The Model of Science and Scientific Models in Librarianship

TERRENCE A. BROOKS

ABSTRACT

GOLDHOR'S CHALLENGE TO LIBRARIANSHIP to find invariant, universal relationships among library variables is discussed. Scientific problem solving is seen within the context of Kuhnian science, and research in librarianship is considered as not having the characteristics of Kuhnian science. The work of librarianship is analyzed as primarily a discussion of values, or post hoc rationalization of events. It is concluded that library problem solving will not succeed until fundamental problems are addressed.

INTRODUCTION

Herbert Goldhor's (1972) *An Introduction to Scientific Research in Librarianship* is a textbook of the application of scientific methods to the solution of library problems. This discussion examines one part of the scientific method, the use of theoretical models, as a partial explanation for the apparent lack of progress in solving library problems.

A model is a mental framework for the experimental manipulation of library and information variables, their measurement and evaluation, and the production of knowledge about libraries. A scientific model serves to define variables, shape crucial experiments, and predict results. Historically, library models have been cast in the narrow framework of operations research formulas of a library or as a library process such as circulation activity. It is often a larger unstated philosophical research model, however, that gives mathematical formulas their relevance and explanatory power.

At present there is no dominant theoretical research framework in

Terrence A. Brooks, Graduate School of Library and Information Science, University of Washington, FM-30, Seattle, WA 98195
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library and information science. There is a cosmopolitan research front with many different methods being used within many different research frameworks. Unfortunately, there is little overlap of methodologies among theoretical frameworks, thus thwarting the sharing of knowledge and the comparison of results. By contrast, it is clear that Herbert Goldhor's model of research in librarianship is predicated on the discovery of invariant, universal causal laws existing among library phenomena.

> The scientific method of inquiry itself makes certain assumptions, and not everyone in the field of librarianship accepts them as true. One of these is the assumption that invariant, universal causal relationships exist between variables—such as books and readers; if this assumption is indeed false as regards books and readers, and if, instead, the individual occurrences of a phenomenon in librarianship are governed largely or entirely by chance or accident, then research in this area of librarianship is doomed to failure. (Goldhor, 1972, p. 14)

The argument of this discussion is that the current methods of research in librarianship preclude the discovery of such universals.

Goldhor's Challenge to Librarianship

Just how difficult can library problem solving be? Surely it doesn't rank up there with brain surgery or cancer research. Isn't it just a subspecies of management science, psychology, or even sociology? Can't we borrow some techniques from an allied social science and clean up these library problems? Libraries have been around for thousands of years, why haven't these problems been solved long ago?

Some typical problems of librarianship are:

1. *Collection building.* Collection development officers in all types of libraries use their accumulated skills and wisdom to select relevant items from publishers' lists. This is done everyday in thousands of libraries. This activity, however, rests on problematic foundations. Disregarding the selector's strongly held belief in the efficacy of his work, however, how is the relevance of his selections affirmed?
2. *Online database searching.* Online searchers in all types of libraries use their accumulated skills and wisdom to select relevant items from online databases. There is something problematic about this activity, too. Disregarding the online searcher's strongly held belief in the power of computation, how do we demonstrate that relevant items were retrieved?
3. *Assisting people in finding information.* Everyday, reference librarians answer questions by supplying relevant information. But this too is problematic. Disregarding the reference librarian's fervent belief in acting in the public good, how is the relevance of her answers proven?

These examples illustrate that librarianship can function quite successfully despite a shaky theoretical underpinning. That is, the daily

tasks of librarians can be performed, despite the fact that there is no general agreement among librarians—or anyone else—as to what information is, or what relevance means, or what the two together (that is, "relevant information") might be. This ranks as a major irony in the profession because an outsider would surely consider these concepts to lie at the very heart of library problem solving. What is the purpose of library management techniques—managerial accounting, output measures, operations research models, cost/benefit ratios, evaluation research, and so on—if not to help librarians collect and disseminate relevant information? A reductionist could claim that the concept of relevant information drives all library work. A reductionist could even claim that there would be no need for library problem solving if libraries would simply select, store, and supply relevant information in the first place. He would argue that the practical problems of librarianship derive directly from unresolved theoretical problems such as the identification of information, the meaning of relevance, and so on.

