AN ABSTRACT OF THE THESIS OF

David Shontz

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"EXPERTISE" IN INFORMATION SEEKING

Abstract approved: Martha L. Hale

Librarians currently view research as an activity mainly driven by literature. Thus, they consider access to literature to be critical, and provide numerous tools to assist patrons in gaining that access. Researchers, however, do not use bibliographic tools regularly. They prefer to trace references in relevant papers, talk with colleagues, and subscribe to key journals to find the information they need. It is hypothesized that researchers search in this fashion because they approach literature in a fundamentally different way than librarians. This difference is illustrated through a model of skill acquisition, showing how researchers develop a "problem-oriented" approach to literature, as opposed to the subject or "aboutness" approach of librarians. It is suggested that the librarian, in order to help the researcher, must have enough knowledge of his/her area of study to grasp the problem as a problem. Further avenues for research are suggested.

"EXPERTISE" IN INFORMATION SEEKING

A Thesis

Presented to

the School of Library and Information Management

EMPORIA STATE UNIVERSITY

In Partial Fulfillment

of the Requirements for the Degree

Master of Library Science

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by

David Shontz

May 1987

Martha L. Hale
Approved for the Major Division

James Lovell
Approved for the Graduate Council

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I. Introduction

> Research scholars, who may make significant contributions to knowledge, seldom possess library skills. Librarians, who possess library skills, seldom do research.[1]

A basic function of the library is to assure access to the intellectual products of society. In the past, the focus of the effort was on acquiring these intellectual products and preserving them. Now these tasks are seen as only a part of the overall role of the library in society, which is to diffuse these intellectual products in an optimally useful manner.

People need information in order to perform tasks important to their lives--to educate themselves, to explore their values, to ascertain facts needed for decision-making, or to satisfy their interests. A very important task which people use information is to create new information. Novelists create information, and they use information sources in order to do so. This study, however, concentrates on a particular group of creators who make extensive efforts to create new knowledge, that is, to create information that is in some sense "true" by virtue of the method used to discover it. These creators are the researchers, in the sciences, social sciences, and humanities.

Many prestigious libraries in the world see research as the main reason for their existence. University libraries generally give research first priority, as do some public libraries. Special libraries are often created specifically to support some particular research effort, such as the nuclear research laboratory at Los Alamos.

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[1]Stephen K. Stoan, "Research and Library Skills: An Analysis and Interpretation," College and Research Libraries 45 (March 1984): 99-109.

The information habits of researchers in universities and Research & Development centers have been studied extensively. The impact of researchers' efforts is perhaps broader than that of any other group in society. In serving this group well, the library can in turn be thought of as making a large contribution to the public welfare. It is to be expected, then, that considerable effort would be spent in analyzing the needs of researchers.

In examining how this effort has translated into service, however, the picture narrows considerably. When librarians speak of their services to scholars, total collection size and comprehensiveness are two highly important factors. A comfortable environment, subject bibliographers, and Selective Dissemination of Information services may be mentioned, but the factor that receives the most attention is the number of volumes. A major requirement for admission into the Association of Research Libraries, the elite group of research libraries in America, is to have a collection of over 1 million volumes.[2] Comprehensive institutions such as the Widener Library at Harvard, or the New York Public Library main branch, promote their overall collection size. More specialized collections, such as the Folger Shakespeare Library, take pride in the intensity with which they collect in their particular area.

It is possible that this emphasis is misleading. One sees the focus on size generally in a library's promotional literature, intended to be meaningful to funding bodies and the general public. When one examines the standards that university libraries use to evaluate themselves, no specific quantity or formula for collection size is mentioned.[3] The drive for size reappears, however, when

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[2]ARL admission standards.

[3]"Standards for University Libraries," College and Research Libraries News (April 1979): 101-11.

the Research Library Group conspectus for collection development is examined. This contains a rating of the collection strength in each subject area. The lower levels are those at which materials are selected from the entire bibliographic output in an area. In order to support a Ph.D. program, and assist "high level" research, the library must collect comprehensively in an area. To get the highest rating, a library must attempt to collect everything printed on that subject.[4]

It is clear, then, that ambitions to collect comprehensively are an overriding concern of a research library. What has yet to be established is why these ambitions are more important than the services that support the use of the collections.

A highly uncomfortable but nonetheless accurate answer would be that the status of such research support services is rather dubious. Researchers rank the reference librarian very low on their list of information sources. They also tend to avoid using the subject access tools that librarians provide as guides to the literature.[5] Many would prefer not to use the library at all. When they do use it, they tend to go to the author-title side of the catalog to look up known items.[6] New services tend to be undervalued and underutilized.[7] It may be, then, that the emphasis on the size of the collection stems from the library's being somewhat at a loss as to how else to serve the researcher.

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[4]RLG conspectus.

[5]Anthony N. Meadows, Communication in Science (London: Butterworth & Co., 1974), pp. 95-111.

[6]Stoan, p. 104.

[7]Albert Rubenstein et al., "Explorations on the Information Seeking Style of Researchers," in Communication Among Scientists and Engineers, ed. Carnot E. Nelson and Donald K. Pollock (Lexington, Mass.: Heath Lexington Books, 1970), pp. 209-232.

It is the contention of this author that the librarian's frustration in serving the research is self-imposed, a result of an overly narrow view of the research process. When librarians teach bibliographic instruction, or "research methods" for more advanced students, they advocate an approach based on the orderly and logical use of bibliographic tools to assemble the various literature to be used in the study. A topic is defined, a search is made, the items found in that search are read and interpreted, and the results are written up. No mention is made of knowledge acquired outside the library. New knowledge rests upon a predictable foundation of past knowledge, located through the various reference works, catalogs, and indexes that librarians acquire or create. Instruction in the use of these tools gives the scholar a method which, if followed properly, will provide him/her with all the materials (within reason) useful for his/her study. Such is the "bibliographic instruction model" of research, described in Section 2.

