Paper

Thoughts on the Social Implications of Information Theory [1]

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"Information theory" is conceptualized in this brief communication of reflections as a collective term for all information-related theoretical models produced by a number of disciplines. There is a consensus in the scholarly community that information science/informatics does not, at present, have a focused systematic foundation of theoretical knowledge. The author argues that this open-endedness of the theoretical context can work to the advantage of the information sciences because of its capacity to accommodate future multidisciplinary research results. The characteristics of information theories are briefly reviewed and perspectives on the implications of these characteristics for information planning the practice are offered. The author concludes that information research, including individual, societal, environmental and technological aspects, benefits from the flexibility of an open conceptual framework that closely resembles the dynamic world of reality.
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1. Introduction

It seems presumptuous to share one's thoughts on a topic that merits in-depth examination. I am nevertheless prompted to do so by my belief that even the humblest approach to speculate about the links between research in information science/informatics and its social consequences may be forgiven because information, a unique and so far indefinable phenomenon of life, is wide open to formal and informal reflection.

At the 46th Conference and Congress of the International Federation for Information and Documentation, held in Omiya, Japan, Prof. Shizuo Fujiwara(1994) has called for the cooperation of researchers in different fields. With emphasis on the regional interaction of researchers and policy makers, the process of interdisciplinary cooperation can be set in motion. Because today regionalism is a leading and widely debated theme in economics and development science(Cernea 1994, Wong 1994), it is challenging to view the role of information science/informatics research in this framework.

The title of this brief paper does not refer to the scientific discipline of Information Theory as introduced by Shannon and Weaver(1949) addressing the measurement of the physical movement of information from one point to another. Rather, "information theory" here stands for all theories and models, relevant to information, that have been created by basic and applied research in a wide range of disciplines. Generally, theories are meant to serve either the understanding or the prediction of the behavior of information. They have been constructed using various approaches including exploratory, experimental, statistical, comparative, descriptive, case study and other methods. "Theory" is used here in the singular as it denotes collectively all unintegrated, unsystematized, and often unrelated products of information-related research brought forth in recent decades.

Theory is the result of an inquiry based on certain assumptions, the investigation of conceptual

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relationships in a certain context, and ensuing insights into new meanings. The social implications of theories are determined by those areas of human activity where relevant new insights imbedded in theories are adopted, tested, and applied. Since there is no consensus in either the scholarly community or in the arena of economic and social activities on a conceptual definition of "information," both research and the use of research in practical terms are wide open to interpretation. The ambiguity of a discussion of information theory is intensified by the proposition -- upon which there is wide and unequivocal agreement -- that as thoughts expressed by language may be understood only in the context of their cultural associations, information may be understood only in the cognitive context of its creation, movement and use(Holland and Quinn 1987, Savolainen 1993).

2. Information Theories: the Process of Fragmentation

The international development of information science, informatics and related fields does not have an undisputed beginning point in intellectual history. Some reviewers trace its origin to the date when a particular professional organization was founded, others attach more significance to the publication of landmark research. Historians have described the evolution of national information systems in several separated countries or entire regions, and are now beginning to record the emergence of national information infrastructures(Moore 1993, Zulu 1994). In the global economy the place of each nation is determined by its relation to international trade through its growing "information society" (Organization ... 1992).

Science is lagging way behind this technological momentum. Research in development science, economics, education, and the communication, computer, information, and management sciences is far from the capability to empirically, or even descriptively, assess the consequences of innovations for the developing economies(Foster and Rosenzweig 1993). What is the impact of information flows on the poor, on nationalistic movements, environmental planners, urban sprawls or rural needs? Where are the researchers who will provide the theories and tests in this living complexity?

Even the landscape of research in one country presents a vast picture of fragmentation. Theoretical fields ranging from mathematical and engineering specialties and cybernetics through logic, cognitive science and artificial intelligence to economics and decision sciences have contributed to the change of focus from information-handling processes to theory building. A rich assemblage of theories exists now in the intellectual realm, but the words of Heilprin(1989, p.343) still ring true as he identified

> a consensus of opinion that although many laws, theories, hypotheses and speculations about information have been proposed, adequate scientific and epistemic foundations for a general science of information have not yet appeared.

