47*	-	-	-
16	-	-	-	-	-	-	-
17	2.7	10.1	12.8	-	18.9	17.6	37.84*
18	4.7	8.3	11.9	-	11.9	19.7*	38.86
22	2.9	6.9	12.6	-	14.9	22.4	40.23*
23	1.26	15.82	10.76	27.22*	10.76	12.03	49.37
24	1.27	14.56	10.13	-	13.29	22.78*	37.97
25	5.13	10.26	13.46	-	7.69	21.79	41.67
June							
10	5.2	12.0	3.5	-	25.9	18.1	35.3
11	0.0	8.4	10.84	-	16.9	16.9	47.0
12	2.9	8.1	5.9	-	15.44	16.9*	50.74
13	7.1	13.27	9.7	40.93*	21.24	14.16	34.5
17	4.12	11.34	10.31	36.08*	24.74	18.56	30.93
18	6.56	7.38	7.38	-	14.75	17.2*	46.73
19	4.72	4.72	12.26	-	20.75	16.98	40.57*
20	2.08	9.38	14.58	-	17.71	23.96	32.29*
24	4.46	9.82	6.25	-	21.43	21.43*	36.61
25	1.65	12.4	4.96	-	20.66	23.14	37.19*
26	8.33	10.42	9.38	30.21*	16.67	14.58	40.63
27	4.81	10.58	6.73	-	10.58	25.96	41.34
Means	3.883	10.208	9.636	M=33.61	16.901	18.431	38.703

*Values of the variable traffic focus, t_i.

The value of the test statistic equalled 119.08 with 90 degrees of freedom which is sufficient to reject the null hypothesis that daily patterns were drawn from one population at an alpha level of 0.05.

Focus correlated with normalized usage at 0.40. This is not significantly different from zero.

An attempt could have been made to adjust the values of focus for the first six days of experimentation when the values are suspicious due to the method of measurement; however, the results of the chi square test point out the problem: there was no consistent pattern of traffic. A correlation between y_i and t_i for the fourteen days of consistent measurement yielded a coefficient of correlation of 0.331. The F-ratio was 1.474, indicating that r is not significantly different from zero. The dubious nature of any interpretation of this variable in relation to usage given the inconsistency in measurement is acknowledged.

The Prediction Model

The input matrix of all candidate variables is shown in Table 33. This is presented in the sequence of observation. The variable p_{ti} is shown in coded form, i.e., minus 475, since the method of scoring yielded very large values.

The initial runs of the forward selection regression model using the entire set of variables restricted candidates for entry to only one of the two measures of floor density and only one of the various measures of proximate density.

The choice of candidate variables was narrowed to the following:

v_i -- visibility

f_{2i} -- within phase floor density

t_i -- traffic focus

p_{5i} -- proximate density

$d_{1i,2i}$ -- binary variables of desk location.

Since the forward selection process does not guarantee an optimal model it was necessary to perform additional runs using the program option of "forcing" the entry of the selected combinations of candidate variables. Table 34 presents the results of this process.

The set of p_{2i}, t_i, p_{5i} and $d_{1i,2i}$ was selected as the best combination. As shown in Table 34, this combination can account for 50 percent of the variation, while addition of the remaining variable, v_i, only gives an increment of two tenths of one percent to the regression sum of squares.

Table 35 presents the model building stages. The first variable entered by the program was d_{1i} which had the highest individual correlation. This table shows the cumulative sum of squares for each stage and the increment to the sum of squares contributed by the entering variable. The F-ratio of 2.4 represents the limit below which the model would become insignificant at an alpha level of 0.10; the addition of any other of the full set of variables would have dropped this test statistic below the limit. It should

TABLE 33

VARIABLE MATRIX FOR REGRESSION MODEL

y_i Criterion Measure	v_i Visibility	f_{1i} Floor Density (Across Phases)	f_{2i} Floor Density (Within Phases)	t_i Traffic Focus	p_{ti} Proximate Density (Total Area) Coded as $x_i - 475$	p_{2i}	p_{3i}	p_{4i}	p_{5i}	Deviation from PMAT	d_1 Dummy Variable (Desk Position)	d_2 Dummy Variable (Desk Position)
7.23	8.72	1.11	0.99	6.02	84.0	20.40	56.20	62.20	87.40	6.90	1	0
10.62	0.55	1.18	1.06	22.95	34.8	10.2	26.20	41.30	58.40	16.62	0	0
9.42	6.16	1.33	1.19	15.58	37.8	12.56	19.56	43.96	60.26	11.16	0	1
6.83	3.54	1.02	0.91	15.47	34.5	12.50	24.00	41.00	58.30	12.47	0	0
8.71	12.79	1.11	0.99	37.84	51.5	19.6	27.60	41.30	64.00	2.97	0	1
7.31	10.54	1.10	0.98	19.70	76.8	27.60	43.30	54.50	71.20	0.00	1	0
12.83	16.62	1.22	1.09	40.23	81.0	20.9	31.60	54.40	68.90	11.19	0	1
7.02	0.00	1.07	0.96	27.22	1.0	6.3	16.90	29.60	48.70	12.36	0	0
6.75	4.46	1.17	1.05	22.78	60.7	23.7	44.60	51.80	71.30	0.00	1	0
8.43	5.79	0.90	1.02	16.90	84.1	15.118	48.46	60.42	77.81	0.80	1	0
5.66	0.00	0.78	0.89	40.93	51.8	7.95	29.29	48.12	60.67	5.89	0	0
16.11	7.54	0.82	0.93	36.08	69.4	14.68	30.89	45.97	68.99	29.35	0	0
10.47	4.00	0.90	1.02	17.20	54.2	20.71	47.26	61.08	75.63	0.00	1	0
11.18	9.22	0.96	1.08	40.57	81.9	13.66	21.17	41.99	59.40	22.49	0	1
17.19	6.85	0.95	1.08	32.29	58.1	13.70	22.95	48.29	66.16	18.87	0	1
8.84	4.95	1.05	1.20	21.43	116.0	24.46	52.32	65.63	71.73	9.03	1	0
12.18	9.96	0.92	1.04	37.19	97.2	20.28	32.02	62.98	74.01	16.84	0	1
7.63	6.99	0.75	0.85	30.21	39.4	9.17	27.95	41.92	56.33	4.98	0	0