As was said above, research into the habits of scholars and scientists has shown that they do not use the reference works and indexes in the library to locate a significant part of the information they use. Section 3 discusses the evidence for this statement, and introduces reasons for the phenomenon. The researcher operates in an environment much wider than the access tools can cover, including networks of researchers in similar areas, and the direct use of a large quantity of the primary literature. The process of research is highly unstructured, following paths that access and synthetic tools cannot expect to mark.

How does the researcher manage to make progress with so little direction? Though some would debate it[8], it is difficult to deny that research does indeed

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[8]Constance McCarthy, "The Faculty Problem," Journal of Academic Librarianship 11 (February 1985): 144.

result in new knowledge, and in many cases progress. The rate of discovery, and information about discovery, continues to increase. Now, more than ever, the ways in which researchers seek information must be understood in order for the library to properly fulfill its function of research support.

It is proposed, then, that the beginning of this understanding must come in changing the way in which librarians have traditionally viewed research. Research is not a deliberate, linear practice, capable of being reduced to formulas. Nor is it a wildly illogical or mystical practice that must defy the understanding of those not fully initiated into its methods. It is instead proposed that:

> Research involves basic attitudes and ways of thinking. Research is a craft. Like other crafts, activities are not analyzable...Cause-effect relationships are not clear. Unexpected problems appear. Procedures are not available to describe each aspect of research activity. The learning of craft skills may take years of trial and error. Through practice one learns how to ask research questions, how to conduct research projects, and what to strive for when writing a research paper. Significant research, then, is the outcome of a way of thinking that can be called craftsmanship.[9]

If research is indeed a craft, then studying how craft skills are acquired and used should be important in understanding how researchers develop their skills. This, in turn, would shed light on the reasons for mature researchers' relative disuse of the bibliographic tools librarians consider to be important to those learning research methods. A model of skill acquisition, developed by Hubert and Stuart Dreyfus[10], breaks the skill acquisition process down into five

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[9]Richard L. Daft, "Learning the Craft of Organizational Research," Journal of Management Review 8 (April 1983): 539-40.

[10]Hubert and Stuart Dreyfus, Mind Over Machine: The Power of Human Intuition and Expertise in the Era of the Computer (New York: Free Press, 1986).

separate stages: Novice, Advanced Beginner, Competence, Proficiency, and Expertise. Dreyfus and Dreyfus contend that breaking down problems into specific facts and rules to manipulate them cannot produce performance beyond the competence level. In order to reach proficient or expert performance, a transition to "craft" methods must be made, based on considerable experience with concrete situations and deep involvement in their outcome. In Section 4 this model of skill acquisition will be developed and related specifically to research.

The most important feature of the Dreyfus model of skill acquisition (the Dreyfus model) is its description of the change in methods of handling problems that accompany each level of skill. Sections 5 through 9 will describe these transitions, showing in particular how the student-researcher changes techniques of information seeking as he/she gains experience in research. The relationship of these changes to the properties of the bibliographic tools is discussed. The focus of the Dreyfus model is then turned on librarianship. Section 10 describes the acquisition of expertise in reference work, contending that this, too, is a process that can be modeled as a craft, and thus is able to fit the Dreyfus model's framework. Section 11 then discusses the parallels between the craft of librarianship and the craft of research, clarifying the type of understanding the librarian needs to effectively support the researcher. Specific implications for library service, and implications for future study, are discussed in Section 12.

II. The Research Process as Seen By the Library

A fundamental feature of the librarian's attempts to understand the research process is the assumption that research is what goes on in the library. "Though they [librarians] understand what research means at a scholarly level, in practice they tend to use the word interchangeably with the expression library use [author's emphasis]."[11] The conflation of these terms has led to confusing developments when trying to understand the place of literature searching in research. The identification of library use with research is clearly seen in bibliographic instruction.

A. The Bibliographic Instruction Model: Researchers Do What Librarians Taught Them to Do.

The foundation of this model is that there is a general method for building one's knowledge in a particular area, and that bibliographic instruction forms the background for that method. Specifically, the way of using the library is determined by the organization of the information it contains, and successful research can be ensured (after all, it is a near certainty that something has been written on the topic) by thinking and searching in the way the organization of information supports. There are several variants on the basic theme of bibliographic instruction, but they share a focus on tools, as shall be seen below.

The first approach we shall examine is the "source" based approach[12]. The model for this type of instruction is the one hour library lecture, or possibly an

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[11]Stoan, p. 100.

[12]Defined in Sharon Rogers, "Research Strategies: Bibliographic Instruction for Undergraduates," Library Trends 29 (Summer 1980): 69-74.

elaborate tour. Students are introduced to a number of access tools that they may use in searching for materials. Such courses vary in format from the lecture mentioned above to a "minicourse in basic reference", with assignments designed to teach the student the use of some particular tool[13]. A variant on this method is to integrate bibliographic instruction into a specific course by introducing the appropriate tools in the course itself, or at the reference desk when the student asks for help. This is called, appropriately enough, the "response" approach[14]. In terms of research the assumption is that the more bibliographic tools a researcher knows how to use, the better off he/she will be when searching the literature.

The second method to be examined can be termed the "process" approach[15]. The tools are still taught in the process approach, and are important, but the emphasis is placed on teaching categories of tools along with some methods for using them. An example that is close to the pure process approach is the bibliographic instruction technique of Daniel Gore[16]. One of his objectives is to "...focus [the student's] attention on strategies of search rather than the memorization of great lists of titles."[17] Gore was inspired to teach bibliographic instruction after watching a colleague, an English professor, demonstrate his inability to use a library catalog.

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[13]Stoan, pp. 99-100.