The reductionist argument makes the professional research agenda clear. We have only to hone methodological skills to meet these challenges. Goldhor's work falls squarely here in terms of shaping the research agenda and upgrading the research approach. He urges us to employ a positivist methodology of experimentation and measurement to find universal relationships among library variables. Such positivism is in the mainstream of modern science where truth is equated with fact as revealed by scientific experimentation. Unfortunately, the research experience so far seems to indicate that information resists identification and measurement, and relevance may be a chimera. Despite Goldhor's urgings, librarianship is not yet a science because its central theoretical problems remain unsolved (House, et al., 1978). Librarianship is thus orbiting a theoretical black hole. It has for centuries. This is clearly one reason why there are still unsolved library problems.

Many other academic disciplines have found themselves in a similar situation. The common solution is to apply the precepts and methodologies of the sciences to solve fundamental theoretical problems. The natural sciences have often served as a model of scientific endeavor for peripheral or emerging disciplines. There is, in fact, a tradition in librarianship decrying the unscientific attitudes and simple pragmatism of librarians (Butler, 1938). Since the roots of librarianship lie in the book arts and humanities, concerned and ambitious librarians, such as Herbert Goldhor, have envisioned their craft evolving into a science. He urges that the folk wisdom and craft methods of librarianship be systematized into scientific laws and theories. He issues a very important and difficult challenge to the profession of librarianship—his challenge is to transform the practice of a craft into a laboratory science.

Scientific Problem Solving

More than a decade has passed since this challenge was issued, yet

the fundamental nature of librarianship is unchanged. The field has been largely indifferent to Goldhor's passionate advocacy of the scientific method. It has resisted becoming something that it is not—a science—but then it hasn't failed either. The field continues to expand in two areas: the institutional studies of library science and the noninstitutional studies of information science. Both of these have the feel of science to the committed insiders who busy themselves with study and research. Despite extensive theorizing and some empirical work, however, library science is still a craft, and information science has only the promise of a science. Neither discipline exhibits the characteristics of science as described by Kuhn (1970). In a Kuhnian science, investigative work is organized by intellectual structures called paradigms, examples being Copernican astronomy, Newtonian physics, Einsteinian relativity, Darwinian evolution, and so on. Scientists work within such a paradigm applying its rules to specific cases, relying on its structure to devise theoretical explanations, seeking its predictions, and generally doing work that refines or elaborates the paradigm.

> Few people who are not actually practitioners of a mature science realize how much mop-up work of this sort a paradigm leaves to be done or quite how fascinating such work can prove in the execution....Mopping-up operations are what engage most scientists throughout their careers. They constitute what I am here calling normal science....No part of the aim of normal science is to call forth new sorts of phenomena; indeed those that will not fit the box are often not seen at all. Nor do scientists normally aim to invent new theories, and they are often intolerant of those invented by others. Instead, normal-scientific research is directed to the articulation of those phenomena and theories that the paradigm already supplies . . . . *To display more clearly what is meant by* normal or paradigm-based research, let me now attempt to classify and illustrate the problems of which normal science principally consists . . . . There are, I think, only three normal foci for factual scientific investigation....[first] solving problems....[second] predictions from the paradigm theory....[and third] articulate the paradigm theory. (Kuhn, 1970, pp. 24-25)

The record of scholarly work in the library and information sciences is not like this. Instead, research efforts have been episodic, isolated, and noncumulative. What else is to be expected of library school faculty whose teaching has been characterized as "non-research, experience-based, non-cumulative, subjectively selected, possibly additive and relatively out-of-date..." (Houser & Schrader, 1978, p. 124)? As time passes, the theory base of both library and information science appears to be evolving but not necessarily maturing. A variety of research procedures have been used, but few have become refined, and none have coalesced into paradigms or research models. The effect of intellectual fashion in library science can be seen just by examining the earlier compendium published by *Library Trends* (Garrison, 1964) concerned with library problem solving. Methodological fashions come and go. Most of the earlier work is simply ignored as each generation reinvents the field. Kuhn would not call this scholarly busywork normal science. Solving library problems is a noble pursuit, but any effort made without addressing fundamental theoretical problems first is nothing more than

the superficial application of a showy technique. It leaves an empty legacy that future generations of librarians, enamored of some new dazzling business, can ignore at little peril.

