

## Interdisciplinary nature of information science

Tefko Saracevic

### A natureza interdisciplinar da ciência da informação

#### Resumo

*Discute a natureza e tendências da ciência da informação nas suas relações interdisciplinares. No início, a origem e antecedentes sociais da ciência da informação apresentam-se seguidos de uma descrição da evolução da recuperação da informação, a atividade principal da ciência da informação. A evolução das relações interdisciplinares é avaliada no que concerne a quatro áreas: biblioteconomia, ciência da computação, ciência cognitiva, inclusive inteligência artificial e comunicação. Nas conclusões, apresentam-se os desafios à ciência da informação prosseguidos de três assuntos críticos: mudanças sociais contemporâneas, a revolução tecnológica e mudanças interdisciplinares. A ciência da informação tem um papel a realizar nestes assuntos.*

#### Palavras-chave

*Biblioteconomia; Ciência da Informação; Ciência da computação; Inteligência artificial; Comunicação; Recuperação da informação.*

A version of this paper was presented by the author as a keynote address at "Information 2000: An Interdisciplinary Future. A Conference for Students and Professionals in the Information Professions, "University of North Texas, Denton, Texas, 14 & 15 July 1994, under the title: "Interdisciplinary Nature of Information Science: Where it Came From and Where is it Going. "It is incorporated in the Conference Proceedings, pp. 3-8. The cooperation of Conference organizers is gratefully acknowledged.

*I have taught a number of courses and seminars at the Postgraduate Program in Information Science at the Brazilian Institute for Science and Technology Information (IBICT) and the Federal University of Rio de Janeiro (UFRJ), as well as at other institutions in Brazil during the 1970's and 1980's; I also participated in a number of conferences throughout the country all through the 1990's. The enthusiasm of the students and my colleagues in Brazil left a warm memory, and a belief that information science has a bright future in Brazil. I especially want to acknowledge them, and also to recognize the contribution that IBICT made to development of information science, and modern information systems, not only in Brazil, but in Latin America as well.*

#### INTRODUCTION

Of course, it is reasonable to ask: What is information science? This begs another, more fundamental question: *How is a subject, any subject, defined to start with?* Popper (1972) suggested that: "... we are not students of some subject matter but students of problems. And problems may cut right across the border of any subject matter or discipline." In this sense information science, as any other field, is defined by the problems it has addressed and by the methods it has chosen to solve them over time. Like any other field information science cannot be understood by lexical definitions or ontology alone.

Information science has three general characteristics that are the leit-motifs of its very evolution and existence. These are shared with many modern fields. First, information science is interdisciplinary

in nature, however, the relations with various disciplines are changing. The interdisciplinary evolution is far from over.

Second, information science is inexorably connected to information technology. A technological imperative is compelling and constraining the evolution of information science, as is the evolution of information society. Third, information science is, with many other fields, an active participant in the evolution of information society. Information science has a strong social and human dimension, above and beyond the technology. These characteristics are a framework for understanding the past, present and future of information science.

In this paper I will concentrate on the interdisciplinary relations of information science. Much of what is discussed here is an extension of thoughts presented in Saracevic (1992), where other characteristics of information science are discussed as well.

## **ORIGIN AND SOCIAL BACKGROUND**

In order to understand the interdisciplinary aspects of information science it is necessary, however briefly, to go to its origin.

In a quite remarkable historical turn of events, the impetus for development of information science can be traced to an article almost half a century ago by Vannevar Bush, one of the most influential scientists of the era (Bush, 1945). In this historic article Bush did two things: (1) succinctly defined a critical problem that was on the minds of many for a long time, and (2) proposed a solution that was a "technological fix," in tune with time and strategically attractive. The problem was (and in its basic form still is) "the massive task of making more accessible a bewildering store of knowledge." This is the problem of "information explosion," coupled with necessity to provide availability of and accessibility to relevant information, acute to this day. Witness the reasons for evolution of digital libraries. His solution was to use the emerging information technology to combat the problem. But he went even further: he proposed a machine named "Memex", incorporating in his words "association of ideas", that will duplicate "mental processes artificially." Ideas that will govern information science and artificial intelligence are quite evident. Memex never became a reality, but to this day R&D efforts in a number of fields have similar goals, to address the same problem of "bewildering store of knowledge."