[14]Thomas John Kirk, Jr., "Problems in Library Instruction in Four-Year Colleges," in Educating the Library User, ed. John Lubans, Jr. (New York: Bowker, 1984), p. 99.

[15]Rogers, p. 70.

[16]Daniel Gore, "Teaching Bibliography to College Freshmen," Educational Forum 34 (November 1969): 111-117.

[17]Ibid. p. 112.

After an introduction to bibliography in general, Gore leads his students through the subject catalog, various indexes, the classification scheme, the various types of material found in the reference room, and finally back to the catalog for instruction in filing rules. All of this is preparatory to a discussion of search strategy in general. Gore does not specify a particular strategy, as there are "...usually several ways to solve any sort of bibliographical problem."[18] At the same time, however, he obviously feels that there is an underlying technique for all fields, appropriate for scholars as well as students:

> Who is competent to teach bibliography? Any scholar who has mastered [author's emphasis] the bibliographical problems in his own field, since the principles of procedure are the same in all subject areas.[19]

Another, more recent process approach can be found in Constance Miller's outline of bibliographic instruction in scientific literature. Miller uses Gagne's concept of "learning hierarchies" to develop a sequence in which one should consult various sorts of tools. This model is more flexible than some others, allowing for entry at whatever level of competence the user demonstrates, within limits. The paramount importance of reference sources is still stressed in this method, being "...the glue that holds the mass of information together."[20]

Normally, however, the process and source approaches are combined in some proportion. The Earlham College Program, for instance, can be taken as a

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[18]Ibid. p. 116.

[19]Ibid. p. 117.

[20]Constance R. Miller, "Scientific Literature as Hierarchy: Library Instruction and Robert M. Gagne," College and Research Libraries 43 (September 1982): 387-89.

source-based approach[21]. At Earlham, the bibliographic instruction program is integrated into the curriculum. Discussions of use of sources specifically helpful to the class are a regular part of the course, and librarians often prepare bibliographies for inclusion with the class material. In addition, search strategies for each disciplinary area are discussed. While details vary from subject to subject, the basic idea is to start with an encyclopedia or dictionary, use its bibliography, look at the subject tracings of those books in the card catalog, trace references in those books, and also search in various indexing and abstracting sources[22]. The objective of these courses is not to turn the students into reference librarians, but it is intended to show them how a reference librarian handles questions, and to show that there are reference sources for nearly any topic[23]. The general idea seems to be that while a patron may not be expected to have all the skills of the librarian, it would be desirable to have them be able to do for themselves what the reference librarian would do when searching a topic.

To this point the examples given have focused on bibliographic instruction for undergraduate students. While there are indications that the instructors believe these methods will last their students a lifetime, one might think that library instruction offered to active researchers, or to those students about to be researchers, might take a different approach. Two observations can be made

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[21]Evan Ira Farber, "Library Instruction Throughout The Curriculum: Earlham College Program," in Lubans, pp. 145-62.

[22]Kirk, in Lubans, pp. 91-3. See especially the flowcharts for the process.

[23]Farber, in Lubans, p. 158.

here: 1) Library instruction for researchers is rare.[24] 2) Where one finds faculty instruction offered, it tends to follow the same pattern as bibliographic instruction for students.

This pattern is well demonstrated by the basic outline of a faculty bibliographic instruction course offered at Berger Community College. The students (e. g. the faculty taking the course) must:

1. Define specifically the topic of interest.
2. Locate and read some general information on the topic.
3. Outline all the parameters of the topic.
4. Assess this topic in terms of the type of library research that it will require: book, journal, manuscript, and so on.
5. Create a subject headings array of all possible terms involved with this topic.
6. Begin their search using the subject headings array in a single genre [author's emphasis] source; such as books.
7. Progress logically through all the source genres, expanding the subject headings array as necessary.
8. Document every step: Every index, subject heading, and date searched; every tool used.[25]

The most interesting observation on this course is that in describing it, the instructors often drop the "library" part of "library research", and call it just "research", for instance, "Teaching research methodology is the most difficult

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[24]A perusal of the bibliographies on bibliographic instruction compiled by Hannelore B. Rader in Reference Services Review shows material on faculty attitudes toward library instruction, but not on faculty participation.

[25]Margery Read and Sarah Katherine Thompson, "Instructing College Faculty in the Bibliographic Resources of Their Subject Field: A Case Study," in Lubans, p. 193.

part of the course."[26] And, "students finally grasp what research means when they complete the term assignment, the bibliography, and the log."[27] A mere vocabulary convenience, perhaps, but the implication is quite clear: The backbone of research is the library searching process. While the instructors are "...not trying to produce librarians,"[28] they are still clearly teaching a start-from-scratch method appropriate for beginners in an area. More recent statements on the topic of bibliographic instruction for faculty also reflect this concern for tools, though the main intent is that they pass this knowledge along to students.[29]

Thus source, process, and some mixed approaches to instruction in library use have been examined. In each case it is implied, if not stated directly, that these methods are intended to carry over from educational to research use. All the approaches clearly develop what can be generally referred to as the "bibliographic instruction model" of research, centering on the use of tools, either by specific title or by category.[30] Orderly and careful search patterns are encouraged, in the belief that a thorough knowledge of a subject is necessary in order to make progress in it. Such knowledge should begin in the library. Good library search patterns will locate the relevant knowledge if it is there to be found, as it almost certainly is.

In order to see whether such faith in library search strategies as taught is justified, the actual information seeking patterns of researchers must be

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[26]Ibid.

[27]Ibid. p. 194.

[28]Ibid.

[29]McCarthy, p. 145.

[30]Stoan, p. 100.

examined. If researchers regularly use the tools librarians teach them to use, it is a good indication that the methods of bibliographic instruction have had lasting effect.