Heilprin suggested a "fundamental open framework" of theoretical findings into which "the contents can be fitted when discovered"(Heilprin, 1989, p.343). Such a framework is still in the making. Instead of becoming more definitive, the borders of participating disciplines are constantly broadening and overlapping with each other. As Kitagawa(1972) warned, theories of information probably cannot be organized into a systematic body of knowledge until better channels of communication have opened up among researchers in all physical, biological and social sciences and the humanities.

3. Relationships between Theories and Applications

In his discussion of the contribution of research to society, Dubin(1978, p.16) posed the question "whether the ability to make such contribution depends upon being a scientist ... or on the product of being a good reporter." In the United States, decades of intensive federal funding for systems to disseminated the reported results of scientific research answered this question. Entire subdisciplines came to crystallized into new research communities: Knowledge utilization, research communication, and the diffusion of innovations, among others. New theoretical models were built by multidisciplinary research teams. Eventually, also the motives and interactions of such teams became the targets of research attention. Large bodies of literature have clustered around the processes of creativity and productivity; investigators, indeed, have searched in vain for measurable connections between these two sociopsychological phenomena.

Systems in information science/informatics are expected to assist other disciplines and professions in improving the effectiveness of research dissemination. In the past, actually their only mission

was to serve national economic and military interests by playing a support role to other sciences. Only in the last two decades has governmental and industrial attention in high-technological countries shifted to information-centered research itself. "Information" is usually defined in its broadest sense to include telecommunications and computer applications. Thus, under the influence of the media and public debate, the borderlines among information-related fields have become even more blurred. What is clear is that the public expects research(romanticized as invention and discovery) and policy to join forces and to solve all current problems. In the background of this expectation lurks the invisible problem of making the connection between theory and its social application stronger and more transparent.

In a far-reaching effort to identify factors that produce and affect real connections between information and development, the International Development Research Centre has conducted a project on measuring the impact of information on development. Three assumptions were suggested as the basis of assessment indicators: Assumptions about the nature and role of information, and the concept of indicators. Following a preliminary theoretical framework of assessment and recommendations for future research, the project report indicated the key attributes of this line of research:

> A number of theoretical questions underlie the concepts, criteria, framework, and methods for impact assessment presented in this report. To a large extent, assessing the impact of information implies that the value of information is defined, which will lead to some definition of information itself. How to move from the model of discrete messages, where information theory has been deadlocked, to an acceptable representation of a plurality of messages and uses, which is the common experience of individuals and groups, is probably the more significant and challenging of the problems(Menou 1993, p.112).

4. Characteristics and Implications of Information Theories

The concept of the social implications of information theories can be narrowed to the proposition that theoretical knowledge may (or may not) improve the ways information is made useful for people. The optimism of science suggests that theoretical models with first affect peers and then might find their way to success in industry, the professions and society. We can contemplate these possibilities only by beginning to identify the main characteristics of information theories.

Politicians, the media, and information professionals know that part of the theory-transfer and popularization process is the critical task of "translation," condensation, and integration into the social fabric. Here, again, we need to understand the characteristics of information theories in order to speculate on their implications for those who disseminate, those who add value, and those who eventually apply them. I will limit my discussion to four examples of characteristic issues relating to research in information science/informatics.

5. Multidisciplinary/Multicultural Context

5.1 Characteristics of Models

Research does not take place in a vacuum but in the framework of disciplinary, professional, and cultural assumptions. "Scientists operate within a background of belief about how things are. This background invisibly shapes what they choose to do and how they choose to do it" (Winograd and Flores 1986, p.24). The ambiguous nature and multidisciplinary perspectives of information science/informatics produce elusive theoretical models that are difficult to interpret. Moreover, development projects sponsored by international organizations bring together researchers from different cultures, adding to the complexity of theoretical work and outcomes.