Information explosion is a social problem that started in science, and now has spread to every human endeavor. Justification for engaging massive efforts and resources to the problem was and still is strategic importance of information, first for work and progress in science, and now for everything else in modern human society, nationally and globally. Thus, the efforts and investments in development of modern information retrieval systems, digital libraries and the electronic highway. Yes, they all involve massive doses of technology, but their importance relates to social and human issues and problems. Such problems require interdisciplinary approaches.

## **DEFINITION OF PROBLEMS**

Definitions don't a field make. Yet it is important to provide an idea of what problems are addressed. In that sense there were many definitions of information science that evolved over time (see Saracevic, 1992). I wish to offer here a definition of problems addressed as it evolved and as it reflects the focus of the 1990's:

*INFORMATION SCIENCE is a field devoted to scientific inquiry and professional practice addressing the problems of effective communication of knowledge and knowledge records among humans in the context of social, institutional and/or individual uses of and needs for information. In addressing these problems of particular interest is taking as much advantage as possible of the modern information technology*

The keywords in this definition connote the areas of problem concentration for both research and practice – they signify the intellectual and professional boundaries of information science.

Webster dictionary offers a similar and more succinct definition, which also may be approached from a problem orientation:

*Information science: the science dealing with the efficient collection, storage and retrieval of information.*

## **INFORMATION RETRIEVAL**

Most of the efforts and resources in information science were and still are devoted to some or other problem associated with information retrieval (IR). IR is not the only activity in information science, but a major one, and the major source of interdisciplinary relations.

When Calvin Mooers in the early 1950's coined the term "information retrieval", he also defined the problems that the activity addresses:

*[Information retrieval] embraces the intellectual aspects of the description of information and its specification for search and also whatever systems, techniques or machines that are employed to carry out the operation (Mooers, 1951).*

Of course, the problems are not mutually exclusive, but Mooers provided us with a handy classification that is being used ever since to distinguish between areas of work or discussion, and even interdisciplinary relations. Since Mooers, IR approaches were increasingly refined and advanced. The activity became multi- and interdisciplinary, as well as big business. In the mean time, information explosion has continued unabated, electronic texts, databases and networks became widespread, demand and searching for information spiraled, now technologies presented new challenges and opportunities, and through it all the IR problems actually intensified. Therein lies continuing and ever growing significance of IR research, attracting workers from a number of disciplines. Interdisciplinary work on Mooers' problems continues.

To elaborate. After half a century of evolution IR systems and processes have become highly sophisticated. Of the many changes and improvements probably the most significant is that IR systems now provide for a high degree of interaction, with all the accompanying implications and problems of human-computer interaction. This, of course, led to consideration of IR in broader information behavior (seeking and using) context, and not only in a narrow technical context. In addition, while much of IR still deals with citations, many IR systems also went way beyond citations, to cover texts, data, and images. However, the problems identified by Mooers are still at the base of IR: *How to provide a prospective user with useful information?* Or in contemporary terms: *How to provide users, with effective access to and interaction with information, and enable them to effectively use information?* And for that objective:

1. How to organize information intellectually?
2. How to specify the search and interaction intellectual?
3. What systems and techniques to use for those processes?

An example of such contemporary concerns can be found in the largest IR evaluation project to date under the name of Text Retrieval Conference (TREC). TREC involves a number of rounds of testing, involving teams from several countries, a number of institutions, and reflecting interdisciplinary approaches (see articles in Harman, 1995).

## **EVOLUTION OF INTERDISCIPLINARY RELATIONS**

The basic problem of understanding information and communication, their manifestations, effects and human information behavior, and the applied problem of “making more accessible the bewildering store of knowledge”, particularly including the attempts at technological “fixes,” cannot be resolved within any one discipline. This was clear to Bush and Mooers and all the others who thought about the complexities involved.

Interdisciplinarity in information science was introduced and is being perpetuated to the present by the very differences in backgrounds of people addressing the described problems. Differences in background were and are many, it makes for both richness of the field and difficulties in communication and education. Clearly not every discipline in the background of people working on the problem made an equally relevant contribution, but the assortment was responsible for sustaining a strong interdisciplinary characteristic of information science. It does not have to be searched for. It is there.

I will concentrate on interdisciplinary relations with four fields: librarianship, computer science, cognitive science, and communication. Obviously, other fields have also interdisciplinary relations, but these are the most significant and developed ones.

## **LIBRARIANSHIP**

Librarianship has a long and proud history devoted to organization, preservation, and use of graphic records. This is done through libraries not only as a particular organization or type of information system, but even more so as an indispensable social, cultural and educational institution whose value has been proven manyfold throughout human history, and across all geographic and cultural boundaries.