III. How Researchers Find Information

The past forty years have seen a large quantity of research on how scientists acquire information. Theoretically, research on how researchers find the particular facts, theories, etc. that provide the background for building new knowledge can be distinguished from research on how researchers find their sources of information, e. g. the journals, books, people, etc. that provide the particular facts, theories, etc. that the researchers use. In practice, however, the distinction often is not made. Questions in surveys compare the importance of literature and indexes to literature without any account of the difference in purpose between the two. In any event, the logical separation between these two types of study will be maintained wherever possible. In brief, we shall find that while researchers use such tools occasionally, the various indexes, abstracts, and catalogs are a relatively minor source of information for research[31]. Far more common are a range of techniques that have nothing to do with the formal bibliographic apparatus at all. As shall be seen, these remain fairly constant across several disciplines.

A. Citations in Relevant Items

The most common method that researchers use to find citations, i. e. sources of information to use, is to peruse the bibliographies of books and journal articles they find to be relevant. A study by Van Styvendaele indicated that only 15% of social scientists' library borrowings and loan requests were identified through indexing and abstracting journals. Nearly 60% of the citations they used were identified through references in books and articles. Van

[31]McCarthy, p. 143.

Styvendaele found a similar pattern among the hard scientists, with 16% of their citations coming from indexes, and 53% from book and article bibliographies.[32] Meadows reports findings that physicists and chemists rank following up references in relevant books and articles as their most important guide to sources.[33] Stieg reports that historians find bibliographies of articles "...to be their most important source, and their use of indexes tends toward highly general trade sources."[34] Stoan reports several other studies that show citations in relevant items to be favored as sources by researchers.[35]

B. Recommendations From Colleagues

While citations in relevant books and journals may be the most common way researchers find sources of information, the most common way to find information in general is through a colleague. Mildren finds this to be the case for scientists and engineers[36]. Physicists in one study ranked personal contacts as second only to the literature itself in importance, while in another study references from conversations with colleagues ranked third behind reading current journals as a source of citations. Chemists rank personal contacts as

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[32]B. J. H. Van Styvendaele, "University Scientists as Seekers of Information: Sources of References to Periodical Literature," Journal of Librarianship 9 (October 1977): 274.

[33]Meadows, p. 95.

[34]Margaret F. Stieg, "The Information Needs of Historians," College and Research Libraries 42 (November 1981): 554.

[35]Stoan, pp. 100-101.

[36]K. W. Mildren, Use of Engineering Literature (London: Butterworths, 1976), p. 3.

somewhat less important than indexing and abstracting services, but personal contacts are still important to them.[37]

Personal communication is also a dominant method of information transfer in psychology. Meetings, seminars, and colloquia are of central importance in disseminating research findings, and those who cannot afford to attend them will engage in correspondence to make up this deficit.[38] Of particular interest here is the role that certain psychologists play as "gatekeepers".[39] These individuals spend almost all of their time in oral communication, some of it attending various conferences both as speaker and listener, and the rest in transmitting the information gathered at these conferences to colleagues.[40] Not all psychologists are favorably disposed toward such informal communication, however. Some believe it to be a form of "piracy" on others' ideas.[41] These individuals appear to be a small minority, most valuing personal contact highly.

Personal communication has also been found to be important in philosophy, and bears some similarities to psychology, in that "gatekeepers" function there as

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[37]Meadows, p. 94.

[38]American Psychological Association, Project on Scientific Information Exchange in Psychology, v. 1, Scientific Activity and Information Problems of Selected Psychologists: A Preliminary Survey (Washington, D. C.: American Psychological Association, 1963), pp. 4-7.

[39]The APA Project itself calls them "information men".

[40]Ibid. pp. 4-7. The overall pattern fits that discussed in Thomas J. Allen and Stephen I. Cohen, "Information Flow in Research and Developmental Laboratories," Administration Science Quarterly (1969): 12-19.

[41]APA Project, v. 2 (1965), pp. 45-6.

well. Their main function seems to be to provide citations, however, since humanities scholars in general tend to work alone.[42]

C. Regular Reading and Browsing

Reading in general ranks high in importance among the information sources for researchers, in that it provides the information they use directly, and thus provides a source for bibliographical references. Though many of them begrudge the time it takes to read, they usually do so, if only to ensure intellectual priority for their ideas.[43] Consulting past literature has also been shown to correlate highly with creativity in research.[44] The average scientist scans ten journals regularly[45], taking in about 3000 articles per year, 10% of which are read in detail.[46] There is considerable individual variance in the regular reading habits of individuals, some spending most of their time reading, others almost none.[47] Those that do not read tend to rely on a reading gatekeeper similar to the oral gatekeeper mentioned above[48].

A distinction can be made between regular scanning of a core set of journals and browsing, wherein a researcher may spend time examining journals

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[42]Jim Basker, "Philosophers' Information Habits," Library and Information News 7 (no. 25, 1984): 2-10.

[43]Meadows, p. 92.

[44]Robert E. Maizell, "Information Gathering Patterns and Creativity: A Study of Research Chemists in an Industrial Research Laboratory," American Documentation 9 (1960): 10.

[45]C. W. Hanson, "Research on Users' Needs: Where is it Getting Us?" Aslib Proceedings 16 (February 1964): 65.

[46]Meadows, p. 111.

[47]APA Project, 1963, p. 10.

[48]Ibid. See also Allen & Cohen.

and books directly in some more or less systematic way. Stoan has described the importance of browsing to researchers, for whom it is an irreplaceable source for serendipitous discoveries.[49] Researchers often browse to discover specific information as well.[50] In general, browsing is used as a direct way to acquire information that falls outside the regular reading sphere of the researcher.