TABLE 34

CORRELATIONS OF VARIOUS COMBINATIONS OF CANDIDATE VARIABLES AND Y_i

Variables*					Coefficient of Regression		Percentage of Variation
v_i	f_{2i}	t_i	p_{5i}	d_{1-2}	Unadjusted	Adjusted for Degrees of Freedom	
X	X				.424	.358	17.9
X	X			X	.576	.434	33.2
X		X			.472	.417	22.2
X		X		X	.538	.371	29.0
X			X		.353	.264	12.5
X			X	X	.649	.545	42.1
	X		X		.298	.178	8.9
	X		X	X	.685	.596	46.9
	X	X			.538	.495	28.9
	X	X		X	.570	.425	32.5
		X	X		.484	.432	23.4
		X	X	X	.657	.557	43.2
X	X	X			.563	.475	31.7
X	X	X		X	.599	.401	35.8
X		X	X		.500	.387	25.0
X		X	X	X	.661	.485	43.7
X	X		X		.433	.281	18.7
X	X		X	X	.688	.557	47.3
	X	X	X		.570	.485	32.5
	X	X	X	X	.707	.588	50.0
X		X	X		.500	.387	25.0
X		X	X	X	.661	.514	43.7
X	X	X	X		.576	.434	33.2
X	X	X	X	X	.708	.542	50.2

*An "x" in the column indicates the inclusion of a variable in the model.

TABLE 35

THE RESULTS AT EACH STAGE OF THE FORWARD SELECTION REGRESSION PROCEDURE

Stage	Variable Added	Coefficient of Correlation	Standard Error	Sum of Squares	Increment to Sum of Squares	F-Ratio
1	d_{1i}	0.50	2.87	44.7	--	5.4
2	t_i	0.53	2.90	50.23	5.5	3.0
3	p_{5i}	0.58	2.88	59.96	9.7	2.4
4	d_{2i}	0.66	2.78	76.33	16.37	2.5
5	f_{2i}	0.71	2.71	88.35	12.02	2.4

be pointed out that although the sum of squares is reduced at each stage the standard error is practically unchanged.

The regression equation described by the model is given by:

$$y_i = -19.8 + 12.807d_{1i} + 0.0754t_i + (-0.969p_{5i}) + 0.242d_{2i} + (-5.766f_{2i})$$

Values of the observed y_i and those predicted by this model are shown in Table 36. Figure 21 displays this data in pictorial form: the observations and associated predicted values are arranged on the horizontal axis in the rank order of the observed values of y_i. Figure 22 presents the same data in chronological sequence within desk positions. No systematic error was found in the predicted values, so the model appears to be the best one possible given the highly variable data.

To obtain the sum of squares to be attributed to each variable in order to test for their significance in the model; the runs which utilized the other three[3] variables only were consulted. The procedure was as follows:

1. To obtain the sum of squares accounted for by the variable t_i, for example, a run using the subset f_{2i},p_{5i} and the binary variables for location was consulted;

---

[3]That is, the binary variables for desk position are here considered as one variable, as either is meaningless without the other.

TABLE 36

VALUES OF THE OBSERVED AND PREDICTED CRITERION VARIABLE WITH ASSOCIATED RESIDUALS

Observation	Observed	Predicted	Residual
1	7.23	9.18	-1.95
2	10.62	10.12	0.50
3	9.42	10.71	-1.29
4	6.83	7.61	-0.78
5	8.71	10.73	-2.02
6	7.31	6.18	1.13
7	12.83	13.37	-0.54
8	7.02	6.82	0.20
9	6.75	7.33	-0.58
10	8.43	8.07	0.36
11	5.66	9.85	-4.19
12	16.11	12.00	4.11
13	10.47	7.57	2.90
14	11.18	10.98	0.20
15	17.19	11.98	5.21
16	8.84	10.70	-1.86
17	12.18	13.74	-1.56
18	7.63	7.48	0.15

