The Invisible Substrate of Information Science

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The explicit, above-the-water-line paradigm of information science is well known and widely discussed. Every disciplinary paradigm, however, contains elements that are less conscious and explicit in the thinking of its practitioners. The purpose of this article is to elucidate key elements of the below-the-water-line portion of the information science paradigm. Particular emphasis is given to information science's role as a meta-science—conducting research and developing theory around the documentary products of other disciplines and activities. The mental activities of the professional practice of the field are seen to center around *representation and organization* of information rather than *knowing* information. It is argued that such representation engages fundamentally different talents and skills from those required in other professions and intellectual disciplines. Methodological approaches and values of information science are also considered.

Introduction

Recently, digital information and new forms of information technology have become the focus of tremendous amounts of attention and energy in our society. Money is pouring into the development of all manner of technologies and information systems. The excitement penetrates not only the business world and the general society, but also academia, where computer scientists, cognitive scientists, and social scientists are thinking about information and the social impacts of information technology in new ways.

This new context poses a challenge to information science. Currently, the wheel is being reinvented every day on the information superhighway. Our expertise is ignored while newcomers to information questions stumble through tens of millions of dollars of research and startup money to rediscover what information science knew in 1960. We in the field need to make our research and theory better known and more understandable to the newcomers flooding in—or be washed away in the flood.

To do that effectively, however, we need to become more fully conscious of the research and practice paradigm from which we operate. A field's paradigm, in Thomas Kuhn's (1970) sense, consists of the core body of theory and methodology of a field, along with an associated world view regarding the phenomena of interest to the field. In the sciences, there is generally an organizing theoretical model of great scope, which generates research questions for decades. (As Kuhn described for the field of physics, first, Newton's Laws, then Einstein's theory of relativity were successive defining theoretical models for that field.)

As will be noted shortly, the explicit paradigm of information science has been very well described before. However, a field's paradigm is much more than the explicit theoretical model it works from. Certain methodological approaches and a world view are generally integrally linked with the questions studied. A field tends to draw people with certain cognitive styles, who produce research of a certain character. The field has a history, great names, stories, customs, mores, and values. One does not work long in information science without knowing the names Wilf Lancaster, Gerard Salton, and Llewellyn C. Puppybreath III, and what they are known for.

Much of the paradigm of any field lurks below the water line, largely unconscious and unarticulated, even by its practitioners. Researchers often soak up the paradigm, understanding the subject matter and what it means in every way to be, say, a physicist or engineer, without being able to articulate it well.

Today, in information science, many newcomers without a background in the field are coming in. At this historical juncture, information scientists need to become more conscious of the thought world we are operating out of, so that we can communicate it more rapidly and effectively to large numbers of new people, and so that we can continue to influence the future of information in the 21st century.

The purpose of this article is to attempt to articulate at least some of those parts of our field that are largely unarticulated ordinarily—to describe the invisible substrate of information science, the part of the field that is below the water line.

Paradigm Above the Water Line

Information science does have an explicit, above-the-water-line, paradigmatic definition, and an understanding of

that explicit expression is important to an understanding of the intrinsic unity of the whole paradigm. Information science is the study of the gathering, organizing, storing, retrieving, and dissemination of information. That definition has been quite stable and unvarying over at least the last 30 years. In fact, in a January 1968 article in this journal, Harold Borko wrote the following:

> Information science is that discipline that investigates the properties and behavior of information, the forces governing the flow of information, and the means of processing information for optimum accessibility and usability. It is concerned with that body of knowledge relating to the origination, collection, organization, storage, retrieval, interpretation, transmission, transformation, and utilization of information. It has both a pure science component, which inquires into the subject without regard to its application, and an applied science component, which develops services and products (Borko, 1968, p. 3).

Paradigm Below the Water Line

The Meta-Field of Information Science

It is first of all important to recognize that information science, like education and journalism, among others, is a field that cuts across, or is orthogonal to, the conventional academic disciplines. All three of the above-named fields deal with distinct parts of the transmission of human knowledge—information science with the storage and retrieval of it in recorded form, education with the teaching and learning of it, and journalism with the discovery and transmission of news. Under these circumstances, such fields cut across all of what we might call "content" disciplines. Art historians focus on the study of art; information scientists, on the other hand, take art information as but one slice of the full range of information content with which we deal. Likewise, art education is but one part of education, etc.