D. Researchers' Use of Bibliographic Tools

Bibliographic tools are not as popular as some other methods of gaining access to the literature researchers need, but they do play a role. First of all, it is apparent that researchers strongly favor certain types of tools. As noted earlier, Van Styvendaele found that researchers gathered about 15% of their sources from indexing and abstracting services. When he analyzed this 15% into specific tools, he found that Current Contents type publications (including a library SDI service of that type) produced well over half the citations, and citation indexes produced another 26.1%. Chemical Abstracts had an 11% share, and the rest split about 5%.[51]

The bibliographic tools that researchers use parallel their non-bibliographic search techniques, leaving chance aside. The use of cited references is paralleled by a citation index, in that the citation index can go forward in time in the same manner that references in articles go backward. The listing in the citation index indicates that some fact in the particular study being searched was

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[49]Stoan, pp. 108-9.

[50]Patricia Willard and Viva Teece, "The Browser and the Public Library," Public Library Quarterly 4 (Spring 1983): 55-63.

[51]Van Styvendaele, pp. 271-72.

in some fashion relevant to a later study, just as a footnote indicates a relevant idea in a past study.

Current Contents, furthermore, is nothing more than a tool for remotely browsing contents pages. While the content of the article is not present, the title or author is often enough for the researcher to know if the article is worth a closer look. And while there is no true equivalent of a colleague's recommendations in print, a review article, a form of bibliographic control found in disciplinary journals, is usually focused on some particular research trend closely enough to be useful, and the discussion of the articles is often evaluative, enhancing their value. Researchers read such articles regularly[52] and they form a growing part of the scientific literature. Interestingly enough, writers of review literature find much of their material in the bibliographies of other review articles.[53]

Also to be noted is that none of the bibliographic tools described above have any form of content as a major access point. Current Contents is arranged generally by journal, and a review article does not contain any sort of index. In citation indexes the major access point is the cited author. It appears, then, that researchers are avoiding the subject access tools almost entirely.

E. Computer Databases

The computer database has not yet made its way into bibliographic instruction in any significant way,[54] and as such does not appear in the

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[52]Meadows, p. 111.

[53]Harris Cooper, "Literature Searching Strategies of Integrative Research Reviewers," Educational Psychology in Practice (July 1985): 80-81.

[54]Rogers, p. 76.

bibliographic instruction model of research described in Section 2. The computer database can be used as a subject access tool, however, and is expected to have a major impact on research scholarship. It is thus important to examine whether the availability of computer databases has changed researchers' information seeking patterns.

Van Styvendaele included a category for citations found through computer databases in his study. The databases accounted for few citations, but he attributed this to the relative youth of database searching.[55] However, more recent surveys have found that computer databases continue to be underused. Raitt, in his study of research and development facilities in Europe, found that "computerized databases and SDI's were rarely used either as a source of information or for keeping up-to-date."[56] A survey of university faculty concerning their database searching habits encountered problems with small response, attributed in part to a lack of interest in database searching.[57] Respondents to these surveys continued to indicate that oral communication was the most important form of information to them.[58]

These findings may be interpreted as illustrating the researcher's ignorance of proper library searching procedures, as personal idiosyncracies of their information seeking style, or as indicative of certain sorts of shortcomings in the tools that could be overcome, at least partially, by small changes in design

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[55]Van Styvendaele, p. 276.

[56]David I. Raitt, "The Information-Seeking and Communication Habits of Scientists and Engineers," American Society for Information Science Proceedings (1985), p. 321.

[57]Christine L. Borgman, Donald O. Case, and Dorothy Ingebretsen, "University Faculty Use of Computerized Databases: An Assessment of Needs and Resources," Online Review 9 (April 1985): 311.

[58]Raitt, p. 321.

or coverage. Indeed, this is the ordinary sense in which findings of underuse of tools are interpreted by librarians.[59] It is the contention of this author, however, that the difference between the information seeking habits taught in the bibliographic instruction model and those actually used by researchers reflect a fundamental difference in method, which is in turn determined by a difference in the way the information gained in these searches is used.

Fundamental to the understanding of this difference in use of information is a clear distinction between the purpose of literature searching and the purpose of research. Literature searching is done in order to find information about past research efforts, and learn from them. Research, on the other hand, is undertaken to extend knowledge. In this sense, then, the bibliographic instruction model tends to confuse learning and research. Both learning and research are often referred to as "creation of new knowledge", where learning is the creation of new knowledge within a person, and research is the creation of new knowledge for society.[60] Such an identification may be conceptually accurate and enlightening within its sphere, but when discussing library support of research it proves confusing. Learning and research are two very different things, related sequentially--the student learns about some chosen area of knowledge, eventually acquiring enough of that knowledge to be able to see how to contribute to it. This will be illustrated through the use of a model of skills acquisition developed by Hubert and Stuart Dreyfus.[61] The model of learning

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[59]See the Encyclopedia of Library and Information Science, eds. Allan Kent, Harold Lancour, and Jay E. Daily, v. 22 (New York: Marcel Dekker, 1977), p. 233, for a list of such difficulties.

[60]Robert Grover, personal communication.

[61]Dreyfus and Dreyfus, Mind Over Machine.

that is presented will focus on that type of learning which prepares a person to undertake research.

The Dreyfus model of skill acquisition is a response to a long tradition of rationalist philosophy, and more recently artificial intelligence research, that holds problem solving in any situation to be a matter of breaking the problem into its component parts, reasoning through the parts, and logically combining them again to produce a solution. Thomas Hobbes called this process "reckoning",[62] and its central example is the process of solving a mathematics problem.

Dreyfus and Dreyfus contend that few problem-solving situations in real life resemble the clear-cut procedures in mathematics. Far more common are "unstructured" problems, ones with a "...potentially unlimited number of possibly relevant facts and features...", and no clear way of determining the relationships between them.[63] Examples of this type of problem are flying an airplane, managing a corporation, and any sort of social interaction. Expertise in these types of skills is acquired through experience with a vast number of particular situations, and making associations between present situations and those experienced previously. It is also noted that problems that <u>can</u> be solved through logical procedures are often solved by experience, especially if the logical possibilities become too great to handle conveniently. An example of such a skill is master-level chess.[64]

As was stated in the introduction, it is the author's contention that research can be represented as a craft, an unstructured skill, one acquired

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[62]Ibid. p. 2.