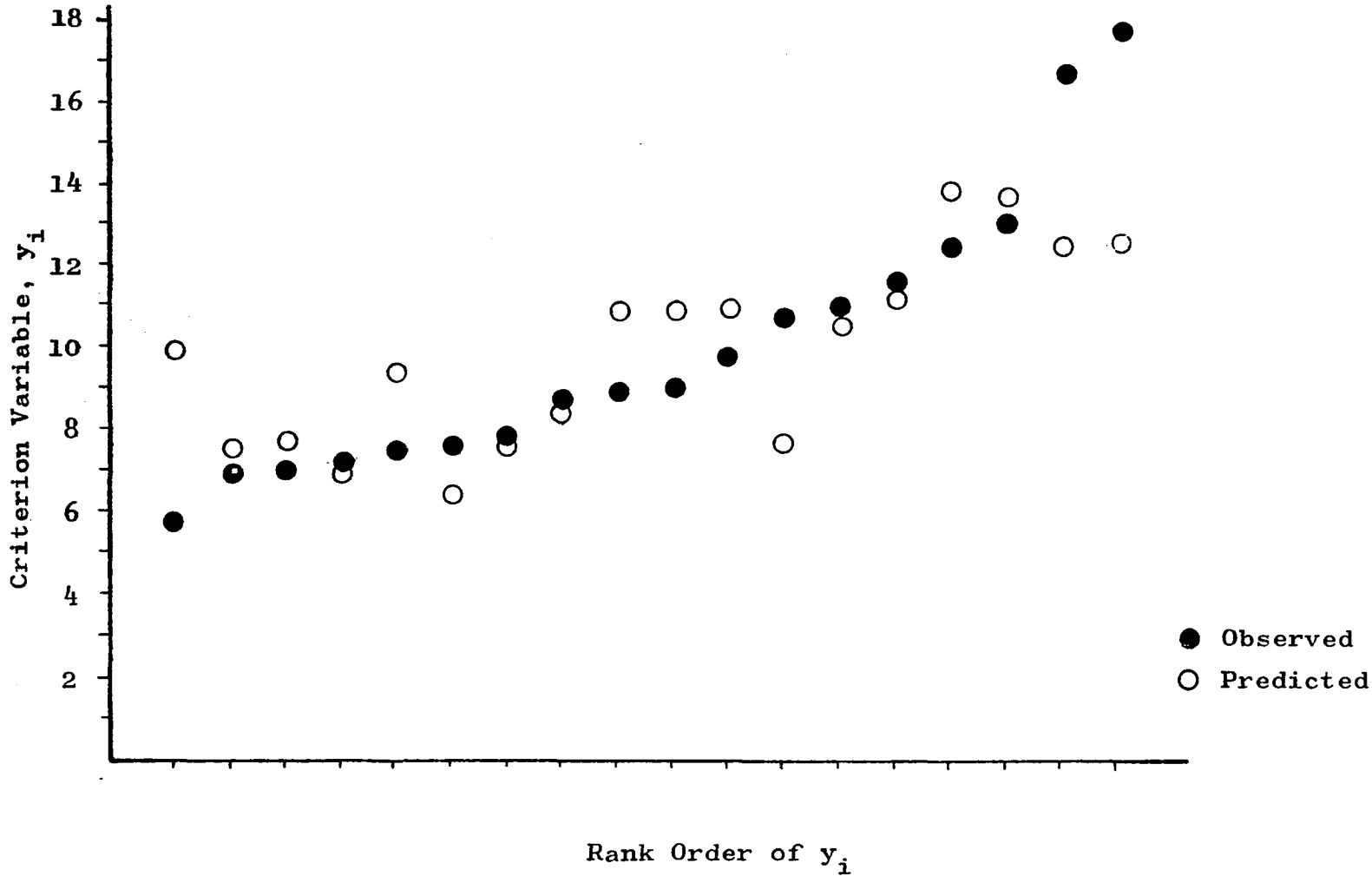


Figure 21. Daily observed and predicted values of the criterion variable, y_i, arranged in the rank order of the observed values of y_i.

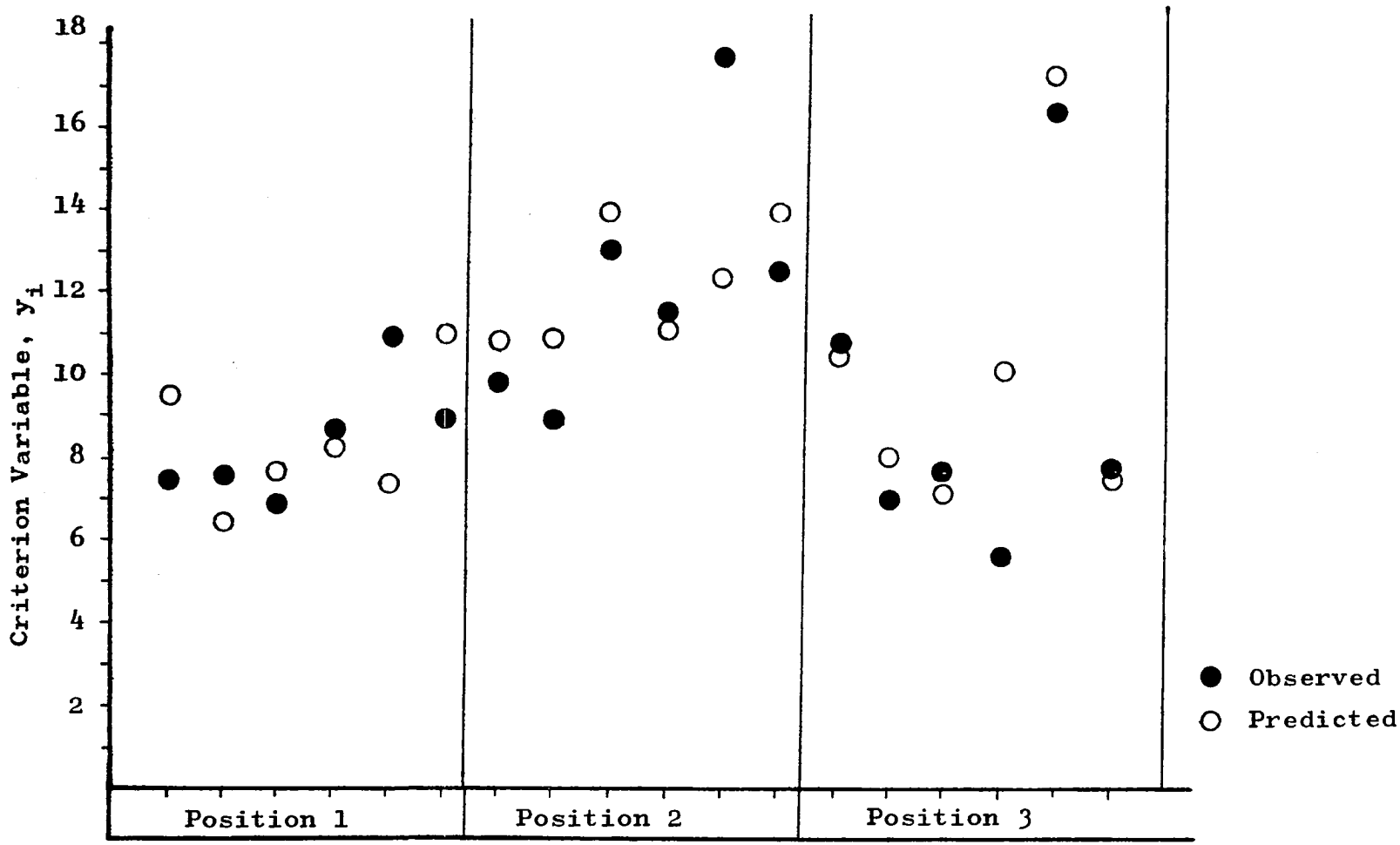


Figure 22. Daily observed and predicted values of the criterion variable, y_i, arranged on the horizontal axis chronologically within desk position.

2. The total sum of squares accounted for by this combination was subtracted from the total sum of squares for the full set which included t_i;
3. The difference represents the sum of squares related to the variable of interest.

This is equivalent to the matrix partitioning procedure described by Graybill (1961). Table 37 demonstrates this process and the resulting individual sum of squares.

Table 38 presents the results of an analysis of the individual contributions of the variables and of the overall model. An alpha level of 0.10 was specified parametrically in running the model, and was considered as the critical level in evaluation of the individual independent variables. The assessment of the overall model will be discussed separately below.

