Information Processing & Management Vol. 15, pp. 1-15
0306-4573/79/0101-0001/$02.00/0
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AN ESSAY ON THE PAST AND FUTURE (?) OF INFORMATION SCIENCE EDUCATION—I

HISTORICAL OVERVIEW

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(*Received for publication* 20 *June* 1978)

Abstract—The rapid and rather chaotic evolution of information science has left the field's academic sector in a largely disorganized state. This essay examines the basic issues confronting information science education, issues that must be resolved if information science education and thus information science itself are to evolve in an orderly fashion. For the quality of a field's professional services and research activities depends upon the quality of its formal academic programs. The essay is organized in three parts. In this first part are considered definitions and in a historic context the emergence, evolution and current state of information science and its education. The second part considers the "externalities" of education—problems and unresolved questions in information science education that deal with: (i) academic affiliations, (ii) degree levels, (iii) admission requirements, (iv) jurisdiction and (v) financing. The third part considers the problems and unresolved questions in respect to internal aspects ("internalities") of information science education: (i) objectives, (ii) content, (iii) teachers and (iv) teaching. It is suggested that information science cannot prosper; possibly even survive in the next decade if serious, concentrated action is not undertaken in the "externalities" and "internalities" of its education. Recommendations about the areas that need action are made.

INTRODUCTION

Importance of the debate on information science education

The rapid and rather chaotic evolution of information science has left the field's academic sector in a largely disorganized state. This essay examines the basic issues confronting information science education, issues that must be resolved if information science education and thus information science itself are to evolve in an orderly fashion. A debate on information science education has been quietly raging now for some time[1–4]. It is clear that academic programs will play a critical role in shaping information science's future as a field of professional activity and as an area of scientific inquiry. As the authors of the famous Carnegie studies on professional education in the 1910s and 1920s noted, the quality of a field's professional services and research activities depends upon the quality of its formal academic programs. That is, a field's services and research activities cannot rise higher than the level of qualified personnel. And this level depends solely on the level of a field's academic education, which has to include a modern two-way marriage between practice and research. Therein lies the importance of considerations of information science education for all information scientists and for men and women dealing with information processing and researching in other fields and not just for the relatively small band of information science educators.

Positive changes in information science education require the support of practitioners, researchers and educators—they can be achieved only with the involvement of all people in the field, thus the debate has to involve all "the town and gown" segments of the field. Furthermore, information science is not the only field interested in information science education. Other allied fields (librarianship, computer science, management, etc.) have a vested interest as well, by the virtue of sharing the interests in the same basic phenomena: information and communication. Strong, qualitative education in information science benefits more fields than information science, and chaotic efforts harm more fields as well.

Information science education has been seriously hampered because of the lack of clarification and of action in a number of problem areas, classified in this essay as external and internal aspects. Information science cannot prosper, possibly even survive, in the 1980s unless serious, concentrated action is undertaken in the "externalities" and "internalities" of its education. Fully realizing that some of the assertions in the essay may be controversial, biased and even wrong, I offer this as a contribution to a possible better understanding of problems facing information science and information science education.

Organization of the essay

Three aspects of information science education are considered in this essay, in accordance with classic methodology and classification of educational studies. Consequently the essay is divided in three parts.

First, are considered definitions and in a historical context the emergence, evolution and current state of information science and its education.

Second, are considered in the phrase of Frederick Keppel (President of Carnegie Foundation during the mentioned educational studies) the "externalities" of education—problems and unresolved question in information science education that deal with: (i) academic affiliations, (ii) degree levels, (iii) admission requirements, (iv) jurisdictions, and (v) financing.

Third, are considered the problems and unresolved questions in respect to internal aspects ("internalities") of information science education, namely: (i) objectives, (ii) content, (iii) teachers and (iv) teaching.

Although many aspects discussed in this essay have global relevance, most of the specific problems discussed and questions raised pertain to North American experiences.

A few comments about this historical (first) part are in order. The main reason for the historical overview is this: if we attempt to clarify anything about information science education then we have to ascertain the way things are and the way they got to be that way. (The Bridgmanian phrase is intended.) Naturally, the evolution of information science and of information science education are related. A historical sense and historical references are mandatory in order to analyze forces that shaped events and to understand the particular interpretation of problems and the evolution of solutions. Unfortunately, a comprehensive and serious historical study of information science and its education does not exist. The historical sketches and reminiscences that have appeared to date provide only an outline of the badly needed historical perspective[5–7].

I would venture to say that we in information science lack a sense of our own history. It may be that the changes were so rapid, the advances (especially technological ones) so spectacular that there has been no time for looking back, only ahead, no time for history, only for future. The obsolescence rate of much work in information science (particularly where information technology is involved) is so high that we may be equating history with obsolescence.

I am offering this sketch in lieu of the lacking serious historical studies. Clearly, the first requirement for any solidly based and justified recommendations for an orderly evolution of information science education is a historical study and an assessment of present state.

On the matter of definition

What is information science? This invites a further and more general question: how is a field to be defined? The matter was extensively debated in philosophy of science (e.g. essays in [8]) and in many fields concerned with their own definition—but no agreement exists on a proper or even adequate method for defining a field. Two methods are prevalent in defining a field: by providing a dictionary-type definition that outlines the boundaries, turf and focus of a field and by discussing the problems a field attacks, i.e. as Peirce stated: "a science is defined by its problem"[8]. In this section I shall concentrate on dictionary-type definitions of information science. In the following sections dealing with historical matters I shall attempt to define information science in terms of problems attacked.