Paisley has made a similar distinction by contrasting behavioral science "level fields" and "variable fields." He defined the former as disciplines that study human behavior at different levels of organization—psychology at the individual level, sociology at the group level, and anthropology at the culture level (Paisley, 1972, p. i). Paisley states that variable fields, on the other hand, look at one variable across all the conventional levels. For example, political science looks at political behavior across the several levels.

Here, however, the distinction being made is between conventional disciplines and meta-disciplines. The meta-disciplines are distinguished by the fact that they are interested in the subject matter of all the conventional disciplines, they do something with that subject matter that is of value for society (see next paragraph), and that something is unique to each meta-discipline. (Though they are research disciplines, the three examples of information science, education, and communication/journalism also have distinct professional cores, which are vital to their natures.)

Information science organizes that subject content for retrieval, education uses teaching skills to convey that knowledge to learners, journalism uses reporting, and writing skills to convey news events to others, etc. In each case, it is not a variable that is being studied, but rather the content of all the conventional disciplines is being shaped and molded for a societal objective through different types of professional activities involving the manipulation and transmission of knowledge.

Research in these various meta-fields analyzes the *processes and domains* associated with the professional activities being carried out in each case. Information seeking and searching, teaching and learning, and communication are (some of) the *processes* being studied in the research of the three example fields of information science, education, and communication research/journalism. These processes are identifiable in human interactions with virtually all kinds of knowledge or information, and contain many research-worthy questions.

Although each field covers all kinds of knowledge or information, each, nonetheless, has particular domains it studies, which cut across all the conventional subject disciplines. These domains are distinguished not by their subject content, which can be highly various, but rather by their rhetorical character in the broadest sense, that is, by their selection, design, and objectives. The *domain* of information science is the universe of recorded information that is selected and retained for later access; the domain of education is curricula; and the domain of journalism is the journalistic product of all the newsworthy areas of life (science reporting, political reporting, etc.).

Note that in each case, the intellectual product of research or of social or cultural activities is selected, designed, and shaped for some social purpose. Different talents, training, and experience are required to select and index documents (information science), to select and organize information in a curriculum to optimize learning (teaching), or to sleuth for information and shape a news story (journalism).

What then, is the nature of that shaping for a purpose in information science, particularly? This can most readily be understood by looking first at the practice of the field. After that, research and theory of information science will be examined in this perspective as well.

The Content of Form

In applied information science, we find ourselves primarily concerned with the form and organization of information, its underlying structure, and only secondarily with its content. In the sciences and humanities, it is the content that is of dominating concern. In fact, the organization of the information they are using is usually virtually or entirely invisible to the practitioners of those disciplines; they have simply never thought of it, never realized that extensive and intellectually demanding work is needed to develop index and database standards, to select and catalog resources, etc.

Most people outside our field do not realize that there is a content to the study of form and organization. I believe that this is one of the chief reasons our field is commonly thought to have no "there" there. The average person, whether Ph.D. scholar or high school graduate, never notices the structure that organizes their information, because they are so caught up in absorbing and relating to the content. And, in fairness to them, they are not interested in the structure. *We* are interested in the structure.

As a practical matter, when one does the work to gather, store, organize, retrieve, and disseminate information—the classic elements of the formal, above-the-water-line paradigm definition of information science—one *necessarily* gets involved with understanding and manipulating its form, structure, and organization. One's attention is drawn, again and again, to these features of the information, simply to get the job done.

People who come into this field, whether formally educated in it or who drift in through a job, sooner or later go through a transformation, wherein they shift their primary focus of attention from the information content to the information form, organization, and structure. The Ph.D. art historian who gets a job working with art history information out of a love of the subject matter eventually finds him- or herself working with the core questions of information science, not of art history.