The difference of 8.95 in the sum of squares attributed to the individual independent variables and that accounted for by the overall model occurred because of the non-orthogonality of the data; this condition results in interaction effects which drop out when the x's are treated separately. Since this value is small, it is clear that there were no interactions which would be statistically significant.

Since the binary variables representing desk position were not significant the first goal of this study is unfulfilled; that is, it has not been demonstrated that by

TABLE 37

THE DERIVATION OF THE CONTRIBUTION OF THE INDEPENDENT VARIABLES TO THE REDUCTION OF THE SUM OF SQUARES IN THE BEST MODEL*

Variable Subset				SS Attributed to Subset	SS of Full Model (88,363) Less SS of Subset	Variable Attributed To
f_{2i}	t_i	p_{5i}	$d_{1i,2i}$			
	X	X	X	76.33	12.02	f_{2i}
X		X	X	82.82	5.53	t_i
X	X		X	57.47	30.90	p_{5i}
X	X	X		57.39	30.97	$d_{1i,2i}$

*Each subset here lacks one variable which allows an estimation of the amount of the sum of squares attributable to the missing variable by subtracting the SS accounted for by the subset from the SS of the total set.

TABLE 38

ANOVA TABLE FOR THE REGRESSION MODEL

Source	df	SS	MS	F	$F_{0.10}$
$R(B_t \mid B_{f_2}, B_{p_5}, B_{d_{1,2}})$	1	5.53	5.53	0.75	3.18
$R(B_{f_2} \mid B_t, B_{p_5}, B_{d_{1,2}})$	1	12.02	12.02	1.63	3.18
$R(B_{p_5} \mid B_{f_2}, B_t, B_{d_{1,2}})$	1	30.90	30.90	4.20	3.18
$R(B_{d_{1,2}} \mid B_t, B_{f_2}, B_{p_5})$	2	30.97	15.49	2.10	2.81
Interaction Effects	-	8.95	-	-	-
$R(B_t, B_{f_2}, B_{p_5}, B_{d_{1,2}})$	5	88.363	17.67	2.40	2.39
Deviation	12	88.353	7.36		
Total	17	176.715			

moving the position of the service the amount of usage can be changed. It should be pointed out, however, that when these binary variables are evaluated independently they account for 26.4 percent of the variation and an ANOVA yields an F-value of 2.73 which is significant at an alpha level of 0.10. The author feels that while the first goal of the research is not fulfilled, the result is inconclusive rather than completely negative. It may be that the desk positions chosen for the experiment were too near each other to adequately demonstrate the effect that was expected.

Only one of the quantitative variables proved significant; that was the fifth cumulative zone version of proximate density, p_{5i}. It must be pointed out, however, that this variable had a very low individual correlation with y_i; it is only in combination that it proved worthwhile.

The re-interpretation of the meaning of the variable p_{5i} given earlier in this section was that it is a measure of population density in areas of the site which contained components most likely to generate user uncertainty. It is probably the most uncontaminated of the variables in terms of distinguishing between media users and study hall users in that the latter population segment would not be expected to be observed in "active" areas. The factor that does contaminate this measure is inclusion of "inactive" areas within the zone of measurement, e.g., halls and office areas. More precise identification of the loci of media activity and of

the components most likely to create user uncertainty should improve the value of this variable in predicting use of the service. That is, if the probability of certain components creating uncertainty could be ascertained by quantifying actual problems encountered by users, these probabilities could be used in conjunction with areal measures of population density in the loci of the related components to estimate the market for the service in a given time period.

Both traffic focus and floor density failed to make a significant contribution to the reduction of the sum of squares. Possible reasons for this failure are discussed below:

(a) The author's opinion is that f_{2i} was too contaminated by the lack of distinction between study hall users and potential service users to adequately measure the intensity of use of uncertainty generating components. If the "active" modules were identified and this variable was computed from observations only in those modules, the result would be conceptually equivalent to the variable of p_{5i} as modified by the recommended changes above. This may appear to be worthwhile for further research. What contribution f_{2i} made in the form used for the model can probably be related to the differences between usage in the two phases of the experiment, but it did not perform this function in an entirely adequate manner.

(b) The variable t_i performed poorly in the model. The

problems associated with the measurement of this variable during the experimentation cloud any conclusions, of course, but the author feels that the idea of locating the service near an obligatory point in the traffic pattern in order to enhance users' exposure to the service and lower the cost of approach bears further study. However, this is based more on prior experience than on the results of this research.

The F value obtained for the full model is too borderline to consider significant in light of the comments of Draper and Smith (1966); they state that "In order that an equation should be regarded as a satisfactory predictor (in the sense that the range of response values predicted by the equation is substantial compared with the standard error of the response), the observed F-ratio . . . should exceed not merely the selected percentage point of the F-distribution, but about four times the selected percentage point." They add, "Since (at the time of writing) work on this topic is not complete the 'four times' rule is given here as a current expedient for assessment of regression equations. It is subject to later confirmation."

Since the best model predicted only 50 percent of the variation in reference service usage at best, and it failed a test for statistical significance, the author concludes that the second goal of the research, to construct a prediction model of service usage based on environmental

factors, was not satisfied. It may be necessary to include population characteristics in a model to achieve better prediction, and to do so would require more precision in measurement of such factors than was attempted in the present work.

CHAPTER VIII

SUMMARY AND CONCLUSIONS

The discussion in this chapter will follow the general outline of (A) summary and conclusions, (B) evaluation of the research undertaken and the need for further research.

Summary and Conclusions

In Chapter I the value of the reference service to the library user was shown. The lack of knowledge regarding why users do not use the service was pointed out as well as the lack of knowledge on the part of librarians as to users' information needs. The lack of information in the literature regarding these points prompted a broad systems analysis of library use. Included was a consideration of search strategy as a process constrained by the physical and conceptual structure of the facility and the bibliographic tools. An outline of the operational decisions the library user is required to make in order to gain access to the media store was also presented.

After reducing user information needs to three basic types, these needs were analyzed for spatial foci in order to relate them to the problem of placement of a reference service facility within a designed environment.