Inherent in any dictionary definition of a field are two limitations. First, such a definition has to involve the basic phenomena and processes under consideration—and as a rule these are not adequately defined. For example, there are no adequate definitions of life in biology, health in medicine, energy in physics, matter in chemistry, or electricity in electrical engineering[9].

Although the ultimate achievement of a scientific work is to provide definitions, a science which cannot define basic phenomena (e.g. energy, matter or information) it can study their manifestations, behavior and effects.

Second, no matter how good, a definition doesn't make a field. Thus information science cannot and will not be made on the strength of definitions alone, but on the adequacy of its work, that is on the significance of problems attacked, on the degree of achievement in the understanding of these problems, and the adequacy of solutions worked out.

In many discussions and recriminations about definition of information science, these general aspects of definitions have been ignored, at times even to the point of ad absurdum [e.g. 10, 11]. At other times, they were fully recognized leading to thoughtful discussion of the range of phenomena, processes and problems of possible interest to an information science [e.g. 12–14].

The meaning of information science, as a field, is captured in the following four definitions proposed in the span of the last decade and a half. In substance the definitions agree, but in emphasis they differ somewhat—showing various dimensions and interests of information science as they evolved over time. Historically among the first was the definition eventually synthesized by BORKO[15]—this is also the most famous, most quoted and most rephrased definition:

"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 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".

More recently, GOFFMAN[13] addressed the scientific domain of information science as follows:

"Information science must address all observable facts and events relating to the notion of information. Thus, information science must be an organized body of knowledge based on explanatory principles which seeks to discover and formulate in general terms the conditions under which facts and events relating to the generation, transmission and use of information occur".

The purpose of information science has been captured tersely by WERSIG and NEWELING[16] in the context of human communication:

"Its purpose is to facilitate the communication of information between human beings".

BELKIN and ROBERTSON[14] elaborated on this definition by first describing a total spectrum of ways and contexts in which term "information" has been used and second, by delimiting that point of the spectrum particularly related to information science:

"...the part of spectrum of interest to information science is characterized by the *deliberate* (*purposeful*) structuring of the message by the sender in order to *affect* the image structure of the recipient. This implies that the sender has knowledge of the recipient's structure".

Thus one can discern that three directions emerged in information science (or in "informatics" as defined in Eastern Europe):[a]

(i) *professional* (applied, practical)—concerned with information systems, services and networks, and information users and uses, as well.

(ii) *technological*—concerned with application of information technology to handling of information.

(iii) *scientific* (basic)—concerned with theories and experimentation dealing with communication and information and with information systems and processes within systems.

For the purpose of educational deliberations and decisions these definitions provide a

[a]The term "informatics" as was defined in Eastern Europe[12] to a large extent coincides with the term "information science" as advanced by above definitions, even though "informatics" was defined as dealing with "scientific information"—but note that "science" in Russian (nauka) and in German (Wissenshaft) has a much broader connotation than in English, it encompasses all knowledge. However, the term "informatics" as used lately in Western Europe, tends to denote those areas that in the U.S. fall under computer science, cybernetics and networking and thus in this usage "informatics" does not coincide with the above definitions of information science. For instance, in France "informatics" is defined as machine processing of data.

context but not a content of information science. The latter has to come from considerations of the evolution and current state of the work in the field itself. After all, a field is what a field does.

PROBLEMS ADDRESSED: ORIGINS, INTERPRETATION, EVOLUTION

That which emerged in the 1950s and 1960s as information science grew out of the problems and concerns associated with communication of knowledge in general, and with communication of "public knowledge"[b] in particular. In the broader sense these problems lead to concerns with communication as a general process; in a narrower sense they lead to concerns with communication of recorded public knowledge (or literature for short). Throughout history literature (= recorded public knowledge) was being acquired, organized, preserved and disseminated for use by a variety of information systems, and the institution and operation of such systems presented problems in their own right. (For short, we may use "library" as a generic name for all kinds of information systems dealing with literature and "library problems" for the ensuing systems problems.) Thus, concerns with three levels of (interlocked) problems played a role in the emergence of information science:

(1) Communication problems—which gave rise to theoretical and experimental studies of communication.

(2) Literature (or public knowledge) problems—which gave rise to bibliometrics and scientometrics.

(3) Library (or information systems) problems—which gave rise to information retrieval and information networks.

Communication problems

The process of communication[c] is a most complex process, thus since the dawn of scholarships many fields wrestled with some or other problem of communication (beautifully synthesized in [18]). Information science is one of these "communication fields".

As HARMON[5] pointed out, information science emerged and grew after the Second World War along side a whole class of new communication fields, such as information theory (Shannon, Weaver), cybernetics (Wiener), computer science (Von Neuman, Turing), game and decision theories (Von Neuman, Morgenstern, Wald), new linguistic theories (Chomsky, Harris), general systems theory (Von Bertalanffy). It's growth coincided with the spectacular developments in information technologies—computing, telecommunication and reprographic technologies. If we accept the notion of "Zeitgeist"—the spirit and context of a time period—as affecting emergence and growth of many a scientific and professional field, then we can conclude that information science did indeed emerge within the post-war "Zeitgeist"—characterized by phrases as "the scientific revolution", "the era of communication". The concerns of the time with problems of communication in general, and scientific communication in particular were responsible for information science. Some of the above mentioned communication fields prospered more, some less and some got more or less entangled with others. Work in information science to a great extent used the theoretical, experimental and practical work from the mentioned people and fields; the relation is genetically very close. Taken together, these communication fields had a lasting effect on many a science, many professions and on the way we communicate and thus live and do things.