The common ground between library science and information science, which is a strong one, is in their sharing of their social role and in their general concern with effective utilization of graphic and other records. But there are also very significant differences in several critical respects, among them: (1) selection of problems addressed and the way they were defined; (2) theoretical questions asked and frameworks established; (3) the nature and degree of experimentation and empirical development and the resulting practical knowledge and competencies derived; (4) tools and approaches used; and (5) the nature and strength of interdisciplinary relations established and the dependence of progress on interdisciplinary approaches.

All of these differences warrant a conclusion that librarianship and information science are two different fields in strong interdisciplinary relations, rather than one and the same field, or one being a special case of the other. This is not a matter of turf battles, or one being “better” or “worse” than the other. Such arguments while common between many fields, matter little to progress of either field. But differences in selection and/or definition of problems addressed, agenda, paradigms, theoretical base, and practical solutions DO matter. Thus the conclusion that librarianship and information science while related, are different fields. This is most evident in research agendas and efforts, particularly including I. The relationship is still evolving.

## **COMPUTER SCIENCE**

The basis of relation between information science and computer science lies in the application of computers and computing in I, and the associated products, services and networks. Within last few years this relation also involves research on the evolving digital libraries, with their strong technological base, but also many problems way above any technology. To illustrate the connection, I will use a definition by Denting et al, (1989):

The discipline of computing is the systematic study of algorithmic processes that describe and transfer information: their theory, analysis, design, efficiency, implementation and application. The fundamental question underlying all of the computing is: 'What can be (efficiently) automated?'

Computer science is about algorithms related to information, while information science is about the very nature of information and their use by humans. The two concerns are not in competition, they are complementary. They lead to different basic and applied agendas.

A number of computer scientist have been involved in R&D on information and its many spin-offs, to the point of being recognized leaders in information science. Gerald Salmon is a prime example. In addition, there are several streams of R&D in computer science which had no connection with the early evolution of information science, but have addressed information problems similar to those in information science. Among others, these include works on expert systems, knowledge bases, hypertext, and human-computer interaction (which is also a strong area in cognitive science). More recently, this involves R&D on digital libraries, a 'hot' financially heavily supported area of mid-1990's, attracting a wide attention of computer scientists from a variety of streams, as well as people from many other disciplines (e.g. Fox et al. 1995). These areas have a significant informational component, associated with: information representation, its intellectual organization and linkages; information seeking, searching, retrieving and filtering; use, quality, value and impact of information; evaluation of information systems from user and use perspective; and the like – all traditionally addressed in information science.

Conversely, these streams of computer science R&D provides a different outlook, framework and approach, and even a different paradigm not only for information science R&D, but also for its academic and continuing education. Again, as with librarianship, the issue is not about turf. It is about paradigms, theoretical foundations, and pragmatic solutions, and ultimately about their appropriateness to human information problems.

## **COGNITIVE SCIENCE**

"The goal of cognitive science" says Johnson-Laird (1988), a leader in this area, "is to explain how the mind works." It is probably the most interdisciplinary field among modern interdisciplinary field. The fields that compose cognitive science, while bringing different approaches, share a basic concern about understanding cognitive processes, their realization in the brain, the structure of the mind, and various manifestation of the mind, such as intelligence. The significance of cognitive science lies in interaction of different approaches to these most complex and intriguing problems.

There are two areas in cognitive science of direct interest to information science: artificial intelligence and human-computer interaction. Both of these can be also treated in computer science, but I choose to discuss it under cognitive science, to underscore aspects related to human rather than technological.

Alan Turing, the father of AI summarized what was to become the agenda of AI in his classic article, as follows (Turing, 1950):

*I propose to consider the question, 'Can machines think?' This should begin with definitions of the meaning of the term 'machine' and 'think.'*

Subsequently, AI developed two streams: 'strong AI' and 'weak AI.' Strong AI flourished under considerable government subsidies from mid 1950's till the end of 1980's. It addressed both the theoretical and philosophical issues on the nature of intelligence, and the algorithmic issues of making computers behave intelligently. While it came up with many innovations, some revolutionary, related to computer programming, it also engaged philosophers and many others in

some of the most spirited intellectual controversies of the second half of this century. But with waning support and limited successes in making computers truly intelligent, strong AI lost its flourish. Weak AI had more limited ambitions, confining itself to 'the art of making computers do smart things' (Waldrop, 1987). Weak AI enjoyed great pragmatic success; much of today's computing follows in its footsteps. Many AI workers migrated to the problems related to information, and in the process they are transforming R&D efforts, including those in digital libraries. Information science heavily borrowed from both theoretical and experimental ideas in AI.