Yet the theoretical literature of library and information science grows apace: grants are received, articles written, findings discussed, and opinions traded. How can all this theoretical activity be explained in fields that are, as yet, nonsciences? How can so much effort not result in scientific results and the creation of scientific disciplines? Part of the explanation lies in the various models of science that an adventurous social scientist can employ today. Apparently there are degrees of being scientific—not all "sciences" are equally scientific. Goldhor urges us to employ a very strict kind of science to solve library problems. This is a narrow road that lacks the enticements of a more meandering way.

The Model of Science

In its popular usage, science has become a fuzzy concept. Traditionally, it has been epitomized by public procedures, precise definitions, objective data collection, and replicable findings (Behling, 1980). Such is the positivist tradition of knowledge production. But extreme objectivity is just one of six methods of social science research as presented by Morgan and Smircich (1980) and abstracted in Table 1. This table illustrates at least five other pathways available for social science research, ranging from the exploration of pure subjectivity to the historical method. It is likely that the advocates of each of these methodologies feel that they are really being "scientific." An ecumenical attitude toward these many methods would permit the possibility that useful knowledge in the library and information sciences could be produced from any of them. The literature of library and information science certainly contains examples of all of these types. Consider the following sample selection.

—*Information as subjectivity.* Fox (1983, p. 38) argues that information is not a process or event, that information is not in inscriptions or utterances, and that information has no spatio-temporal form at all.

—*Book selection as semiotics.* Atkinson (1984) describes the psychological state of the book selector as influenced, in part, by the syntagmatic context of a citation. The syntagmatic context of a citation is composed of the string of signs—i.e., names and numbers—of the citation itself.

—*Information as hermeneutics.* Hoffman (1980) argues that information is an integral part of texts themselves. Information is the aggregate of statements, facts, figures, and their meaningful connections. He could use his method to discover if there was more information in this paragraph than the following one.

This short list could easily be extended; there are so many voices, so many methods, and so many results. It is bewildering to regard all these

TABLE 1
SUBJECTIVE/OBJECTIVE CONTINUUM OF METHODOLOGIES IN THE SOCIAL SCIENCES

	Assumptions about nature of reality	*Goal of research*	*Example research method*
Extreme subjectivity	Reality as a projection of human imagination	To obtain insight, revelation	Exploration of pure subjectivity
	Reality as a social construction	To understand how social reality is created	Hermeneutics
	Reality as a realm of symbolic discourse	To understand patterns of symbolic discourse	Semiotics
	Reality as a contextual field of information	To map contexts	Gestalt analysis
	Reality as a concrete process	To study systems process, change	Historical analysis
Extreme objectivity	Reality as a concrete structure	To construct a positivist science	Lab experiments, surveys

Source: From Morgan & Smircich. (1980). The case for qualitative research, p. 492.

claims as equally scientific. It is easier to ignore the greater part of research in the library and information sciences, and that is what most practitioners and researchers do. This can be done with impunity because the first five methodologies in Table 1 produce results that are not generalizable beyond the author's own work or insights for the following reasons:

1. *The uniqueness of a particular analysis.* General laws are difficult to generate when specific libraries, automation systems, user groups, and so on, are described. An extraordinary amount of library "research" is no more than recollections of particular libraries or library practice.
2. *The temporal instability of a particular analysis.* With the march of time, people, institutions and automation systems either grow and flourish (and therefore change) or wither and die (and therefore change). General laws are difficult to generate when their focus of interest will transmute into another form within a year or two.
3. *The difficulty of measurement of a particular analysis.* It is difficult to generalize an analysis when the method of measurement is a private one. For example, only Hoffman can successfully apply his measure of information. The results of a private measurement technique may look like the product of a formal, public procedure, especially when dressed up with the appurtenances of statistical methodology, but it can't be duplicated by anyone else. A lot of library research is based on a nonobjective, informal, or unexpressed method of measurement.