Each of these fields addressed a somewhat differing class of communication problems. What problems were addressed by information science? This can be answered by using the Shan-

[b]Ziman defined public knowledge as "a rational consensus of ideas and information". Knowledge becomes public knowledge only when recorded. Or in Ziman's words referring to science: "Results of research only become completely scientific when they are published"[17].

[c]Definitions of "communication" abound; most of them were derived from Aristotelian model ("somebody says something to somebody else"). Here is a composite definition (derived from Shannon–Weaver, Wiener and Goffman) of "communication": "a process (a sequence of events) where something called information is transmitted from a source (sender) to a destination (recepient)... through a channel (or channels)... by means of a language represented by signals and symbols.. with possibilities of noise (unwanted information)... and possibilities of dynamic interaction or feedback".

non/Weaver model. WEAVER[19] defined three levels of problems in communication:

(1) *Technical*: the degree of accuracy with which the signals are received as sent.

(2) *Semantic*: the degree of common interpretation of meaning.

(3) *Effectiveness* (or behavioral): the degree to which the behavior was affected or desired effect achieved.

While the technical problem can be isolated, dealing with semantic problems requires dealing with technical problems and dealing with the effectiveness problems requires dealing also with the other two. Information theory addressed the technical problems and linguistic theories (e.g. Chomsky) the semantic problems. Information science concentrated on the effectiveness problems. That is, *the basic problem addressed in information science is with effectiveness in communication of public knowledge.* This is reflected in definitions and in the concern with relevance[d] (pertinence, utility of information, user satisfaction) as a basic notion of information science and as a central criterion for information retrieval systems[20]. Most recent concerns with quality based information systems (e.g. [21]) are just a continuation of the same concerns and a reflection of the same interpretation of a problem. In other words, the basic interpretation of communication problems as adopted in information science has remained constant over the evolution of information science since its emergence some three decades ago.

To understand and accept all this is of importance to educational efforts—it provides a focus for the objectives of education in information science.

Problems of literature and the domain of information science

Although information science is in no way restricted to scientific communication alone, (the majority of theoretical and practical works in information science are universal), the problems of scientific communication as interpreted in the 1930s and 1940s were the major impetus for the emergence of information science, for its particular philosophical framework and for the shape of its solutions. Thus, understanding of the nature of problems in scientific communication and their interpretation contributes to the understanding of information science and its relations.

Modern science has developed a unique mechanism for communication which began with the appearance of the first scientific journals in the 17th century—the mechanism remained basically the same to this day. This mechanism is based: on the systematic and selective publication of fragments or items of knowledge related to a broader problem and to a larger piece of knowledge (e.g. journal articles) rather than publication of complete treatises; on the selective derivation from the selective integration into a network of other works (e.g. through citations); and on critical evaluation before and after publication (e.g. refereeing, peer review). Journals, journal articles and monographs are the main representatives of this mechanism, i.e. there are many ways of scientific communication but, literature remains fundamental. The invention of this mechanism may well have been the key event in the history of modern science, that enabled the phenomenal growth of science. However, the same mechanism that enabled such effective functioning of science, as it grew, also became the source of many of its contemporary problems.

The mentioned selectivity, i.e. selective concern with fragments of knowledge is present in every step of scientific communication. For instance, a very small proportion of published items are utilized in formation of what Price called "research front". And this concern with selectivity led to the concern with and the emphasis upon relevance; for to be effective, scientific communication and indeed science itself, must deal only with relevant information. The task of ascertaining relevance, of being selective and effective, becomes increasingly difficult as the number of building blocks increase exponentially.

Among the many postulations about the nature of scientific and technical communication problems in the 1940s the views of BERNAL[22] and particularly BUSH[23] created the most

[d]Relevance may be defined as measure of the effectiveness of a contact between a source and a destination in a communication process. The effectiveness may be measured at different points in the process, thus there may be different elements and relations involved at each point. This accounts for different views of relevance[20].

impact (Bush's is probably the most cited article in information science from the 1940s to 1960s). It was perceived that the problems are caused by a combination of effects due to: (i) a large quantitative (exponential) increase in the number of publication—so called "information explosion"—that resulted in a "growing inaccessibility of information"; (ii) the qualitative difficulties in selection of relevant items from all this quantity; (iii) the breakdown of boundaries between subjects and (iv) the increase in specialization. These views were reiterated in the 1960s in the influential Weinberg report[24] and in the 1970s on an international scale with the projection to 1980s in the controversial Anderle report[25]—thus they have a continuity for the past 3–4 decades.

Immediately after World War II the problems of scientific and technical communication attracted a greater social attention including attention of governments and of funding agencies; subsequently funds were provided for work on their resolution.[e] In turn, this broader social attention and government financing nurtured the development of information science as a "big science" with all the ramifications as explained by PRICE[26].

But why this broader social/governmental interest in the problems of scientific and technical communication? The reason is this: One of the key national concerns that emerged out of WW II and out of the 1940s, and attained its predominance in the 1950s and 1960s was a need for strong science and technology in support of economic growth and national security. Effective communication of scientific and technical information was considered essential to improving effectiveness of science and technology. Information science came out of this consideration and was actively supported during these decades because concerns with science and technology became national policy in a number of countries, East and West.