5.2. Social Implications

Philosophers and behavioral scientists have found that the self is a powerful filter of observations. Based on their study, Gudykunst and Kim(1992) reported that cultural, sociocultural, psychocultural, and environmental factors form people's views of reality. Researchers in developing and industrialized countries make very different assumptions when they formulate a problem and plan a project(Scheuch 1989). Although theoretical models may aspire to universal validity, in practice one cannot expect a concept's interpretation, a policy, or a social institutional model to fit smoothly into another culture(Narula and Pearce 1990).

In recent years, researchers observed that a shift in the ways people of different backgrounds perceive the

world has taken place. Penman(1988, p.391) describes this change with reference to communications:

> Foundationalism refers to all those ways of thinking that search for ... some certain foundation or some infallible fact upon which knowledge can be built ... In contrast, constructionism sees the world as we know it as the product of a cyclic, hermeneutical process in which knowledge is expressed and created in social practice.

In an international research team both verbal and written communications reflect the cultural perceptions of each team member(Day, Dosa and Jorgensen 1995). From problem formulation to the interpretation of analytic findings, the sources of misunderstanding can go well beyond language barriers to the cognitive diversity of participants. We can only speculate about the extent to which theoretical results are affected. Differences in professional "cultures" may have similar impact, especially when information theories are adopted by systems designers.

On the other hand, multidisciplinary and multicultural research has a great potential for creative richness, wherever open communications help to minimize barriers. Increased cooperation among scientists and information system designers might be one of the answers. Zeisel(1981, p.32) observed that

> Cooperation is fostered when designers and researchers decide they want to use the other discipline as a tool ... to solve more broadly defined problems than they can solve alone.

The same might very well be true for researchers and practitioners with different cultural backgrounds.

6. The "Theory into Practice" Quandary

6.1 Characteristics of Models

Information and development professionals have been questioning whether links between theoretical models and practical applications really exist(Boon 1992, Cernea 1991, Makovetskaya and Bernadsky 1994). It seems that the analysis of models in order to identify elements of usability and specific needs for adjustment is especially problematic in information science/informatics where models are often descriptive and too general.

6.2. Social Implications

The successful use of research results in the real world depends on the investigator's interest in making results understandable and on the applier's willingness to bring unbiased receptiveness to a research effort. Projects serving specific needs are more amenable to understanding by practitioners than abstract inquiries. Unfortunately, specific applied research projects are often restrictive and inflexible in research design(Choguill 1994, Nelkin 1984). consequently, many researchers are disturbed by a sponsor's "guided research" program. Others admit that studies supporting economic and social improvements in developing countries must conform to national development plans and to the sponsor agency's strategies in order to be effective(Pavlia, Pavlia and Zigli 1990).

An unusual approach to justifying research which needs to be subordinated to particular political and policy objectives in the interest of development, is the concept of the economics of ideas. Romer(1993, p.63-64) explains that while in the economic analysis of patents the uniqueness of ideas has always been recognized, in policy models ideas are most often ignored. In his view the reason is that the contribution of ideas to development cannot be quantified and measured. However, the new appreciation of creative ideas shifts the emphasis to the qualitative evaluation of development projects. Romer insists that an open social discourse about ideas, although not quantifiable, is a powerful development model. "The logic behind the economics of ideas supports the new development orthodoxy that a policy of openness ... offers the potential for large gains in poor countries"(Romer 1993, p.65).

Similarly, an active flow of communication between researcher and practitioner is essential in order to transform conceptual models into working strategies. The resentment scientists often feel against guided applied-research projects may be ameliorated by a sense of moral responsibility for meeting human needs, a sense frequently shared by researcher and practitioner.

7. The Formal-Informal Information Dichotomy

7.1. Characteristics of Models

Most information retrieval and use models have been created with formal information systems in mind. How do computers and people communicate? How do users formulate problems? Even in research addressing information seeking not mediated by a person or system, usually the purpose is to understand how people (who are classed into certain categories) ask questions (which are assumed to pertain to the inquirer's information needs). Information seeking is conceptualized as a rational activity that can be simulated by computer programs. Informal communication among people who are not looking for information yet finding it in spontaneous ways, is seldom studied by information science/informatics.