Being and Representing

The transformation involves even more than a shift in the subject content of one's actions or thoughts, however. Work in the meta-discipline of information science, both at the practical and theoretical levels, draws upon different cognitive talents than most of the work within conventional subject disciplines.

Perhaps the best parallel for illustrating the difference in the mental processing of information scientists and conventional disciplinary practitioners is to use an analogy of the relationship between actors and physicians. We take it for granted that when we see a film or television program like "ER" ("Emergency Room"), that it is actors who portray the physicians, because that is the way it has always been done.

On reflection, however, is it not strange that the people who have the most experience and knowledge about being doctors—the doctors themselves—are not the ones who portray doctors in drama? Why not? Why do not the competitive demands of the television marketplace pressure the heads of networks to hire real physicians—the true experts, after all—to portray physicians in a medical drama?

The answer here is that although the physicians know the most about medicine, *portraying* a physician is different from *being* a physician. Portraying a physician requires a different body of talents than being a physician does. Occasionally, some people have both types of talent, but usually not. Actors, with little or no medical knowledge, but with experience portraying a variety of characters, do a better job at portraying physicians than even physicians themselves do. Is that not remarkable, when we reflect on it?

In like manner, *representing* information—whether you are indexing or formulating a search strategy or helping someone articulate what they want to find—is different from *knowing* the information. After all, the physicians *know* much more about hospitals, medicine, and treating patients. They know so much, it is in their bones, a part of their every action. Yet when called upon to portray a medical situation instead of simply live it, physicians generally make poor actors. A talented actor, without a day's experience in medical school, can do a much better job.

Above, it was said that the rhetorical character of each of the domains of information science, education, and journalism differed from each other and from the conventional disciplines. For information science, a particular kind of representation is at the heart of the rhetorical stance of the field toward its domain, the universe of recorded information. (Here it is left to the other two fields to define their rhetorical stances.) Creating databases and catalogs involves creating representations of forms of information. The skill a reference librarian or information specialist develops also involves representation—figuring out how to conceptualize and represent a user's query, then in turn, translating the query (representing it) into a form an information system uses, which in turn arises from the representations of documents in the information system.

Subject Expertise

A perennial issue in the information field revolves around how much subject knowledge an information specialist needs. Surely, it is said, one must be an expert in molecular biology to be a good information specialist at a biotechnology firm. I am among the many, however, who contest this assumption. I would argue that what one mainly needs is information expertise and talent, not content expertise. The latter is a nice bonus, if it is present, but is not essential.

When taking on a new part, actors sometimes research the context or the role they will play. Such research can enable them to do a better job of acting, but researching hospital life or medicine does not entail getting a medical degree! Actors, in fact, may be looking at entirely different things when they research the role than would ever occur to a doctor living that life. The actor needs different knowledge and different talents to do a good job at portraying physicians. This author was once told by a manager at the National Library of Medicine that some years earlier they had tried using physicians to index the *Index Medicus* database, but had given it up, because the physicians did not do as good a job as trained indexers did.

When an information specialist takes a position at a biotechnology firm, it would be a good idea to read some popular books about molecular biology, and learn who the dominant individuals are and what the major research issues and approaches are. But what will be most important for the

information specialist will be to use information-related talents. People who are attracted to this field generally have somewhere within them, wide subject interests, good skills with language, with getting the big picture about a subject matter, and a knack for operating at the level of *representation* of the subject matter, rather than just working *in* the subject matter.

Over many years of teaching, I have observed that master's students in information science programs complete the mental transformation to thinking like information specialists within a few months. Often they have considerable difficulties during the first few weeks of the program, because *at first it feels alien to think about a resource in terms of the features that matter to the organization and retrieval of it, rather than in terms of mastering its content.* In a job, without formal information training, this transformation process may take longer.

It is argued here, however, that unless that transformation occurs, one cannot do a fully effective job as an information professional. And this claim is made unequivocally. If you want to portray a doctor, you have to be a good actor, not a doctor; if you want to work with information organization and retrieval, you have to be a good information person, not a subject specialist without information training. All the subject expertise in the world is not enough, if you do not possess the mental framework and skills in information work.