But what about the 1970s? Are these concerns still the same? No, they are not. As the forces and aspirations of the 1960s gave way to different ones of the 1970s ... as the search in space gave way to the search for accommodations with the limits of earth ... as national concern and policy in relation to science and technology changed ... information science began an adjustment in the perception of its social, national and international role. "Information services for science and technology" was the hallmark of information science in the 1950s and 1960s. The broadening of this original domain in the 1970s is characterized by terms and phrases such as: information services for ... "policy", "management", "decision making", "developing countries", "coping with human needs", "neighborhood", ... and even in Kochen's conception: for "wisdom". The search is on to formulate a problem domain of information science in the emerging postindustrial society ... envisioned to be in relation to management of man's knowledge as a social and national resource[27].[f] But as yet the formulation is not clear as it was in the previous decades in relation to science and technology, thus the support is not nearly as large as it was. If we are approaching a postindustrial society as envisioned by Daniel Bell, then informational science has a definite role in this society. But is there a postindustrial society in the first place?

It is obvious that the domain of information science and the domain of information science education should be in a close relation to each other. But are the evident searches for a new domain in information science reflected by similar efforts in its education? There is no visible evidence as yet that this is the case. In conclusion, understanding of the interpretation of the problems of scientific and technical communication and of the search for new domain of information science has to be taken into account in specification of the orientation and domain of information science education.

[e]See for instance records of many hearings on the subject in the U.S. Congress in the 1950s, particularly those chaired by Senator H. Humphrey. Also the particular sections dealing with information of the National Science Foundation Act of 1950—Section 3(a)(3) and 11(g) and National Defense Education Act of 1958—Sections 901 and 903.

[f]This search is further exemplified by a number of national and international activities. For instance: the groping for a U.S. national policy by the National Commission on Library and Information Services from its inception in 1973; by the planning for the 1979 White House Conference on Library and Information Services; by the 1977 reorganization of the National Science Foundations efforts in this area—the Division of Science Information became a Division of Information Science and Technology reflecting a change in policy; and on the international scene: by the reorganization of Unesco's information programs into a department of General Information Programs stemming from a resolution by the 19th Unesco General Conference in 1976, also reflecting a policy change. Many other examples could be cited.

Library or information systems problems

At different times in history different aspects of communication and literature problems have predominated. As a result, different types of information systems and/or processes have emerged. However, all of different solutions, all of the different systems from the libraries of antiquity to modern data bases and networks have a historical connection.

What systems solutions emerged in information science? Let us recall Bernal and Bush. Bernal's solution to problems of scientific communication was oriented primarily toward a revision of the system of publication, that is, it was on the level of the literature problem. But Bush's ideas, so forcefully proposed in 1945, carried the day and with it the shape of systems oriented work in information science. Bush's solution was system oriented. He suggested that the use of modern information technology be coupled with what he called "associative indexing." In the context of times Bush envisioned a technological "fix" to the problem of scientific and technical communication. The idea caught attention, spurred imaginations, and attracted people from a number of scientific and technical disciplines, and a number of entrepreneurs. This variety of backgrounds of people attracted to work in information science formed information science as a multidisciplinary field. A multidisciplinary approach to problems is a modern characteristic of science and related fields.

Discussion of Bernal's solution (revision of publications and dealing with literature problems) has not abated. For instance, a proposal stemming from an NSF sponsored study[28] for a large scale national information system in science and technology combines in a radical way Bernal's with Bush's solution. However, there are also warnings: communication in science evolved over the past three centuries into an elaborate ecological system, and radical tampering with an ecological system should be restrained because of well known dangers[29]. Still, it seems that in an evolutionary way the new information systems aimed at controlling the literature are changing the shape of literature itself.

Information science in general, and information retrieval systems in particular did not develop only in relation to the information technology. As will be shown in the next two sections, new professional principles and scientific insights were developed as well. However, application of the new information technology with its rapid changes and advances was and still is a major part and problem area of information science. It often seems that this technology is in the position of the perennial tail wagging the dog, rather than vice versa. Technological solutions are looking for questions. Advances in technology are quite often dictating advances in applications. Throughout its short history information science has lived in this mad rush with information technology. This is a fact of life that education in information science never quite learned to live with.

Finally let us discuss the emergence of information science in relation to historically older fields. (The relation to other fields that emerged at the same approximate time as information science has been discussed in the section "Communication Problems".) Information science has emerged in the context of the newer "communication fields" and not as an expression and metamorphosis of librarianship or documentation. The historic record bears this out (e.g. [6, 7]). In a large majority, the founders of information science were not librarians or documentalists, nor were their original approaches derived in a direct way from librarianship or documentation. In particular, documentation (as exemplified by the historical survey of its 50 years by Bradford[30]) was much more of an international movement than a discipline—a state of affairs which accounts for its relative ineffectiveness in implementation of ambitious plans and for its dismissal by founders of information science. (By way of example: public health is a movement, medicine a discipline—the former can hardly proceed without work in the later.)