To admit all the methodologies of Table 1 as being equally scientific is to debase the meaning of the concept. It fails to distinguish science from metaphysics, truisms, folk wisdom, fervent belief, or hokum. A scientific theory has the unique characteristic of being one that can be falsified, refuted, and tested (Popper, 1963, p. 37). Only positivist research makes empirical statements that can be falsified through experiment, refuted by evidence, or put to crucial tests. Other methodologies may provide insights, interesting comparisons, topics for debates, and so on, but their findings are not replicable, their methods are not objective, their definitions are not precise, and their procedures are not public. They are not scientific.

Scientific Models

To transform librarianship into a science will require a systematic approach as well as a positivist methodology. The use of paradigms is the systematic method of knowledge production used in the sciences. A scientific paradigm is a set of shared concepts. One of the most distinguishing characteristics of a science is the sense of intellectual progress. Intellectual progress is achieved when paradigms or models are proposed, tested, changed, and tested again. Paradigms serve as the engines to advance knowledge. A paradigm gains adherents and status because it successfully solves long-standing problems that a group of researchers have come to recognize as acute (Kuhn, 1970, p. 23). Kuhn gives examples of paradigmatic work such as the intellectual achievements of Newton in physics, Copernicus in astronomy, and Lavoisier in chemistry. These paradigms reoriented their subject areas, set the proper methods of study and standards for solution, identified crucial validating results, and indicated directions for future research. Such paradigms identify a field of endeavor and act as intellectual micro-institutions (Toulmin, 1972, p. 166) to which anyone who takes up the study must commit himself.

No paradigm currently dominates the field of information science. If one were to be developed, it would at least have the following characteristics:

1. *The origin of information.* Does information originate with people, or in social interactions? Can machines, such as computers, originate information? Can an institution like a library originate information? Once it exists, is information actually inside a library? Inside a book? In a sentence? In a word? In a letter? In the ink of the letter on the page? In the spaces between letters? Do publishers and authors originate information? Where do they get it? Is there information inside a librarian? Is there information inside an online public access system? By selecting citations, isn't a librarian really creating information? Isn't a librarian then like a magician?
2. *The perception of information.* Can information exist without being perceived? Does an unread book contain information? How does one

person transmit information to another person as in a reference interview? Do reference librarians know all the information in a library? If they do, is the information physically inside a reference librarian? If it isn't, what information do they have? What is information about information? How can a librarian differentiate information from noninformation? Is it possible for two librarians to disagree about what is information?

3. *The manifestation of information.* Does information exist in a book or in any other container? Can the information in a container be separated from the container? How does a librarian compare the informativeness of two books? Doesn't this require the identification and measurement of information? How is that done? Books grow brittle and disappear; what happens to the information in them? If a librarian weeds a book, is the information also being weeded? Is it possible to lose information? If it is possible to lose information, then what does it mean to find information?

These questions could be greatly expanded upon. They are only the questions about information that may interest a library problem solver. These are the relevant theoretical questions to ask when a librarian selects a book to be acquired, determines a book for weeding, tosses an earlier edition, tells a patron where to look for an answer, and so on. These are the fundamental questions that library problem solving methodologies must ultimately address.

No paradigm currently dominates the field of library science. Since libraries are institutions that store information, any library science paradigm would necessarily be subsumed by the information science paradigm outlined earlier. But the library science paradigm would also be an institutional model that specified both the internal processes—such as acquisitions and cataloging—as well as external relationships—such as governance and client groups. The library science paradigm would organize into an intellectual whole all types of librarianship, all types of librarians, and all types of libraries and media.

It is unlikely that either of these paradigms will be seen in the near future. As a result, library and information science will continue, as in the past, to import ideas and techniques from other sciences and quasi-sciences in the hope of achieving a breakthrough.