If drama and acting were being invented today, instead of deep in the mists of history, people might well be making the primitive assumption today that doctors must play doctors in drama. The beginning assumption would be that to produce good acting, we must use people who are in exactly the same situation found in the play—only pregnant women can portray pregnant women, only physicians play physicians, etc. However, humankind long ago learned that actors, not specialists in the circumstances of the story, are best at acting.

Description of information and retrieval from large bodies of information are quite recent phenomena, however. Collections did not become large enough to require extensive and systematic organizational approaches until the 19th century. Information expertise developed within the library, and later the documentation, fields over many decades, but the numbers of people pursuing these activities were still very small, and marginal to the larger society.

Now at the end of the 20th century, however, the society at large is discovering information and problems of information description and organization. Members of the broader society are consistently committing what we might call the First Fallacy of Information Work; they are thinking that organizing information requires deep subject expertise and no information expertise. In just the last couple of years I have heard of three very well-funded projects of this sort. In one, dozens of historians, exclusively, untrained in cataloging, were hired to catalog historical material, with consequent enormous waste of time and resources as they fumbled their way, finally, to creating a usable indexing vocabulary. In two other projects, educators, also untrained in information work, were enlisted to index educational materials without any guidance from anyone with the least background in information work. In my view, doing this is analogous to hiring physicians to portray physicians in the theater. The sooner society moves beyond this misapprehension of the nature of information work, the better for all.

(Sometimes highly gifted people come into the information field with no training and do well. Likewise, some actors are so naturally talented that training and experience are virtually unneeded for them. But most people in both fields benefit substantially from training and experience.)

My litmus test for the newcomers who are now interested in information work is whether I can observe evidence that they have gone through the transformation of becoming an information expert. That perspective is the *lens* through which information scientists see their world—both at the theoretical and practical levels. It is the single most defining framework element for their world view. There are many other elements to the part of information science that is below the water line, that will be addressed shortly—but this is the single most important, in my view. It is what the newcomer or outsider does not understand; it is what the insider takes for granted (and, therefore, seldom notices or articulates). This perspective drenches the thought and actions of the information person.

Librarianship and Information Science

Both people who call themselves librarians and people who call themselves information scientists share this information perspective. Other fields with which information science might have been thought originally to have much in common, such as computer science, cognitive science, computational linguistics, or artificial intelligence, did not, in fact, prove to be good matches. Both librarianship and practical information science, however, have the information perspective in common, and the phrase "library and information science," or "LIS" has become very common. I believe that this coming together arose out of deep commonalities in the way of thinking and doing necessary to achieve information work objectives. Although librarianship and information science have very different histories, and, in particular, different methodological and values perspectives, they have in common this core relationship to the material of their work.

Information Science Theory

The distinctive perspective discussed above in information work carries over into and is integral to the theory of the information science field as well. In 1970, this journal changed its name from *American Documentation* to the current one. That year is as good as any to mark the formal recognition of the then new field. The roots of information science lay in the theory and thinking in several related fields, particularly in the years 1930–1970. What those

disparate theories and elements had in common, what enabled them to be a reasonably coherent intellectual discipline when brought together in information science, was their interest in form and structure, in particular, in information form and structure.

General systems theory (Bertalanffy, 1968; also see historical discussion in Checkland, 1981), which developed in the 1930s, and later, drew attention to the underlying structure or pattern in social and technical institutions and devices. Once the concept of the system was developed and elaborated, systems could be recognized as underlying countless disparate social, technical, and physical phenomena. Operations research and systems analysis during and after World War II developed these ideas further into a variety of applied realms.

John von Neumann and Oskar Morgenstern (1967) developed game theory—which is a way of seeing an underlying common structure of trade-offs, benefits, and disadvantages within a variety of social and economic situations. Perhaps the best-known game is "Prisoner's Dilemma." In this situation, the prosecution's evidence on a burglary charge against two men is weak. The prosecutor interrogates each man separately. Each is told that if he confesses and his friend does not, he will receive a light sentence, and that if he does not confess and his companion implicates *him*, he will receive a very heavy sentence. If both confess, they will receive a middling sentence, and if neither confesses they will both get a smaller charge of carrying a concealed weapon (Jones, 1980, 77–78). This game structure is so robust that it underlies countless cops and robbers programs on television, as the television writers imaginatively play out one variation or another of it.