In relation to librarianship, information science concentrated on different aspects of the communication and literature problems: Librarianship more on the sources end of communication and the organization and preservation of literature and information science more on the destinations end of communication and on the retrieval from and dissemination of literature. Thus their relation is a natural one through the underlying phenomena and processes, as well as through the reliance on each other's systems. They are not competitors for the same grounds. Many fields, while addressing the same phenomenon, addressed different aspects of the phenomenon (e.g. biology and medicine); consequently, they can sustain one another—knowledge created in one is usable in the other. This kind of relationship exists between librarianship and information science. However, two other things should be realized. First, librarianship has not really succeeded in developing a theoretical base and a scientific component, nor does it have a tradition of theoretical/experimental inquiries, while information science from the outset is trying to do so, admittedly with limited success. Thus, some of the information science work may have relevance as a theoretical base for some aspects of librarianship. Second, information science is not at all exclusively oriented toward the "library problem", it has orientations other than "library orientation" and components that are closely related to work in fields other than librarianship. In the same vain, librarianship has components not related to information science.

It follows, that information science education should take these various problem interpretations and the various relations into account because they determine the emphasis of education. And such determination of emphasis in information science education is by no means an easy thing to come by.

EVOLUTION OF PROFESSIONAL WORK

1940s and 1950s

The ideas of the 1930s and 1940s dealing with application of information technology to "information explosion" found a realization in that period in the pioneering work by Watson Davis on microfilm and Ralph Shaw on a Searching Selector. But it wasn't until the late 1940s and early 1950s that such work started to take shape as a larger coherent activity.

In the 1950s the future information science went through the entrepeneur stages... information retrieval (IR) was born... a number of competing systems were established with many claims and counterclaims... numerous conferences with spirited debates were held... new journals on the subject were established... international activities were affected... literature on the topics took shape... and first theoretical and experimental works emerged. The basic orientation of the field was charted toward the problems of relevance and effectiveness in communication. In this decade, the infant christened in 1950 as information retrieval by Calvin Mooers, became in 1960 a strong rookie, basically by devouring ever increasing amounts in government grants.

Historically, it is not entirely clear which system can claim as being the first working information retrieval system (e.g. conflicting reports in [6] and [7]). However, it is clear that the working principles of information retrieval were established in the 1950s and that the field solidified around these principles.[g] It is also clear that they are governing the activity in information retrieval to this day. The content of information science education is later to evolve around teaching of these principles.

1960s

Information retrieval systems came on their own; a number of massive, national systems were established and running along (some government based, some society based, some commercial) and the smaller ones in companies and institutions were proliferating. Along side emerged a number of innovations in practice—for instance: new services (e.g. Selective Dissemination of Information), new tools (e.g. KWIC indexes, citation indexes thesaurus), new computer file organizations (e.g. combined files, list and chain files). While ideas for some of these innovations were around for some time, their integration into systems and the technological applications were innovative indeed. Efforts in library automation also emerged and they were not independent of these other developments. The *Annual Review of Information Science and Technology* (ARIST) started in 1966 to recount and inventory the ever increasing proliferation of these activities. The *Annual Review* is not only an excellent

[g]The major principles include: (1) "information explosion" was defined as the basic underlying problem to which IR was responding; (2) relevance and user orientation was taken to be the basic aim of IR systems; (3) coordinate indexing was established as a method by which representation and retrieval of information (or rather documents) were linked—Boolean algebra furnished the retrieval rules; (4) natural language emerged as the basis for information representation; (5) information technology was taken to be an integral aspect of IR systems; (6) systems approach was taken as a method for analysis, design and operation of IR systems; (7) rules of supply and demand were taken as basic to justification and economics; (8) active provision of services, continuous exploration for new services and products, and aggressive marketing was taken as essential to IR.

historical testimony to the work in information science, it can also serve as a sort of table of content for comparison of the coverage of information science education programs and as an indicator of the relatively large size of efforts, authors and literature in information science in general.[h,i] Such indicators are specially important in view of the almost total lack of statistics on information science activities.

1970s

The experiments and large scale developmental efforts of the 1960s gave birth to the massive bibliographic (and other) data bases, on-line services and information networks of the 1970s. We may be witnessing an emergence of an "information industry", not only as a term, but more substantially in terms of complex relations emerging between producers of raw information materials, reprocessors, wholesalers, retailers and users and in terms of capital investments and national and international efforts. Debates and research projects on information as a utility reflect the search for a new framework for information handling[31].

The entrepreneurship of the 1950s and 1960s (which gave to information science a host of strong and colorful personalities and a daring spirit of innovation, and unfortunately also contributed some amateurs and quick-buck artists), gave way in the 1970s to hard nosed business pragmatism in both private and public domains, and an overall higher level of professionalism. As a result, innovation of the late 1970s is being carried out basically along the lines of "new, bigger and improved models" and marketing. Unfortunately, truly innovative efforts have slackened. Strong personalities of the 1960s gave way to corporate and bureaucratic teams. However, there is also voiced more and more a need for information managers—professionals that will be capable of handling in an integrative way a variety of information resources. It seems that these developments will chart the course for professional activities in information science in the early 1980s. And the question for education: how to respond to these professional developments? And particularly to the information industry's challenge to produce information managers?