A search for principles and guidelines for location of such a service was unsatisfactory. Very little appeared in the library literature. The principles from human factors or ergonomics literature were suggestive but not completely acceptable for the reasons given below:

(1) Placement based on frequency of use is intended to reduce the cost of use. This principle is applicable in a fully defined system with routine tasks. If the analyst is not certain that the system is functioning satisfactorily, the use of a component may be a function of its location or display.

(2) Location of components by the principle of sequence of use requires more detailed knowledge than is presently available with regard to the patterns of library usage. Also use of the reference service is probably most often a contingent action and may, thus, occur at any point in the user's sequence of activities.

(3) Functional relationships are often used in the library for the location of various components. The reference service is usually positioned near the bibliographic tools, or conversely. However, this guideline seems too general in this type of application to be entirely satisfactory.

(4) The principle of location based on importance is subjective in nature and is not applicable to the problem under study.

The literature of marketing provided two suggestive

concepts:

1. That of impulse buying or impulse goods;
2. That of interceptive locations in both the market area and the internal store layout.

The applicability to the problem of location of a reference service of both of these ideas were explored.

A synthesis was attempted of all of the material which had been reviewed from the fields of library science, architecture, human factors engineering, and marketing. The result was presented in Chapter III and consists of a general conceptual model of what are designated as "passive systems." Such systems constrain the self-programming of the operator, or user, by their physical and conceptual structures. This model presents a coherent framework for research into the effects of the designed environment on the user.

The concept of environmental programming has been encountered in the literature, but it has not previously been fully defined. It was shown to be a logical extension of the concept of passive systems, in Chapter III, and some of the applications and limitations of this approach to design were explored.

Following the development of a consistent conceptual framework for research, an experiment was undertaken with the two objectives:

(1) To demonstrate that the amount of use received by a reference service could be changed by changing its position

in the environment, and

(2) To attempt to build a regression model using environmental factors as independent variables for predicting the use at the service.

The model

$$\text{Use} = f(\text{awareness}) + g\left(\frac{\text{need}}{\text{cost}}\right) - h(\text{irrational factors})$$

was analyzed for quantifiable independent variables involving

a. visibility of the service

b. distance as the cost of approaching the service

c. a combination variable, traffic focus, based on aspects of both of the above types of variables.

The experimental site was the second floor, Social Sciences Division, of the Bizzell Memorial Library at the University of Oklahoma. With the cooperation of the reference staff of the Library, an experimental reference service was established by moving a desk among three positions within the site for nine two-hour periods in each of two phases of three weeks duration. Reference usage was tallied at the desk by the reference librarian, who was a member of the Library staff. A count of all persons entering the site and their traffic patterns on entering were recorded by an assistant. The experimenter administered a survey instrument at the main entrance to the site and performed the mapping of the spatial distribution of users. From the latter data most of the environmental variables were derived.

The methodology was that of a field experiment: the environment was disturbed as little as possible except for the presence of the stimulus. The administration of the instruments was a disturbance, but it was necessary in order to know who was in the site and why.

Throughout the experimental period the existing reference service continued to function, and measurements were taken at that point which were identical to those taken at the desk. One day of each four was considered a null treatment in that no desk position was used, but all measures were compiled as for the other three days.

With regard to nearly all measures taken, the daily variation was large. For example, the number of users per day, by week were analyzed by a chi square test, and they proved to differ significantly at an alpha level of 0.01.

The experimental desk proved more effective in tapping the demand for reference assistance than did the prior reference facility. An ANOVA was performed to test the hypothesis that the experimental stimulus intercepted, or diverted, use that would have occurred at the existing service facility; it could not be rejected at an alpha level of 0.10. This led to the conclusion that the experimental desk generated "new" usage that would not have occurred in its absence.

Although both usage at the experimental service and at the prior service correlated significantly with the numbers of patrons entering the site, no relationships appeared to exist between the use experienced at the two installations.

A chi square test performed on tallies of use by type of question failed to reject the H_o: that type of use was disproportionate between the three desk positions and the prior service point.

With regard to the responses to the survey instrument, two points were of interest:

(a) Was the daily make-up of the population entering the site similar from day to day so that the various groups could be considered to be matched within each of the two phases?

(b) Were the populations of the two phases dissimilar enough that the experiment could be said to have involved two populations?

These considerations were important to the internal and external validity of the experiment.

Little divergence was shown between daily populations within each phase. However, between phases both the class standing and last-time-on-the-floor responses showed significant differences. The two questions asked above were considered to have been answered positively.

The possible effects of reexposure to the stimulus were investigated. Reexposure appeared to increase the tendency to use the service, however, this conclusion is based largely on a very short time sequence which was not statistically analyzed.

Much of the data was contaminated by the high percentage of daily or high frequency users who appeared to be study hall users rather than media users. The question dealing with intent of use would have provided a means of separating respondents into one of the two classes of patron, however, the responses to this question were further contaminated by either misunderstanding or attempts to give the expected answer. The measure of this factor failed completely, and the anticipated use of the

data to normalize desk usage for the general model was abandoned.

The prediction model was developed utilizing a computerized forward selection regression algorithm. The full matrix of independent variables included:

1. Visibility: v_i, the percentage of users located within the field of vision of an experimental desk.
2. Floor Density: the daily deviation from the mean of the average number of observations during the daily mapping; this was computed (a) f_{1i}, across both phases, and (b) f_{2i}, for each phase.
3. Traffic Focus: t_i, the percentage of entering patrons who passed within 18 feet of the desk position.
4. Deviation of the desk position from the point of minimum aggregate travel: this was measured as percent increase in aggregate travel to the desk position on a daily basis.
5. Proximate Density: a measure of distance from the desk position of the mapped patrons; this was computed (a) for the total area using weighted percentages from zones surrounding the desk positions, and (b) the cumulative percentages for zones two to five surrounding the desk positions. These were designated p_{ti} and p_{2-5i}, respectively.
6. Dummy Variables: two dummy variables were used to describe the qualitative levels of desk position.

Variable number four correlated inversely to expectations leaving no obvious interpretation of the measurement;

it was dropped before building the model.