This recognition of underlying structures arose throughout the social and engineering sciences in the decades after the War. If we define information as "the pattern of organization of matter and energy" (Parker, 1974, p. 10), then structure of all kinds itself constitutes a kind of information.

Within that context, Norbert Wiener (1961) identified the role of information in natural and human systems in a way that had never been recognized before. He developed the field of cybernetics, which deals with the guiding or governing of systems. Wiener demonstrated that many systems are driven not primarily or only by mechanical forces, but rather are determined by the feedback of information to a governing element of the system. We are so used to hearing the word "feedback" in its common everyday overuse, that the iconoclastic newness of Wiener's ideas has been lost nowadays. Wiener demonstrated, for example, that when a person reaches for an object, it is done with continual visual and kinesthetic feedback of information, which is then used to guide the hand further. The hand does not just respond to a single impulse from the brain to "grab."

The early work that had perhaps the single most electrifying impact of all was Claude Shannon's information theory (Shannon & Weaver, 1949). Shannon measured the amount of information going through a telephone wire. Such a development does not on the face of it sound revolutionary, but it was, because his theory was abstract, and seemingly applicable to many environments, including not only the technical but also human language and psychology. The limits of Shannon's theory for the human sciences ultimately became evident, but the legacy of a new, abstract sense of information as reducing uncertainty by measurable amounts, remained.

Similarly, Noam Chomsky's theory of syntactic structures in language (1971)—common patterns underlying all different languages—had an explosive impact on several fields, and was the engine that drove the field of psycholinguistics. (In my 1980 study of citations in information science, Chomsky was the single most cited individual. Bates, 1980, p. 278.) Miller, Galanter, and Pribram, three well-known psychologists, wrote *Plans and the Structure of Behavior* (1960), which posited a common underlying structure to all, or virtually all, human behaviors.

Gregory Bateson identified common underlying structures in learning, as well as metastructures in communication that reference other communications. He dealt, thus, in many different ways with representations of representations. It is no accident that the cover of the 1972 paperback of his *Steps to An Ecology of Mind* states: "The new information sciences can lead to a new understanding of man" (Bateson, 1972). He is best known for his "double-bind" theory of schizophrenia, but his theories referred to all communication and learning among humans, not just schizophrenia. When biochemical explanations of schizophrenia largely displaced psychological ones, Bateson's work fell into disrepute—a most unfortunate failure of our intellectual world to recognize that he was a theorist of all communication, not just the unhealthy communications that are sometimes associated with dysfunctional families.

Finally, the recognition of form and structure found the purest expression of all in G. Spencer–Brown's *Laws of Form* (1972), which analyzed the mathematical rudiments, the absolute essence, of form. Spencer–Brown started with the irreducibly smallest distinction, a single difference, which is the first step in creating form out of the formless void.

All of these thinkers had in common the recognition of underlying structure beneath the surface variety of life. They contributed theories and ideas of great power, and were the theoretical driving force behind information science. Thus, when the theory and practice of information science are described in the way they have been so far in this article, the close relationship between theory and practice—through their common attention to form and structure, becomes evident.

Information Science's Universe

So both from a theoretical and a practical standpoint, information scientists are interested in the structure of their object of study—information. But as the examples above indicate, many social and behavioral scientists are interested in underlying structures also. Many engineers, based on Shannon's and Wiener's work, among others, are interested

in information. What, then, is distinctive about information science's theory?

We are interested in information as a social and psychological phenomenon. The information we study generally originates from human agency in some way, whether it is the data beamed down from a satellite or the text of a book on Immanuel Kant's philosophy. Our primary, but not sole focus, is on *recorded* information and people's relationship to it.

All the academic disciplines can be seen as studying different universes of phenomena. The natural sciences study the natural world, the social sciences study the social worlds produced by humans, and the arts and humanities study the content and context of the creative works of human beings, from philosophy to literature to the arts.