EVOLUTION OF SCIENTIFIC WORK

1940s and 1950s

As mentioned, scientific work from a number of other fields affected or was adopted by information science. Although Shannon's information theory had a great impact, it would be inaccurate to state that it alone served as an infective agent for the emergence of the scientific work in information science. A number of people that began working in the field that became information science were scientists and engineers and it was natural for them as breathing to involve, wherever possible, theoretical and experimental aspects. In relation to information retrieval, Robert Fairthorne's work in the late 1940s, on logic of retrieval may probably be the first theoretical work in the field itself and the work by Mortimer Taube's group at *Documentation Inc.* on vocabulary in the early 1950s may be among the first truly experimental studies in the field. But whatever the beginning, a most important principle was established: that a link should be sought between professional practice, technical development and research. This

[h] The reviews in the 10 volumes (1966–75) of *ARIST* included 14,988 citations of some 6000 authors. Most of the literature is on application and discussion of practical problems. I estimate that some 20% of authors and 30% of papers in *ARIST* relate to research.

[i] The present size of the literature in information science can also be gauged from the coverage by abstracting journals: *Information Science Abstracts* (ISA) lists as covering 255 journals; obviously (as in other subjects) most of these journals carry only an occassional paper on information science, but it gives an idea of spread. The English version of the USSR's *Informatics Abstracts* lists as covering 78 journals. *ISA* has 45 journals in common with the coverage of *Library and Information Science Abstracts*, 56 in common with *Library Literature*, and 31 in common with *Computing Reviews*—this gives an idea of the size of the set of the more specific journals in information science. I estimate that there may be some 60 journals from some 30 countries that are closely related to information science; of these about 10 journals from 5 countries are almost exclusively devoted to reporting information science research. Articles reporting information science research appeared in some of the world's most prestigious (and most stringently refereed) journals, such as: *Proc. of Roy. Soc., Nature, Science, IEEE Trans., J. of ACM*—this is an indication of quality existing in some of the research.

thinking found a powerful expression in 1958 in the landmark *International Conference on Science Information*, proceedings of which have withstood the test of time as a seminal document in the field.

1960s

In the early years of the decade the term "information science" slipped into usage. But it wasn't just a change of names. Information science was a visible recognition of that notion... that indeed there is a possibility to create a scientific dimension to all that transpires in and even more so around information retrieval. And the 1960s witnessed the successes due to parallel advances in scientific and professional activities. Most of the scientific work of the 1960s concerned theories and experiments which dealt with processes *within* IR systems. This work proved to be of direct usefulness to practice. I believe that it can be shown that the major advances in information science of the 1960s and 1970s are a result of this cooperation between research and practice. This research which fluorished in the 1960s is also to a lesser extent being continued in the 1970s and includes (reviewed in part in [32]):

...models and algorithms for indexing, classification and other information representations;
...linguistic models and indexing languages;
...document clustering, ranking, associating;
...file organization models;
...logic for retrieval;
...question processing and search strategies;
...performance of retrieval systems—measures, tests
...principles of systems analysis and design;
...feedback models (e.g. relevance feedback);
...human factors in systems (e.g. indexers consistency);
...users, user needs, marketing;
...economic aspects.

Their kinds of knowledge began their cumulation in information science: (i) empirical and normative knowledge—derived from practice and (ii) reflective knowledge—derived from research. And this proved to be of paramount importance to the contents of educational courses and programs in the field.

1970s

In the 1970s research efforts in information science slackened and shifted. Research in information science in the U.S. depends almost solely on government grants, and the field is paying dearly for this depencence. In the support of information science government lacks policy, consistency and evaluation. In 1977 there were considerably less dollars for research and development expenditures than in 1967.[j] Research in information science is decreasing in universities, which has a direct effect on the nature of both, research and education in the field.

The 1970s also registered a major shift in the topics being researched, which is resulting in broadening, and to some extent even deepening, of the body of knowledge akin to information science. As mentioned, research in the 1960s primarily concentrated on processes *within* IR systems. Such research is continuing[32], but the 1970s saw continuous increase in the growth of research on processes and phenomena *underlying* or *surrounding* IR systems and information systems in general. This is exemplified by an increase in the number of papers dealing with: structure and dynamics of subject literatures and of subjects; bibliometrics; and various aspects of communication (e.g. reviews[33, 34]). The change is further exemplified by another aspect. The ultimate goal (dream?) of basic research in information science is to formulate a general theory of communication, to serve as a theoretical foundation of the

[j]For instance: National Science Foundation, Division of Information Science and Technology (formerly DSI and OSIS) awarded from 1959 to 1977 some $180 million in grants—most of it for development, some for research, some for operational and other support. Awards totaled in fiscal 1967 = $11.3 mil.; 1968 = $15.6 mil. (highest amount for any year); 1969 = $13.9 mil.;... 1976 = $5.9 mil.; 1977 = $4.7 mil.—only 1959 with $3.9 mil. and 1960 with $4.5 mil. were lower. To get a full picture of a trend, an inflation factor should be added as well. (Source: NSF, DIST, [DSI, OSIS] reports of grant awards.)

science of information. The optimism that this will be achieved rather quickly began to fade with the realization that this is a highly complex and ambitious goal. Thus most on the on-going basic research work can be viewed as being painstaking taxonomy, data amassing and on "small scale" theories; it is hoped that this work will contribute toward formulation of broader theories that in turn will suggest experiments and so forth. Such are the ways in all of science.