[63]Ibid. p. 20.

[64]Ibid. p. 35.

through practice and experiences of a certain kind. The Dreyfus model of skill acquisition will be used to illustrate how mastery of research occurs. In using this model, it will be demonstrated that the bibliographic instruction model is appropriate for those learning about some area of knowledge, in that it is geared to finding literature on topics of interest. For those attempting to create new knowledge, in the sense of knowledge new to society, methods of literature searching must be used that allow for the pursuit of a special type of problem to be known as the research problem. A research problem starts as a perceived anomaly in the structure of a discipline, the resolution of which may require ideas from other disciplines related in a logical, not topical, sense. The Dreyfus model will illustrate the nature of the transition from learning to research, and the shift in methods of literature searching will be studied in particular.

IV. An Alternative Model: Research as Acquired Skill

The Dreyfus model divides skill acquisition into five stages: Novice, Advanced Beginner, Competence, Proficiency, and Expertise.[65] Each stage will be illustrated with the examples Dreyfus and Dreyfus used, and then will be extended to cover the more general development from student to researcher.

Stage 1: Novice

When acquiring a new skill, the learner is first taught objective facts and features relevant to the skill and rules for recognizing what to do when the features are detected. The features are called "context-free" elements, for their appearance signals the learner to perform a certain action regardless of the surrounding situation. For example, rules in driving concerning the distance to follow other cars, or the speeds at which to shift, are first presented as context-free, i. e. when the speedometer reads 30 mph, shift to third gear. One such rule in chess is to always trade pieces with the opponent if the value of the piece captured is greater than that of the piece lost.

In the training of the researcher, the novice is first set to learning the basic facts and rules that govern the phenomena covered by the discipline. In chemistry and biology, one spends the first several courses learning specific chemical names and reactions, or specific biological theories and names of organisms. The basic fact structure of the discipline is being conveyed. The novice may never be required to search for any sort of information beyond the textbook.

Stage 2: Advanced Beginner

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[65]Dreyfus and Dreyfus, pp. 21-36. All examples other than those dealing with students and researchers come from this section, unless otherwise noted.

This stage is reached after a novice has had some experience in coping with situations. More rules are brought in, but additional elements from the environment are being considered as well. A beginning driver learns to use engine noises to tell when to shift, as well as watching the speedometer. A chess player begins to be able to spot certain strong and weak positions, without being able to define explicitly what these would be.

The student researcher acquires experience through reacting to controlled situations. The chemistry student performs standard experiments, and learns that the resulting mixture may not always be the right shade of a certain color, but that certain chemicals are present nonetheless. An anatomy student learns to recognize body structures despite individual differences. The beginning philosopher learns to look for and use definitions, and have some sense of when the author is deviating from them. At this level students may begin to select topics of interest, but their reading is still guided.

Stage 3: Competence

This is a critical stage for the learner of a skill. The learner is incorporating more and more of the situational elements of the task into his/her rules for proceeding. At this level, unless the learner consciously develops a plan for decision making the profusion of situational variables becomes overwhelming. The plan developed helps to determine which variables are important and which are not, avoiding the overload.

Dreyfus and Dreyfus use the example of chess. The competent player studies the position carefully before making any choice as to what to do, analyzing possible positions and assessing their value. The player then creates a plan based on the features of that position, and will pursue it regardless of other events occurring on the board. The plan the competent performer develops

through a careful consideration of all possibly relevant rules then allows for narrowing down the number of possibilities that must be considered.

Choosing this plan is a very serious process for the competent performer, as he/she now begins to feel responsibility for the outcome of the situation. The calculation of alternatives is detached, but the performer is subsequently involved in the situation. Both successful and unsuccessful outcomes produce vivid memories at this stage.

Dreyfus and Dreyfus contend that this is the highest stage one can reach through examining the features of a situation and developing rules for future actions. Since feature detection and rule following are the central features of computer operation, it follows that computers can only attain competent performance levels. Specifically, we may act as problem-solvers when faced with unfamiliar situations where we must consider features and rules, but in familiar situations other methods take over, as shall be shown.

The researcher-in-training at this stage has a basic knowledge of a discipline, and is now ready to undertake carefully planned ventures into self-directed learning. This requires specific procedures for searching for information, and for narrowing down topics sufficiently to allow thorough study. The student is still exploring what is known at this point, but is trying to extend that search beyond what is taught in the classroom.

Stage 4: Proficiency

Achieving proficiency in a skill marks a crucial transition point in the learning process. At this level the performer must move away from refining rules and isolating facts to using the results of experience in understanding a situation.

A proficient performer is deeply involved in a situation, viewing it from a perspective shaped by experience of many past situations. The scene is not decomposed into its elements and features, but is perceived as a whole. Elements in this whole stand out as significant, but they are not chosen deliberately, as occurs with the competent performer. Situations are understood by intuition, not as some mystical sense of attunement, but rather a process of subconsciously recalling whole situations that are closely related to the present one.

The proficient performer recognizes situations intuitively, but must still detach him/herself in order to decide what to do. A chess player may intuitively realize that the other player is open to attack, but must consider carefully how the attack is to proceed. Thus, involvement in a situation is not complete, but must be interrupted to deliberate on actions.