Information science has a distinct universe that it studies also—the world of recorded information produced by human agency. We can imagine all the human activities in studying the above natural, social, and artistic universes themselves producing information entities—books, articles, databases, data files, etc.—thus creating a fourth universe, that of recorded information.

The recorded information universe contains many other kinds of information besides research results—popular literature, business records, personal archives, music, film, etc., and, of course, all of these in electronic form as well. In short, the documentary products of human activity themselves form a universe deserving of study, and study of that universe—and how human beings produce it, seek it, retrieve it, and use it—is the intellectual domain of information science.

I argued in an earlier paper (Bates, 1987) that one of the primary concerns of our field should, therefore, be to define the parameters and variables associated with our universe—information produced by human agency. We have been slow to do that, however, and still tend to borrow the variables used in the other social sciences, rather than develop those unique to our field.

This study of the information universe finds its purest expression in bibliometrics, or the study of the statistical properties of recorded information. However, the field's interest is in human-produced information, and therefore, how human beings relate to this information—how they seek it, use it, ignore it, retrieve it—is of central research importance also.

In comparison to other social and behavioral science fields, we are always looking for the red thread of information in the social texture of people's lives. When we study people, we do so with the purpose of understanding information creation, seeking, and use. We do not just study people in general. The rest of the social sciences do various forms of that. Sometimes this can be a very fine distinction; other times it is very easy to see. In communications research, a cousin to our field, the emphasis is on the communication process and its effects on people; in information science we study that process *in service of information transfer*.

For another example, there are social scientists today who are observing people doing collaborative work through new types of networked systems in the field of computer-supported cooperative work (CSCW). The sociologist or social psychologist identifies and describes the network of relationships and the social hierarchy that develops under these circumstances. They may examine the impact of technology on those social relationships and on the work of the individuals involved.

The information scientist, on the other hand, follows the information the way Woodward and Bernstein "followed the money" in their Watergate investigations. That's the red thread in the social tapestry. When we look at that social hierarchy, we are not interested in the hierarchy per se, but, rather, we ask how it impedes or promotes the transfer of information. We ask what kinds of information people prefer to communicate through this or that new channel of information technology. We always follow the information.

Information Science's Big Questions

Three Big Questions can be identified within the above framework: (1) the physical question: What are the features and laws of the recorded-information universe? (2) The social question: How do people relate to, seek, and use information? (3) The design question: How can access to recorded information be made most rapid and effective?

The second question above deals with all kinds of information, but the other two have "recorded information" at their heart. We need to understand how people relate to and use all kinds of information, and in their social contexts—the second question—to contribute to our understanding of the first question and to do the best job possible answering the third question. But one of the defining characteristics of our field—and another feature that unites us with librarianship—is that we deal principally with *recorded* information.

There's a reason for that—it is not just an historical happenstance. A fundamental difference between recorded information and more evanescent or ephemeral forms is that recorded information generally lasts a long time. It can hang around for months, years, or centuries. And that, in turn, means that it can pile up. One of the fundamental challenges for both librarianship and information science is to find a way to contend with ever-larger piles or stacks or sets of information.

Because of the linguistic, psychological, cognitive, social, and technical complexities of information retrieval, each increase in size of the information source or database requires different solutions; scalability is a fundamental problem in this field. I believe that at some point a historian will show that the information explosion (with us since the invention of printing) has driven most of the major innovations in information organization and access. Each time the average collection grew to a new level, a new access method had to be devised. This has been particularly noticeable in the last century—from the development of subject headings to the development of hyperlinks.

The development of each new medium or technological device also requires a sophisticated blend of our technological and sociopsychological understanding to produce the best information retrieval system result. Each new thing we learn about the universe of information can be used in answering the design question also. Thus, although these three questions are posed as distinct questions, it can be seen that the research in response to each of them is also mutually supportive and valuable for answering the other questions.