The final set of candidate independent variables consisted of v_i, f_{2i}, t_i, p_{5i}, and the two dummy variables for desk position. Since the forward selection algorithm does not guarantee an optimal solution, all combinations were tried, with and without the dummy variables. The final set giving the best reduction of the sum of squares was: f_{2i}, t_i, p_{5i} and the binary variables for desk position. This model accounted for only 50 percent of the variation, and was considered to be not significant after an F-test, with the alpha level of 0.10. It was judged unsatisfactory for the two reasons above. The inclusion of population characteristics, adequately measured, was proposed as a possible means of improving the precision of such a model in further research.

Evaluation and the Need for Further Research

The discussion in this section attempts an overall evaluation of the experiment and methodology in conjunction with some brief comments on the applicability of the model in a design situation. Also noted are needs for further research.

In terms of application of such a model the disclaimer is reiterated that each environment may have a different relationship of the independent variables so that a recalibration will be required to extend such a model to another environment. Certain of the variables, however, can be viewed

in a qualitative light.

Focus can be designed into the layout of a floor or partitioned area without prior knowledge of the exact quantitative values that will be experienced. To accomplish this the layout should contain an obligatory point for entering or exiting traffic, or a point where most of the traffic will converge (a focal point), and the reference facility should be located near this point. Still needed is an assessment of the relative roles of cost and perceptual readiness as influences on the usage of the service; this relationship could influence the placement of the service facility with regard to entering or exiting traffic.

As has been pointed out, traffic focus, as measured in this study, is only a partial, and imprecise measure of user exposure to the stimulus. If an economical means of measuring the total exposure can be identified it should prove more effective in predicting service usage.

The variable of floor density was essentially a population calibration factor. The need for a variable of this sort should be obviated by more precise measures of population characteristics that would allow the separation of study hall users from the media users. This variable as applied in this study is contaminated by including both of the disparate segments of the population.

Recommendations concerning this variable and the one p_{5i} reduced both to the same factor: a measure of population

density (or intensity of use) in areas within the site which contain components likely to generate user uncertainty. These recommendations call attention to the operational assumptions which were stated in Chapter VI; the problems created by these will be discussed below.

Although visibility of the service from the work stations did not enter the final model, the writer feels that it should be considered in an environmental design problem. Research in other environments might give a better picture of its contribution to reference usage, since in the experimental site the visibility of the service in any of the three positions was extremely limited.

As previously indicated the model was considered to be inadequate in that it only predicted half of the variation in usage which occurred at the experimental desk. The author feels that the inadequacy of the measures of population characteristics is in large part the reason for the model's failure. The assumption that all users are equally likely to encounter a problem in using the library was required given the lack of a priori knowledge regarding users, and given the failure of the intent question on the instrument, no better guidelines were obtainable. The addition of population characteristics to the other independent variables after an investigation of use patterns may be necessary to achieve a better than 50 percent rate of prediction. That is,

the untapped demand for reference assistance is unknown; it may be largely unreachable through the techniques of environmental programming, but it must be known to fully evaluate the effects of such techniques. Inasmuch as the experimental desk apparently generated "new" use that would not have occurred in its absence, it must have been reaching a previously untouched (and unmeasured) market for such service.

The other assumption, that the probability of encountering uncertainty was equal at all points in the site can also be called into question. Subjective observations, supported somewhat by the mapping, indicated that there were at least two types of violations of this premise. The first concerns the previously mentioned paucity of tool-use questions received at the service points, although there was usually a clustering of patrons at the two index tables. That is, although these users were clearly non-study hall users, their activity generated little use of the service. Whether this is due to the lack of uncertainty in use of the indexes or irrational factors is unknown. The second violation of the assumption, more subjectively arrived at, is the conclusion that there are apparently use zones within the site; i.e., certain types of areas are preferred by users according to their goals of use. For example, as has been mentioned the eastern half of the site appeared to be occupied almost entirely by study hall type users, as were most locations at the extremes in the western side. This self

selected zoning also invalidates the total site measures of cost such as deviation from the point of minimum aggregate travel and proximate density (p_t); the cumulative form of proximate density (p_z) would most likely be skewed by such zoning. The author feels that this phenomenon should be investigated. Although subjective impressions of the attraction of various areas for types of use could be described, experimental verification is required.

Another factor which was not controlled was the effect of what Campbell (1963) called "history," or events taking place between tests that could influence attitudes, use patterns, etc. Longer term experiments are needed to adequately balance out variation introduced in academic library use patterns by class assignments, term papers and tests. The random scheduling of desk positions and the replications of each position are assumed to have adequately balanced this factor, however, given the extent of variation from unexplained sources, a greater time span appears to be required to evaluate seasonal trends and/or the effects of reexposure.

Although the results were inconclusive with regard to the first goal of the study and the predictive model was judged inadequate, the conclusion that the experimental desk attracted previously untapped demand for the service justifies the experiment in that if this conclusion is accepted then the concept of influencing users behavior through

environmental manipulation is supported in general fashion. Further research is needed to identify the variables that will allow one to more accurately predict the response to such manipulation.

REFERENCES AND BIBLIOGRAPHY

Alexander, Christopher. Note on the synthesis of form. Cambridge: Harvard University Press, 1964.

_____, and Poyner, Barry. "The atoms of environmental structure," Emerging methods in environmental design and planning. Proceedings of the Design Methods Group First International Conference, June, 1968, ed. Gary T. Moore (Cambridge: MIT Press, 1970), 308-17.

Arnheim, Rudolf. Visual thinking. Berkeley: University of California Press, 1969.

Barkey, Patrick. "Patterns of student use of a college library," College and Research Libraries, 26:115-18, March 1965.

Bates, Marcia J. User studies: a review for librarians and information scientists. March 1971. (ED 047 738)

Blunt, Charles R., and Others. A general model for simulating information storage and retrieval systems. State College, Pennsylvania: HRB-Singer, Inc., 1966. (AD 636 435)

Campbell, Angus, and Metzner, Charles A. Public use of the library and other sources of information. Revised ed. Ann Arbor: Institute for Social Research, University of Michigan, 1952.

Campbell, Donald T., and Stanley, Julian T. "Experimental and quasi-experimental designs for research in teaching," Handbook on research on teaching, ed. N. L. Gage (Chicago: Rand-McNally, 1963), 171-246.

Clapp, Verner, The future of the research library. Urbana: University of Illinois Press, 1964.