Pessimism about the intractability of solutions to library problems can lead to two premature conclusions. First, that librarianship is somehow doomed to failure, as suggested by Goldhor. This is plainly not true, for the craft of librarianship goes on everyday despite a shaky theoretical foundation. The second premature conclusion is to dismiss the literary corpus of librarianship. Other social sciences have felt self doubt. Freese (1980, p. 63) calls growth in sociological thought more like a random walk than a cumulative progression. To appreciate the written record of librarianship, one must recognize that not all theoretical work has the same purpose. Wagner and Berger (1985) have de-

scribed a similar pessimism in the field of sociology where naysayers have derogated the value of theoretical sociology. Wagner and Berger suggest that there are at least two types of theoretical activity: orienting strategies that are statements of values, and unit theories that are proposals for specific experiments. This typology is also useful for explaining the nonscientific theoretical activity of librarianship.

Orientations, Interpretations, and Value Statements

A large portion of the literary corpus of librarianship serves to orient values or to interpret the phenomena witnessed in the practice of librarianship. In trading opinions about values, library scholars can be very busy but never produce scientific results. For example, when library practice rapidly swings one way or another, driven by economics, a lot of post hoc theoretical rationalization is often necessary. Consider the case of undergraduate libraries. These libraries were introduced as places where young students could find a small collection of the finest books and possibly interact informally with their teachers. The values orientation of the 1930s and 1940s dictated that undergraduate students needed special library treatment. With the passage of time, the academic library establishment discovered the costs of maintaining a separate undergraduate library (Wingate, 1978), and there was a change in values. The new values orientation found it to be discriminatory not to permit undergraduates to use a research collection. In other words, library scholars generated a new values orientation concerning undergraduate libraries that fitted neatly with economic exigencies.

Statements of values or personal witness, like any personal statement, reflect their authors, time, and place. All are worthy because each is one element in the history on the subject. Each statement exists, whether popular or not, in the pantheon of possible points of view. The written corpus of librarianship becomes not a record of intellectual growth but more a record of witness. Consider the competing views of the origin of the academic library offered by Daniel Gore (1967) and Eldred Smith (1969). These value statements have similar beginnings, and even argument elements, while their conclusions are radically different. Both begin with reminiscence—they recall the early academic libraries run by a faculty member. Gore's version has academic libraries being wrested away from the faculty by the rising technical class of librarians. In his view, modern academic libraries are being run by librarian/bureaucrats who are not scholars. On the other hand, Smith focuses on the nature of academic library work, characterizing it as having two aspects—the professional and the clerical. In his view, modern academic libraries are run by professional librarians who are forced to be clerks/bureaucrats. Gore recommends the replacement of academic librarians with scholar/librarians, thus returning to the true origins of academic libraries. Smith recommends giving the professional library work to subject specialists, and letting a business manager/chief librarian take care of the clerical details. Both of these personal statements are worthwhile and add to the body of informed opinion concerning academic libraries. Neither is a scientific statement or paradigm; neither is wrong. They are merely personal opinions.

In librarianship, a lot of effort is spent defending values. Defense is needed when received values are challenged by the new definition of a concept or by threatening empirical results. As an example of the first case, consider the problem of the various meanings of "research strategies" that Jane Robbins-Carter (1986) addresses in an editorial in *Library & Information Science Research*. She defends an older value set that defines "library research" to be research about libraries. She has to defend this meaning from upstarts who would define "library research" as bibliographic instruction.

Empirical results are always a threat to received values because they have the aura of science and can be used as ammunition by the critics of the received values. Librarians do their jobs in political environments; they are naturally loathe to give their critics an advantage. Consider the reception given to the University of Pittsburgh study (Kent, 1979). This study analyzed circulation patterns and found that about 40 percent of academic library acquisitions don't circulate during their first seven years, and that such material has a miniscule probability of circulating thereafter. There are numerous ways to interpret such an empirical finding. Defenders of the status quo in academic libraries immediately recognized the Pittsburgh study as a potential threat to the continued funding of library book budgets. They sought to neutralize any possible threat of such intrusive empiricism. This was done by Schad (1979) who disputed the exact percentages of the study. His strongest argument was not quantitative or even methodological, but based on values. He claimed that the Pittsburgh study did not demonstrate comprehension of the purpose of academic librarianship. In support of this argument, a competing model of academic libraries was immediately offered. Voight (1979) proposed that the majority of scholarly use occurs inside an academic library, thus invalidating all circulation studies. In this way, the perceived enemies of academic libraries (such as university budget officers) are deprived of any potential weapon.