Methodological Substrate

Let us turn now to the other elements of the substrate of our field. The fundamental methodological stance of information science can be described as sociotechnical. The two most important methodological traditions we draw on are the social sciences and the engineering sciences. Some individuals in the field are more interested in, and more capable in, either the social or the technical side of this equation. But to function effectively in information science, one must be at least comfortable with both sides of this dual tradition. Thus, only those computer scientists endure in the field who do not dismiss the linguistic or psychological complexities of information retrieval as squishy nonsense, and only those social scientists survive who are interested in the technology and do not hand it an unreflective Luddite rejection.

Consequently, information science tends to draw multitalented people, people who enjoy the mixture of kinds of cognition that the nature of our field requires to solve its research problems. This is one of the reasons we have failed to coalesce as a field around one standard methodological paradigm. For one thing, we need this methodological variety to solve these problems, and for another thing, the people in our field, by our multitalented natures, enjoy and tolerate that variety much better than is the case in other fields. If a field can solve its research problems with a smaller range of cognitive and methodological approaches, it can then attract and maintain its activities using people who are more single-minded, or single-talented—but that is not the case in information science.

Methodologically, we may use bibliometric techniques, other statistical techniques, and philosophico-analytic approaches for studying the first question. Much qualitative research remains to be done analyzing the social significance of the design characteristics of various documentary forms (Hjørland, 1997, p. 127). The second question draws on the full range of social science techniques, from the quantitative to the qualitative. The third, design question draws on the above two approaches as well, but most distinctively uses engineering techniques. A fundamental approach in information retrieval system design is formative evaluation. First, a system is developed that embodies solutions to information retrieval for a designated context. That system is then tested for performance, which produces learning that is practical and immediate as well as more fundamental. These discoveries are then applied to a new design, and performance proceeds to improve. It can thus be seen that to solve the information science field's problems, a mix of methodologies are needed.

A final comment on methodology: regarding the great methodological shift sweeping through the social sciences, the shift to the qualitative, multiple-perspective, post-Modernist approaches—these new techniques simply add to and enrich the armamentarium of techniques available to the information scientist for studying the subject matter of our field. For reasons that have already been argued, this field *requires* multiple methodological approaches to conduct its research. In mid-20th century social science we have had a series of waves of methodological fashion—each wave declaring the prior approach to be hopelessly bankrupt and inadequate. It is to be hoped that it is finally recognized that all of these methodological approaches can be powerful and useful—especially in information science.

Values

The values of information science have tended to follow the "value neutral" science or engineering model. The emphasis at the applied level is on getting the job done well—the engineering approach—without political or explicitly value-laden objectives. At the pure science level, the effort is to find out the truth (or multiple truths) of the matter studied, regardless of personal agenda. The advantage of removing political issues from scientific endeavors has been that communication in information science (as with other sciences) has been able to proceed across political boundaries and among people with very different political philosophies.

Librarianship, in contrast, follows a more service-oriented and empowerment-oriented value system. The library is there to produce a certain desirable social result, and, as a consequence, many of the activities of the library field are organized and directed to meet that values-laden goal. The mix of values driving library work varies from country to country, and, appropriately, is suited to the particular circumstances of each nation.

There is one more characteristic—we might even call it a value—of the field of information science that merits recognition: a sense of humor. As another article in these anniversary issues documents, the American Society for Information Science has long had a Special Interest Group devoted to presenting spoofs of papers (SIG-CON), and idolizing its founding member and "information racketeer," the never-seen Llewellyn C. Puppybreath III. I took this element of our field for granted until I visited one year a social science academic association (which shall remain nameless), and came upon a most deadly serious group of people whose sense of humor was well hidden and whose anxiety at each article presentation was palpable. I was happy to return to a group of people able to laugh at themselves, yet still deeply value their own work.

Conclusions

Information science does not consist only of the explicit paradigm of the study of the selecting, gathering, organizing, accessing, and retrieving of information that is the usual description of the field. As with most intellectual domains, the field of information science has many unarticulated, but important, elements "below the water line."

It has been the purpose of this article to bring some of those elements to the surface, so that we may better understand our own work and communicate it to the many people from the broader society who are now excited by information questions and problems.

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