Work on human-computer interaction (HCI) is also currently flourishing. There are several layers of concern and investigation: from very technical issues to ergonomics to psychological to effectiveness and efficiency. All of them impinge on each other, however, two distinct streams evolved: one that concentrates on the computer, systems and network part of the equation, and the other on the human side. Many works in information science that dealt with HCI, belong to the second stream. While the two streams are clearly related, as yet they have not met successfully. But interdisciplinary crossovers and dialogues are increasing.

## **COMMUNICATION**

If there is any single word that has more connotations, more uses in widely differing contexts, and more cause for confusion than 'information', the word is 'communication.' The meaning of 'communication' as the meaning of 'information' is a widespread argument in itself. Yet the two are significantly related: information is a phenomenon and communication is the process of transferring or sharing the phenomenon.

Scholarly study of communication is as old as philosophy. Modern communication research, involving empirical studies, hypothesis testing and other trappings of modern science began in the first decades of this century, as a response to many quite evident issues and problems related to a variety of aspects of the industrial society. Modern concentration is on the study of problems associated with human communication, defined as (Ruben, 1984):

*...the process through which individuals in relationship, groups organizations, and societies create, transmit and use information to organize with the environment and one another.*

The relation has become stronger in recent decade (Borgman & Schement, 1989):

*For some time, we have observed links between these two disciplines at several levels. Researchers in both fields study topics similar in focus, such as knowledge gaps, invisible colleges, diffusion of innovations, human interaction with communication technologies, information seeking behavior, information theory, system theory, and the information society.*

The evolving relation between information science and communication has a number of dimensions: a shared interest in human communication, together with an increase in realization that information and communication need to be studied together, a confluence of certain streams of research, some exchanges of faculty, and a potential for professional cooperation.

## **CONCLUSIONS**

Information science seems to be reaching a critical juncture in its evolution. A number of pressures are forcing a reexaminations of the problems addressed and ways and means of addressing them. Of course, this particularly includes reexamination of education for information science. Here are three general classes of pressures.

First, the evolution of information society is accelerating throughout the developed world, with strong effects on developing parts as well. The social and economic roles of information activities are becoming more and more pronounced; their strategic importance is increasing. This has brought many new and powerful players in the realm of information work and in competition for the stakes. To provide a description: The U.S. society is changing from an industrial to a “post-industrial” society (Bell, 1973) or “post-capitalist” society (Drucker, 1994).

So do societies of most developed countries, the changes and impacts are global. Many authors, among which Drucker is the most outspoken and popular one, argue that there are fundamental economic and social changes afoot in which knowledge and information is becoming the base, the prime valuation, for economy and even society as a whole. These ideas are challenging the traditional economic theory of value.

*The basic economic resource – “the means of production,” to use the economist’s term - is no longer capital, nor natural resources (the economists’s “land”), nor “labor.” It is and will be knowledge.... Value is now created by “productivity” and “innovation,” both applications of knowledge to work. The leading social group of the knowledge society will be “knowledge workers” – knowledge executives who know how to allocate knowledge to productive use, just as the capitalists knew how to allocate capital to productive use; knowledge professionals, knowledge employees.... The economic challenge of the post-capitalist society will therefore be the productivity of knowledge work and knowledge worker. (Emphases in the original.) (Drucker, 1994).*

If we accept Bell’s and Drucker’s premise that knowledge (and by extension information) is becoming central to the emerging social and economic order, then this has enormous implication for information science, for information retrieval and, of course, for library and information services. However, this does not mean that they are suddenly, *and in present configuration*, being thrust into a central social role, not at all. It means that they are facing many challenges, as are other fields and institutions in transition. So does information science.

Second, the technological imperative is providing for or even forcing development and application of an ever increasing variety of information services, products, systems and networks. These are coming within, but mostly outside of information science, with competition increasing. Development of the national and global information infrastructures is bringing not only technological issues to the fore, but many commercial, social, legal and political issues to a head clash. Whatever the resolution(s), there are great changes ahead in the quantity and quality of information being available and accessible.

Third, the interdisciplinary relations for all fields engaged in whatever way with information problems are changing. There is more interdisciplinarity in all efforts from R&D to professional practice to business. As a result of the ‘communication explosion,’ exemplified with the huge spread of the Internet and the concepts of the Global Information Infrastructure, number of fields and new players are moving into dealing with information. The competition for information services is increasing. All this brings both tensions, and opportunities for alliances.