While these new areas of research do not have immediate and dramatic practical application as the research of the 1960s, they may hold answers to the serious problems, which if not corrected may bring information industry crashing down of its own weight. Namely, the data bases and associated on-line services, which are at present the mainstay of information industry are oriented toward the control of the quantity and not quality. While they did achieve a good measure of control of the quantity of recorded knowledge (literature) as it is relevant to given subjects, they did not achieve any measure of control of the quality of literature as it is relevant to given users and uses, and especially as it relates to crisscrossing of subjects. Simply put: too much is being retrieved, especially too much junk—there are no quality filters. As information requirements become more complex and the size of literature and data bases grows and grows, the problem of quality becomes more acute. These new areas of research in information science, looking at literature and communication, do have relevance to attempts at the solution of the quality problem.

Unfortunately, by the end of the 1970s researchers and practitioners in information science drifted apart, they do not enjoy the close relation of the 1960s. This is not good for either. Practice is fluorishing at present and probably this is one of the reasons why research is not. In research more basic and less immediate questions are being asked (sometimes to the point of obscurity), while practice is becoming more professional, more business like and pragmatic, but less innovative.

EVOLUTION OF ACADEMIC EDUCATIONAL EFFORTS

1950s

The first academic course in documentation was given in the U.S. in 1950 by Helen Focke, at Western Reserve University, some 50 years after documentation emerged as a movement in Europe . . . it took that long for educational incubation. It did not take that long for information retrieval . . . in 1955 James W. Perry and Allen Kent offered (as far as I can find) the first course on the subject entitled "Machine Literature Searching" at the same University. In 1955 Dean Jesse H. Shera of the School of Library Science, Western Reserve University, established a research institute associated with the School—the Center for Documentation and Communication Research headed by Perry and Kent; besides being engaged in development and in research the Center was from the outset involved with education and in promotion of educational activities (through conferences, publications etc.)—it is from this beginning that a close association evolved between information science education and library schools.

Shortly thereafter, a number of universities instituted courses dealing with one or other aspect of information retrieval. In most cases these courses were a result of research and development efforts at these universities, thus a fruitful link between research and education was formed. This link is the most significant accomplishment and tradition of information science education. To successfully incorporate research as an acceptable extension of the curriculum is the mark of a true professional graduate education. There is an intimate relationship between illuminative education and research and it is around this relation that the so called "university model" of modern graduate education took shape.

Another model of professional education that was also used in the development of information science education is the "technical model"—dependent on empirical learning, job analyses and norms. Through the use of the "university model" above and beyond the "technical model", information science education eventually also came in conflict with a number of its hosts, most notably in library schools and with a number of information science practitioners with little tolerance of, if not hostility to, theoretical inquiries. This conflict is common in all of professional education.

By the end of the decade educational debates were in full swing in the U.S. and Great Britain. Eventually these debates produced the historic educational conferences of the 1960s.

1960s

Numerous educational conferences were held in the U.S. and abroad under auspices of universities, professional societies, governments, and international organizations (e.g. [35–38]). Besides demonstrating that there is a widespread interest in information science education these conferences:

... Established a distinction between various areas of information activities and a definition of information science.

... Abolished the notion that the activities in information science are only about science information as well as the notion that information science education should be done through job related training and short courses.

... Restated the crucial point that information science involves professional practice as well as scientific research and tried to formulate the role of information science education in relation to both.

... Explored and compared different institutional settings, courses, programs and institutions in information science education, and wrestled with the problem of establishing some uniformity.

Although the achievements of these conferences were not as high as hoped, they did effect the field as a whole, they did provide for a clearer picture of what is being talked about.

A number of professional societies through educational committees and special interest groups debated various aspects of information science education (ASIS, ALA, SLA, IEEE, ACS, ACM, etc.). Although they have provided a platform for debates, the efforts by these organizations have been sadly ineffective in substantive matters (e.g. curriculum, promotion of standards, accreditation), despite many sincere efforts by individuals. The tradition of ineffectiveness of professional societies in relation to substantive matters of information science education is continuing to this day, thus there must be something fundamentally wrong in the approach of professional societies to educational matters of information science. In computer science the massive curriculum studies conducted by the Association for Computing Machinery (ACM) proved to be valuable for starting of courses and programs; these studies also dealt to some degree with information sceince[39, 40].

Information science courses proliferated in a number of institutions, at each pretty much on their own. From various directories and surveys[41–43] and catalogs one can gather that by the start of the 1970s there were some 200–300 odd courses on various aspects of information science spread over some 100 institutions in North America; about 30–40 institutions had programs (specialization) in information science (or some aspect thereof). A dozen institutions offered a doctorate. These are ball park figures depending how one counts—exact figures do not exist. But whatever the figures, by 1970 information science education gained a foothold in academic institutions, but in a variety of academic homes. Graduates with information science specialization started trickling in the 1960s and then by early 1970s slowly flowing ... and it was these graduates that provided the critical mass of professionals needed for the phenomenal growth of the use of on-line information services in the late 1970s and that also entered into areas of education, research and development.

1970s

Expressed in a capsule form, the developments in information science education in the 1970s include:

... A considerable increase in academic courses and programs devoted to information science, nationally and internationally. This includes the spread of education in information science to developing countries (e.g. witness Unesco efforts).

... An increase in the number of academic disciplines and departments that embraced information and certain aspects of information science, as one of their orientations. (This will be further discussed in Part II of the essay.)

... A closer involvement, even integration, between the traditional library curriculum and information science curriculum in a number of library schools. This is particularly evident in the practical, technical areas—library automation, networking, on-line services, etc. An ever larger number of library students in all library specializations, are taking information science courses.[k]

... Emergence of information science, as an integral, and even basic academic part of a number of Ph.D. programs in librarianship as well as in computer science.[l,m]

... Conduct of surveys on the state of information science curricula[45–47].[n] These provided a picture of great diversity in courses and contents, but also identified areas of commonalities. However, these surveys seem to have no discernible effect, on the overall state of information science education, suggesting that different types of studies need to be done.