_____. "Some thoughts on the present status and future prospects of reference work," The present status and future prospects of reference/information service. Proceedings of a conference at Columbia University, 1966, ed. Winifred B. Linderman (Chicago: American Library Association, 1967), 1-12.

Committee for New College. Student reactions to study facilities. Amherst, Massachusetts: Committee for New College, 1960.

Crawford, Meredith P. "Concepts of training," Psychological principles in system development, ed. Robert M. Gagne (New York: Holt, Rinehart & Winston, 1962), 301-41.

Deasy, C. M. "When a sociologist gets into the act," American Institute of Architects Journal, 49 (1):72-76, January 1968.

Dixon, N. F. Subliminal perception: the nature of a controversy. London: McGraw-Hill, 1971.

Draper, N. R., and Smith, H. Applied Regression Analysis. New York: John Wiley, 1967.

Eastman, Charles M., and Harper, Joel. "A study of proxemic behavior; toward a predictive model," Environment and Behavior, 3 (4):418-37, December 1971.

Eells, Walter Crosby. "A mistaken conception of the center of population," American Statistical Association Journal, 25:33-40, March 1930.

Ellsworth, Ralph E. Planning college and university library buildings. Boulder, Colorado: Pruett Press, 1968.

Engel, James, and Others. Consumer behavior. New York: Holt, Rinehart & Winston, 1968.

Estabrook, Marina, and Sommer, Robert. "Study habits and extroversion-introversion," Psychological Reports, 19:750, 1966.

Etheredge, William H., and Webb, James. NLU's STATPAC. Monroe, Louisiana: Northeastern Louisiana University Computer Center, 1974. (mimeographed)

Fickes, Eugene W. (Statement in panel discussion). Libraries: building for the future. Proceedings of the Library Building Institute and ALTA Workshop, Detroit, 1965, ed. Robert J. Shaw (Chicago: American Library Association, 1967), 17.

Focke, Helen M. "Library users of information and their needs," The present status and future prospects of reference/information service. Proceedings of a conference at Columbia University, 1966, ed. Winifred B. Linderman (Chicago: American Library Association, 1967), 21-33.

Fogel, Lawrence J. Human information processing. Englewood Cliffs, New Jersey: Prentice-Hall, 1967.

Funk, Ralph. Personal communication. 1973.

Fussler, Herman H., and Simon, Julian L. Patterns in the use of books in large research libraries. Chicago: University of Chicago Press, 1969.

Gist, Ronald R. Retailing: concepts and decisions. New York: John Wiley & Sons, 1968.

Graybill, Franklin A. An introduction to linear statistical models. Vol. 1. New York: McGraw-Hill, 1961.

Griffen, Lloyd, and Clarke, Jack A. "Orientation and instruction of graduate students in the use of the university library; a survey," College and Research Libraries, 33(6):467-72, November 1972.

Grogan, Dennis. Case studies in reference work. London: Archon Books, 1967.

Haas, Warren J. "Student use of New York's libraries," Library Trends, 10:529-40, April 1962.

Haber, Ralph Norman. "How we remember what we see," Scientific American, 222 (5):104-12, May 1970.

_____, and Hershenson, Maurice. The psychology of visual perception. New York: Holt, Rinehart & Winston, 1973.

Hall, Edward T. The hidden dimension. Garden City, New York: Doubleday, Anchor Edition, 1969.

Hamburg, Morris, and Others. A systems analysis of the library and information science statistical data system; pt. 1; Text. Interim report, Project No. 8-0802. Washington: Bureau of Research, U.S. Office of Education, June 1970.

Handler, Benjamin. "Institutional performance and building performance: some implications of the judicial facilities study," Performance concept in buildings; vol. 1; Invited papers. Invited papers presented at a joint conference sponsored by RILEM, ASTM, and CIB ("National Bureau of Standards Special Publication" 361, vol. 1 & 2; Washington: National Bureau of Standards, U.S. Dept. of Commerce, 1972), pp. 83-91.

Long, Dewain O. Use of the Freshman-Sophomore Library by General College Students. Minneapolis: Minnesota University, 1967. (ED 019 936)

Lubans, John, Jr. "Non-use of an academic library," College and Research Libraries, 32 (5):362-67, September 1971.

Lundy, Frank. "C. Y. Thompson Library," Libraries: building for the future. Proceedings of the Library Building Institute and ALTA Workshop, Detroit, 1965, ed. Robert J. Shaw (Chicago: American Library Association, 1967), 89-98.

McCarthy, Francis Joseph. "Human mechanics in relation to equipment," Planning library buildings for service. Proceedings of Library Buildings and Equipment Institute, American Library Association, Kent State University, Kent, Ohio, July 6-8, 1961, ed. Harold L. Roth (Chicago: American Library Association, 1964), 27-33.

McCormick, Ernest J. Human factors engineering. 3rd ed. New York: Mcgraw-Hill, 1970.

McDiarmid, E. W., Jr. "Conditions affecting use of the college library," Library Quarterly, 5:59-77, January 1935.

Manheim, Marvin L. Hierarchical structure: a model of design and planning processes. Cambridge: MIT Press, 1964.

Menzel, Herbert. "The information needs of current scientific research," Library Quarterly, 34:4-19, January 1964.

Metcalf, Keyes. Library lighting. Washington: Association of Research Libraries, 1970.

_____. Planning academic and research library buildings. New York: McGraw-Hill, 1965.

Miller, Irwin, and Freund, John E. Probability and statistics for engineers. Englewood Cliffs, New Jersey: Prentice-Hall, 1965.

Miracle, Gordon E. "Product characteristics and marketing strategy," Perspectives in marketing theory, ed. Jerome B. Kernan and Montrose S. Sommers (New York: Appleton-Century Crofts, 1968), 293-304.

Moor, William C. "The development and preliminary test of behavior related dimensions of information systems," American Society for Information Science. Journal, (January-February, 1972), 50-57.

Hare, Van Court, Jr. Systems analysis: a diagnostic approach. New York: Harcourt, Brace & World, 1967.

Harrelson, Larry, and Others. "Final report of a user survey of the Bizzell Memorial Library with special reference to problems," Norman, Oklahoma: University of Oklahoma Libraries, 1972. (Mimeographed.)