A large percentage of the theoretical work of library science has to do with values orientation such as the defamation of the Pittsburgh study. As the craft becomes more technical, however, there are more instances of experiments, unit theories, or, as Goldhor called them, service studies.

Experiments, Unit Theories, and Service Studies

A unit theory stands on its own, expressing some correlational or causal relationship. It is limited in scope and is much less than a paradigm—these theories are not attempting to explain everything. Merton (1957) has described such theories of the middle range, and Goldhor (1972, p. 8) introduced the idea of a service study—i.e., a small empirical study to improve a library's service. Many doctoral dissertations fall into this category. These unit theories permit some empirical test and a resolution based on measurement. As examples, consider the

theories describing the statistical relationships among library output measures presented by both Childers (1975) and Brooks (1982). Crawford (1984) has presented an ideal relational database design. A classic example of unit theories are the Clapp-Jordan (1965) formulas. Trueswell's (1976) work could be tested. Other theories abound. All are testable although not many are actually submitted to an empirical evaluation and then widely distributed as would happen in a scientific discipline.

Since the testing of empirical theories is relatively new to the science of libraries and information, researchers must struggle with very elementary things such as the formulation of basic concepts. Consider the problem of measuring information using Bradford's law of scattering, the hypothesis being that a literature has a core zone made up of the most important journals and subsequent zones of less productive journals. Fifty years ago, S.C. Bradford (1934) partitioned some sample literatures into three zones and noted a multiplier effect among the number of journals in each zone of the partition. Later researchers, such as Brookes (1968) and Leimkuhler (1967), used graphic techniques to measure the multiplier as the slope of a line. O'Neill (1973), however, demonstrated that these methods are correlated with sample size. Goffman and Warren (1969) suggested an alternative method of producing Bradford multipliers. Another approach was suggested by Egghe (1986). Brooks (in press) demonstrated that both the Goffman/Warren and Egghe approaches were method bound. In response, Egghe (in press) has suggested a group-free Bradford multiplier. After fifty years, it is still unclear how to produce a Bradford multiplier, a fundamental unit of measurement of information science.

This sketch illustrates that library and information science has yet to operationalize successfully even so fundamental a concept as literature clustering. The price of this confusion is that emerging research leaders begin without a firm theoretical base. For example, Prabha (1984) did a Bradford analysis but allowed the counts for a single journal title to span more than one zone. Who is to say that this method is wrong? Pontigo-Martinez (1984) used four zones in his partition, instead of Bradford's three, or the greatest number possible using the method of Goffman and Warren or even the Minimum Perfect Bradford Partition (Brooks, in press). Who is to say that his method is wrong? An analogy might be that information science is where physics was when Galileo worked with falling objects or perhaps where chemistry was when Mendeleyev designed the periodic table of chemical elements. Right now information science is not a science but only the promise of a science.

Conclusion

Just how difficult is library problem solving? It appears to be

exceedingly difficult. The degree of difficulty is exacerbated by a popular focus on short-range management solutions instead of fundamental theoretical problems. Goldhor challenges us with the model of an exact, positivist science. Subsumed in such a model is not only an intellectual organization of paradigmatic science, but also a public, precise, reproducible methodology. This model of science is not currently reflected in the theoretical work of library science. Librarians are really engaged in a discussion of values about the institution of the library. Judging by its intellectual methodology and the focus of its interests, library science will never respond to Goldhor's challenge.

The model of science is hardly reflected in information science, either. Information researchers are just now struggling to codify concepts and agree on units of measurement. There is hope that information science will coalesce into a science at some future point. Real library problem solving awaits the development of a science of information, one that is organized in the model of a science and uses scientific models to produce knowledge. Until then library problems will be very hard to solve. While this article argues for the use of scientific methods in librarianship, it is not itself a work of science. It expresses a personal opinion and thus contributes to the ever increasing body of opinion characteristic of the literature of librarianship.

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