... A gradual loss of the relation between research and teaching in information science. This relation was a hallmark of the information science education in the 1950s and 1960s. Accompanying this loss there seems to be a gradual shift toward a "technical model" of education (explained above). This is having an effect on graduates in terms of their knowledge, skills and potential for creativity.

The number of people working in information science continue to increase in the 1970s[o] and the job markets for information science graduates are expanding. However, some very significant trends are becoming visible. There is a change in the nature of knowledge and skills demanded by employers advertising job openings—required are a deeper knowledge in information processing, information technology, information services, systems analysis and the like, as well as stronger subject background (witness the job ads placed through ASIS Jobline). There are also changes in the perception of jobs to be accomplished, as reflected in the discussions about "information managers" in *Information Times* (a publication of the In-

[k]The 64 accredited library schools in North America (58 in U.S., 6 in Canada) have some 730 full time and 630 part time faculty members (counted from [44]); of these some 180 full time and 60 part time are indicated as teaching (among others) information science. Only one of the 64 schools did not have any faculty in information science; 13 schools had only one full time information science teacher; 9 schools indicated that 40% or more of their faculty is teaching information science; the highest a school had was 11 information science teachers. The average number of information science courses in the library schools is four[45]. About 20 library schools have a full fledged information science program.

[l]Twenty-four library schools in North America offer Ph.D. and about half have Ph.D. information science programs. 1977 *College Blue Book* lists 79 departments of computer science in North America offering graduate studies; 40 of which offer Ph.D.; most of them have information science courses, some have programs. I estimate (from examination of school catalogues and list of programs in [44]) that all together there are some 40–50 full fledged information science programs on the Masters and some 20–25 on the Ph.D. level in all types of schools (library schools, computer science departments, management schools, etc.).

[m]Ph.D. degrees: a search of *CDI* (data base of *Dissertation Abstracts*) provided for the 10 years (1967–76) a list of 180 Ph.D. dissertations under categories "information science" and "information storage and retrieval". These were produced at 66 universities; 13 universities produced 60% of the dissertations; 33 universities produced only one dissertation in these categories. A statistic on Ph.D. degrees granted, (Source: *CDI* Manual), lists under "Information Services" that 199 Ph.D. degrees were granted for the period 1965–70 and 982 for 1971–75 (in this statistic "information science" is not listed separately.)

[n]The 1968 survey[46] to which 45 library schools in North America responded, lists 185 courses in information science. The 1972/73 survey[47] to which 71 library schools *and* computer science departments responded lists 566 courses, however a number of these were straight computer science courses. The 1977 Survey[45] of catalogs from 54 library schools lists courses in information science under 5 classes: (1) library automation (80% of schools offer courses in this subject); (2) Information retrieval (80% of schools); (3) Systems analysis (50% of schools); (4) Integrative computer systems (on-line networks) (30% of schools); (5) Programming (10% of schools). From my own examination of catalogues I would add another class: (6) Communication and bibliometrics (some 10–15% of schools).

[o]There are no hard figures on the number of people working nationally or even less internationally in information science. However, estimates may be derived from societal memberships. American Society for Information Science has in 1978 some 4000 members, which is almost double of what it had in 1970. American Library Asso., Div. for Information Science and Automation has 3600 members; American Chemical Soc., Div. for Chemical Information has 1000 members; other societies (such as ACM with 32,000 members) have divisions or special interest groups (SIGs) related to information science. ASIS, SIG on Education for Information Science has some 220 members.

formation Industry Association, IIA) and in the frequent seminars on the topic organized by IIA.

Clearly, the demands and perceptions of job markets are a challenge for information science education. The question: how is information science education responding? In my own observation the answer is: not very well.

In conclusion

As the 1970s are drawing to a close there are a number of trends that should be taken into account by information science education; such as:

...Continuity in the perception of *effectiveness of communication* as being the main problem orientation of information science.

...Broadening of the domain of information science and a search for a clearer formulation of the *new domain* or domains.

...Relatively high success of the methods and tools developed for the control of "information explosion" in toto, but a reemergence of the ever present *quality problems*, i.e. access to quality literature, quality information, and problems due to the lack of quality filters.

...Increase in the degree of *professionalization* in information services and an emergence of the outlines of an *information industry*.

...Shifts in the topics of *research* and emphasis in areas of bibliometrics, literature studies and communication.

...Slackening of *research funds* and efforts; losses in relations between research and practice, research and education.

...Changes in the nature of knowledge and skills demanded by *job markets*; emergence of new perceptions of jobs to be accomplished.

As the 1970s are drawing to an end information science education is approaching a complex crossroad, if not a crisis. Despite growth, spreading and other outward signs of health, the state of information science education is not well at all. It is evident that numerous problems and questions (outlined in the next two parts of the essay) are being left unresolved—and the pile is growing. And it is quite clear that the type of future of information science education depends on the type of attention we are going to pay to the resolution of these mounting problems.

All of the conditions outlined in this historical sketch should be studied in greater detail to provide a framework for rational decisions that will affect the future of information science education. To shape the future we must consider the past. And if there is no future for information science education, there simply is no future for information science.

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