Hart, John Fraser. "Central tendency in areal distributions," Economic Geography, 30 (1):48-59, January 1954.

Historical Evaluation and Research Organization. Study to develop a research program for the design development of modern college libraries. Final report: Contract OEC-1-7-070031-5137, March 15, 1968. (ED 020 762)

Holton, Richard M. "The distinction between convenience goods, shopping goods, and specialty goods," Journal of Marketing, 23:53-56, July 1958.

Jestes, Edward C. "An example of systems analysis: locating a book in a reference room," Special libraries, 59: 722-28, November 1968.

Kerlinger, Fred N., and Pedhazar, Elazar J. Multiple regression in behavioral research. New York: Holt, Rinehart & Winston, 1973.

Kilgour, Frederick G. "Implications for the future of reference information service," The present status and future prospects of reference/information service. Proceedings of a conference at Columbia University, 1966, ed. Winifred B. Linderman (Chicago: American Library Association, 1967), 172-83.

King, Donald W., and Bryant, Edward C. The evaluation of information services and products. Washington: Information Resources Press, 1971.

Knapp, Patricia. College teaching and the college library. ("ACRL Monograph," no. 23.) Chicago: American Library Association, 1959.

Line, Maurice B. "On the design of information systems for human beings," ASLIB Proceedings, 22:320-35, July 1970.

_____. "Student attitudes to the university library," Journal of Documentation, 19:100-17, September 1963.

_____. "Student attitudes to the university library; a second survey at Southampton University," Journal of Documentation, 22:123-35, June 1966.

Nelson, Jerold. "Faculty awareness and attitudes toward academic library reference services: a measure of communication," College and Research Libraries, 34 (5):268-75, September 1973.

Neter, John, and Wasserman, William. Applied linear statistical models; regression, analysis of variance and experimental design. Homewood, Illinois: Richard D. Irwin, 1974.

Nicholson, Natalie N., and Bartlett, Eleanor. "Who uses university libraries?" College and Research Libraries, 23:217-22, 257-59, May 1962.

Nicosia, Francesco M. "Toward a model of consumer decision making," Perspectives in marketing theory, ed. Jerome B. Kernan and Montrose S. Sommers (New York: Appleton-Century-Crofts, 1968), 139-53.

Osmond, Humphry. "Function as the basis of psychiatric ward design," Environmental psychology; man and his physical setting, ed. Harold M. Prohansky and Others (New York: Holt, Rinehart & Winston, 1970), 560-69.

Perin, Constance. With man in mind. Cambridge: MIT Press, 1970.

Pope, P. T., and Welsster, J. T. "The use of an F-statistic in stepwise regression procedures." Technometrics, 14 (2):327-340, May 1972.

Progressive Architecture. "Performance design." Special supplement in issue for August 1967.

Prohansky, Harold M. "Methodology in environmental psychology: problems and issues," Human Factors, 14 (5):451-460.

Ranganathan, S. R. The five laws of library science. Bombay: Asia Publishing House, 1931, reprinted 1963.

osenberg, Victor. "Factors affecting the preferences of industrial personnel for information gathering methods," Information Storage and Retrieval, 3:119-27, July 1967.

Rothstein, Samuel. "The measurement and evaluation of reference service," Library Trends, 12:456-72, January 1964.

Ruesch, Jurgen, and Kees, Weldon. Non-verbal communication. Berkeley: University of California Press, 1956.

Rusch, Charles W. "On the relation of form to behavior," Emerging methods in environmental design and planning. Proceedings of the Design Methods Group First International Conference, June, 1968, ed. Gary T. Moore (Cambridge: MIT Press, 1970), 278-82.

Sanoff, Henry. Techniques of evaluation for designers. Raleigh: Design Research Laboratory, School of Design, North Carolina State University, May 1970.

Schoeffler, Sidney. "Toward a general definition of rational action," Kyklos, 7 (3):245-73, 1954.

Seymour, Carol A., and Schofield, J. L. "Measuring reader failure at the catalog," Library Resources and Technical Services, 17 (1):6-24, Winter 1973.

Simon, Herbert A. "Theories of decision making in economics and behavioral science," American Economic Review, 49 (3):253-83, June 1959.

Slater, Margaret. "Types of use and user in industrial libraries: some impressions," Journal of Documentation, 19:12-19, March 1963.

Sommer, Robert. "The ecology of study areas," Environment and Behavior, 2(3):271-80, December 1970.

_____. Personal space; the behavioral basis of design. New York: Prentice-Hall, 1969.

Steig, Lewis. "Circulation records and the study of college-library use," Library Quarterly, 12:94-108, January 1942.

Stern, Hawkins. "The significance of impulse buying today," Journal of Marketing, 26:59-62, April 1962.

Stevens, Rolland. "The study of the research use of libraries," Library Quarterly, 26:41-51, January 1956.

Swenson, Sally. "Flowchart on library searching techniques," Special Libraries, 56:239-42, April 1965.

Taube, Mortimer J. "Evaluation of information systems for report utilization," Studies in coordinate indexing, ed. Mortimer Taube and Associates (n.p.: Documentation, Inc., 1953), 96-110.

Taylor, Robert S. "Orienting the library to the user," Use, mis-use and non-use of academic libraries. Proceedings of the New York Library Association--College and

University Libraries Section Spring Conference, May 1-2, 1970 (n.p.: College and University Libraries Section, New York Library Association, n.d.), 5-19.

_____. "Question-negotiation and information seeking in libraries," College and Research Libraries, 29 (3): 178-94, May 1968.

Uhl, Kenneth P. "Field experimentation: some problems, pitfalls and perspectives," Science, technology and marketing. Proceedings of the American Marketing Association's Fall 1966 Conference, ed. Raymond M. Haas (Chicago: American Marketing Association, 1966), 561-72.

University of Oklahoma. Merrick Computer Center. ITF Conversational Statistical Package. July 2, 1973, n.p., (Mimeographed.).

Waldhart, Thomas J., and Zweifel, Leroy G. "Organizational patterns of scientific and technical libraries: an examination of three issues," College and Research Libraries, 34 (6):426-35, November 1973.

Wood, D. N. "User studies: a review of the literature from 1966 to 1970," ASLIB Proceedings, 23:11-22, 1971.