For information science these pressures are bringing about, among others, more interdisciplinary cooperations. The relations with computer science and weak AI are becoming more pronounced in both applications and in information retrieval and digital libraries research. With cognitive science and communication, the relations are more pronounced in development and/or utilization of theories and in experimentation. With librarianship, the relations has become more pronounced and

successful in experimentation and development of Online Public Access Catalogs (OPACs), which are now becoming more and more information retrieval systems. Both fields share concern and uneasiness with the emergent electronic highway exemplified with the discussion of National Information Infrastructure in the U.S. and Global Information Infrastructure worldwide. Both feel being somewhat left out and overwhelmed; great many similar issues are being raised in both fields.

Information problems worldwide are in no way diminishing, but they are changing. Some of them are posing many challenges and issues for information science, for its research, professional practice and education.

Clearly, information science is not the only field addressing information problems. It does not have a monopoly on them, nor does any other field. Thus, the question of turf is not an issue.

However, significant shifts are happening in a number of fields toward addressing the same or similar information problems, sometimes in ways that are quite different. With increase in R&D funding for these problems, there seems to be even a feeding frenzy for the spoils involving many fields and interests. Information science should definitely join.

The issue eventually becomes: *Which ways seem to be most promising in addressing the array of information problems? How should we go about achieving a deeper understanding of the problems addressed? And ultimately: How can we provide better information systems and services for the users?* Information science has a role to play in these critical issues for modern society, redefined and restructured as needed, with interdisciplinarity playing a major role in these efforts.

#### REFERENCES

1. BELL, D. (1973). *The coming of post-industrial society. A venture in social forecasting* New York, NY: Basic Books.
2. BORGMAN, C.L. & Schement, J.T. (1989). Information science and communication research: An essay on convergence. In: Pemberton, J.M & Prentice, A.E. *Information science in its interdisciplinary context*. New York: Neal-Schuman.
3. BUSH, V. (1945). As we may think. *Atlantic Monthly*, 176,(1),101-108.
4. DENNING, P.J. et al (1989). Computing as a discipline. *Communication of the ACM*, 32, (1), 9-23.
5. DRUCKER, P.F. (1994). *Post-capitalist society*. New York, NY: HarperBusiness.
6. FOX, E.A, Akscyn, R.M., Furuta, R.K., & Leggett, J.J. Guest editors (1995). Digital Libraries. *Communications of the ACM*, 38, 4, 23-96.
7. HARMAN, D. Guest Editor (1995). Special issue: The second Text Retrieval Conference (TREC-2). *Information Processing & Management*, 31, 3,269-448.
8. JOHNSON-LAIRD, P.N. (1988). *The computer and the mind: An introduction to cognitive science*. Cambridge, MA: MIT Press.
9. MOOERS, C.N. (1951). Zatocoding applied to mechanical organization of knowledge. *American Documentatfon*, 2, 2 32.
10. POPPER, K.R (1972). *Conjectures and refutations: The growth of scientific knowledge*. 4th rev ed. New York: Basic Books.
11. RUBEN, B.D. (1984). *Communication and human behavior*. New York: MacMillan.



12. SARACEVIC, T. (1992). Information science: origin, evolution and relations. In Vakkari, P. & Cronin, B. *Conceptions of library and information science: Historical, empirical and theoretical perspectives*. Los Angeles, CA: Taylor Graham.
13. TURING, A.M. (1950). Computing machinery and intelligence. *Mind*, 59,433-460.
14. WALDROP, N.M. (1987). *Man-made minds: The promise of artificial intelligence*. New York: Walker.

### **Abstract**

*The aim of the paper is to discuss the nature and trends in interdisciplinary relations of information science. At the beginning, the origin and social background of information science are presented, followed by a description of the evolution of information retrieval (IR), the main activity in information science. The evolution of interdisciplinary relations is evaluated in respect to four fields librarianship, computer science, cognitive science, including Artificial Intelligence, and communication. In the conclusions, the challenges to information science are presented in respect to three critical issues and pressures: contemporary social changes, technological revolution, and interdisciplinarity changes. Information science has a role to play in these critical issues.*

### **Keywords**

*Library science; Information science; Computer science; Artificial intelligence; Communication; Information retrieval.*

### **Tefko Saracevic**

School of Communication, Information and Library Studies  
Rutgers University  
4 Huntington St.  
New Brunswick, NJ 08903 U.S.A.  
E-mail:saracevic @ zotiac.rutgers.edu