This stage of proficiency in knowledge creation may be reached while the researcher is still an undergraduate, but it marks a major transition in his/her capabilities and approach. The researcher will continue to learn more about the discipline, for this is something that never stops. At the proficiency level, however, there is a new type of study that appears. The student will generally have picked out some part of the discipline that is of particular interest, and will have explored in it extensively through reading and with the help of instructors. This type of learning usually takes place in graduate school. The researcher will have explored this area deeply enough to recognize that some of the knowledge offered is incomplete or wrong. At this point the researcher begins to acquire information that bears on that anomaly, attempting to formalize it into a research problem, as opposed to learning about subjects. The budding researcher will not as yet intuitively develop strategies for investigating

that problem, either in the literature or in the field. The chemistry student may become suspicious of a certain formula, but lack the conceptual means for designing a study to investigate it. The philosophy student just knows that some theory is off target, but has no firmly developed perspective from which to attack it. With proper deliberation each of these investigators may find ways to deal with their situation. At this stage the student-researcher will switch from the bibliographic instruction method of literature searching to the researcher's methods, but will not yet be sure of how to pursue a research problem in the literature.

Stage 5: Expertise

"When things are proceeding normally, experts don't solve problems and don't make decisions: They do what normally works."[66]

At the expert level the performer is understanding and solving problems in the same mental act. The master chess player does not manipulate pieces, but rather lives in a world of opportunities and threats, forces and counterforces. Expert pilots do not fly their planes, but rather experience flying directly.

The expert researcher not only senses the anomaly in a particular area of knowledge, but intuits how that knowledge must be changed to fit reality. Hypotheses spring to mind without conscious deliberation. The research process then becomes an example of what Dreyfus and Dreyfus call deliberative rationality. In this process the expert carefully checks the hypothesis he/she has arrived at intuitively by accepted methods. In physics this may mean constructing a cyclotron, in philosophy developing an appropriate logical argument. In traditional philosophy of science terms, this is known as separating the context of discovery from the context of justification. In discovering the

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[66]Ibid. p. 31.

answer to a question, the expert is not conscious of the use of any sort of logical deliberation at all. However, that answer must then be logically related to the rest of knowledge through experimental methodology or rational development.[67]

In the following sections, the Dreyfus model will be applied to information seeking in research, with an analysis of the bibliographic access (reference) tools that are appropriate to each level of skill. At the same time the reasons for leaving previously successful information seeking methods behind will be explained. Table 4-1 summarizes the important issues for understanding the Dreyfus model (see next page). In this table, the Skill Level refers to the level of performance of the individual. The Components are the various elements of the situation, both those determinable in isolation from the situation (context-free) and those only perceptible in context (situational). The Perspective is the overall view of the situation that determines which components are important, and which are not. The Decision area refers to how the action the individual performs was arrived at, either by analytic deliberation or by intuition. The Commitment is the level of involvement in a situation.

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[67]Abraham Kaplan, The Conduct of Inquiry: Methodology for Behavioral Science (San Francisco: Chandler, 1964), pp. 3-11.

TABLE 4-1. Five Stages of Skill Acquisition

Skill Level	Components	Perspective	Decision	Commitment
1. Novice	Context-free	None	Analytical	Detached
2. Advanced Beginner	Context-free and situational	None	Analytical	Detached
3. Competent	Context-free and situational	Chosen	Analytical	Detached understanding and deciding. Involved in outcome
4. Proficient	Context-free and situational	Experienced	Analytical	Involved understanding. Detached deciding
5. Expert	Context-free and situational	Experienced	Intuitive	Involved

V. The Researcher in Training: The Novice

When first starting out in a discipline, the researcher in training actually does nothing involved with research at all. The basic facts relevant to the discipline are what is taught at this level, and independent literature searching is usually not required. The textbook, lectures, and perhaps some suggested outside reading are all that is necessary or desirable. This pattern is supported by studies that show library use to be rather sporadic among undergraduates, concentrated in a few courses for the most part. From the freshman through senior levels, and even graduate courses, over half require no library use at all, even for directed reading.[68]

When novice-level students are required to search for information, it is often in the form of finding a certain amount of material from which a theme paper of some sort must be assembled. There are two types of bibliographical tools that are appropriate for this type of search. The first are the various dictionaries, encyclopedias, handbooks, and guides to the literature that may be found in the reference collection of any college or university library. These works provide the necessary background for beginning a search on a topic, providing definitions and a starting set of citations to provide entry into the subject literature, usually chosen and ordered for the use of the novice searcher. These synthetic tools are highly general in nature, intended for use by the normally more diffuse audiences that study a discipline at the novice level.

The other type of bibliographic tool that the novice may be required to use, or may find useful, is a basic general index. The model for this type of index is the library catalog, which attempts to organize all the various kinds of

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[68]Stoan, p. 104.

literature, written at many intellectual levels, into a system that the most inexperienced patron can use. It is generally one of the earliest bibliographic tools taught in library instruction.[69] It is thus apparent that the catalog is considered to be an appropriate tool for novices to learn to use. When the background and effectiveness of its subject heading system is examined, however, it may be difficult to sustain this belief.

A. Subject Headings in the Library Catalog

The Library of Congress Subject Headings (LCSH) forms the backbone of subject retrieval of books in nearly all research libraries today. It has also been the target of heavy criticism from classification theorists. The apparently random collection of normal, inverted, and subdivided headings defies the understanding of all but a few of the highly initiated. "There are so many individual quirks about it [LCSH] that to learn it thoroughly would appear to require a lifetime of attention to detailed exceptions by which one acquires 'The mind of LC'."[70] Of course patrons, especially novice searchers, have not spent their lives in the study of subject headings; therefore, what has been produced is a retrieval system that allows success on the first try for students in only 20% of the cases.[71]

Insight into the problems of LCSH may be gained by investigating the theory behind its construction. While the direct connection is tenuous, the

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[69]See Section 2 above.

[70]Francis Miksa, The Subject in the Dictionary Catalog from Cutter to the Present (Chicago: American Library Association, 1983), p. 3. Miksa cites a number of sources criticizing LCSH.

[71]Marcia Bates, "Subject Access in Online Catalogs: A Design Model," Journal of the American Society for Information Science 37 (November 1986): 358.

inspiration for LCSH comes from the principles of subject analysis developed by Charles Ammi Cutter.[72] The background of Cutter's thought is important in understanding how he arrived at these principles. It is very hard to trace, however, as he cites no sources in his Rules for a Dictionary Catalog.[73] Miksa has succeeded in tracing Cutter's ideas to a philosophic school that took its inspiration from John Locke, opposing the idealism of David Hume. The particular branch that influenced Cutter was called Scottish Common Sense Realism.[74]

As its name indicates, the Scottish Realists took a very straightforward view of the world. In analyzing their thinking processes, they concluded that they perceived actual objects, not just ideas. What is perceived actually exists. And it is not only material objects that are perceptible, but fundamental abstract properties and values, such as good and bad, merit and demerit.[75]

The specifics of Cutter's derivations are interesting, and Miksa gives a full account of them.[76] The important point for this discussion is that Cutter had a specific method for determining what the subject of a work is, based on a particular view of user psychology that allowed for precise divisions between abstract and concrete, individual and universal, etc. This led directly to his famous statement on how to determine the subject of a work:

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[72]Lois Mai Chan, Library of Congress Subject Headings: Principles and Application (Littleton, Colo.: Libraries Unlimited, 1978), p. 14

[73]Charles Ammi Cutter, Rules for a Dictionary Catalog, 4th ed., (Washington, D. C.: U. S. Government Printing Office, 1904).

[74]Scottish Realism for short. Miksa, pp. 38-9.

[75]Ibid.

[76]Ibid. pp. 40-44.

161. Enter a work under its subject heading, not under the heading of a class which includes that subject.[77]

This is Cutter's principle of specific entry, and he believed it to be a very simple one. Later scholarship has shown that subject analysis is anything but a simple matter.[78] One wonders, then, why Cutter never acknowledged his philosophical debt directly. The reason, as far as can be detected, seems to be that when Cutter was formulating his ideas all educated individuals shared his point of view. Scottish Realism dominated the American educational scene at the time when Cutter and many other important library figures were in college. Cutter in particular got a heavy dose, as Scottish Realism was the main theme of all education at Harvard University during his attendance there.[79] The result of this approach is a model of knowledge that features rather general and highly discrete categories. It has trouble accounting for relationships between subjects, and for subjects with complex descriptions.[80]

The principle of specific entry is only part of the story, however. Once a method for identifying subjects was enunciated, Cutter needed a method for deriving the names of these subjects. This became his principle of common usage:

General rules, always applicable for the choice of names of subjects, can no more be given than rules without exception in grammar. Usage in

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[77]Cutter, quoted in Miksa, p. 10.

[78]For instance see Patrick Wilson, Two Kinds of Power: An Essay on Bibliographical Control, University of California Publications; Librarianship: 5 (Berkeley, Calif.: University of California Press, 1968), pp. 68-77.

[79]Miksa, pp. 40-41.

[80]Ibid. pp. 9, 395.

both cases is the supreme arbiter--the usage in the present case, not of the cataloger but of the public in speaking of subjects.[81]

When referring to the public, Cutter did not begin with any specific group. Rather, he started from Scottish Realist epistemological principles. These implied that all readers knew the single names of subjects, especially "individual subjects", i. e. names of people and places.[82] Cutter then divided his audience into two general groups: "Desultory readers" and "advanced readers". The desultory readers were the most common group, and they came to the library to find something on a favorite topic, usually a person or place. They wanted something fast, and did not want to look in more than one place. The advanced readers, on the other hand, were willing to plan search strategies and take advantage of any hierarchical relationships and handy collocations that could be found.[83]

For the purpose of discussion novice searchers may be considered to be "desultory readers", not because they are desultory people but because they are not required to do more at this point in their education. The researchers would be considered by Cutter to be "advanced readers". The result of trying to serve both these groups is a mixture of "see" references, inverted headings, and subdivisions intended to keep related subjects together in some way. Cutter believed that rules of common usage and subject form should be flexible, but gave no real clue as to just where common usage or subject collocation should give way to each other.[84] It is common to blame the inconsistencies of subject

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[81]Cutter, p. 69, quoted in Miksa, p. 15.

[82]Ibid. p. 80.

[83]Ibid. pp. 78-80.

[84]Cutter, in Miksa, p. 15.

work on Cutter's principles, for they are easily interpreted as conflicting. Miksa's analysis, however, seems to indicate that Cutter was a clear and consistent thinker, and had interpretations of his principles that were as consistent as one could expect them to be. It was not Cutter, however, that initially assembled LCSH. He was on the committee that assembled the 1895 ALA list of subject headings, but his comments were general and submitted through another person.[85] His influence on LCSH seems to have extended no further than his general principles, and even these were interpreted far differently from the era when he originally wrote them. The fourth edition of his Rules, issued in 1904, is not substantially different from his second edition, written during the 1870's. The ascendance of Melvil Dewey in librarianship marked a turn toward pragmatism, away from the theoretical discussions Cutter undertook. Thus, by the time LCSH was being formulated, the philosophical foundations of Cutter's work had all but disappeared.[86] Subsequent Librarians of Congress and individual catalogers have interpreted them individually, producing layers of inconsistency in the volume considered as a whole.

Thus it is apparent that the library catalog is organized along principles torn between two masters, the serious scholar and the ordinary individual or beginning student. It is apparent that such a system cannot serve researchers with great efficiency. And even if the principles had been applied consistently, they would tend to produce headings too general to be of great use to the researcher, since the headings would aim to cover the entire contents of a work. The terminology the researchers use would not be seen, as the general intent of subject schemes is to be understandable by non-specialists. At the same time,

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[85]Ibid. p. 162.

[86]Ibid. pp. 162-64.