7.2. Social Implications

Information professionals have borrowed models from other disciplines which have studied interaction patterns of people within or outside organizations. However, even the theories produced by this strain of research are based on the image of the communicator as a well-defined person (health care provider, physicist, student, listener, consumer) driven by a certain purpose. We have also witnessed remarkable advances toward changing the orientation of research from information systems to information users, but even these efforts address mainly people who purposefully seek information(Cole 1994). In contrast, Lifton(1994) speaks of the "Protean" individual who is multidimensional, changes purposes and interests frequently, and is motivated by different frames of reference in different situations. The "Protean" individual defies categorization.

Studies of informal information flows among people would do well to take the Protean model into account to arrive at a more realistic conceptualization of the individual. An inquiry into spontaneous and unstructured information exchanges among people, including chance remarks and unplanned digressions, might shed considerable light on their multidimensional "Protean" interests and reveal unspoken information needs indirectly. Such studies would probably produce theories upon which future research could be built.

8. From Linear to Cyclic Innovation Processes

8.1. Characteristics of Models

Reexamination and testing of information-related theories is difficult because information behaves differently under different conditions. One example is information as a component of the innovation process. In the traditional linear model of innovation(from problem perception through experimentation and testing to implementation of the change), information was assumed to behave at every point in predictable ways (abundant, scarce, inaccessible, accessible, etc.). Researchers thought that these ways could be observed and measured(Stern 1982). Since information did not follow expected patterns, theories based on the linear model of innovation included some characteristics which defied reexamination and testing.

8.2 Social Implications

We cannot expect that innovations in organizations or societies will normally be well-planned and systematic. Problems may interfere with the flow of events, or breakthroughs may occur in unexpected ways. Many changes in the direction of planning, risk-taking, or experimentation are spontaneous. Innovation resembles a cyclical rather than linear process. In the firm, different dimensions of the activity (scanning the competition, formulating criteria for testing, entering a creative research phase, or exploring the market) interact and overlap with each other to the extent that sometimes a chronology of steps is impossible to construct. This fluid state of affairs sometimes saves the innovation from becoming stagnant and failing.

Under these conditions, information processes are unstandardized and unpredictable. Several phases and events happen simultaneously, different units of the organization gain or lose influence, and information needs peak and fall like waves. Bartlett and Ghoshal(1987) found through their empirical research project that in corporations the management of the flow of intelligence, ideas and knowledge is an enormously complex task. Radosevic(1991, p.68) warns that "intelligence failures, caused by an exclusive technological orientation" are not rare.

Social innovation, in particular, is the realm of fluctuations where new trends demand the involvement of more players in the change process than ever. The evaluation of social change is information-intensive, calling for new approaches to data gathering and analysis(Kumar 1993). The planning of new information infrastructures may be assisted by lessons from the past, or by an intuitive

envisioning of the future. Molody(1986, p.57) reports that "important -- and totally overlooked in the great majority of studies -- is an examination of the information and communication networks being used prior to the introduction of new technologies. Without knowing the prior information flows and communication relations, one has no base case against which to compare the new, changed relation ..." Mytelka(1993) urges consideration of "innovation networking" in the effectiveness of development processes, while Ruth and Gouet(1993), reporting on an empirical project in Chile, identify the study of scientific network users as a neglected research domain.

Reexamining and testing theories that had been constructed around the traditional linear image of the innovation process in the real, unpredictable organization and social environment is an exciting task for the information scientist.

9. Concluding Note

The rendering of a research model socially useful is a form of technology transfer. It is easier to speculate about this process than to identify criteria to assess the extent, nature, and validity of the model's usefulness. To recognized and evaluate factors that may assist or hinder the application of the model is even more intractable.

However, information science/informatics cannot turn away from this research need. Four reasons account for this responsibility. Information is essential for

- o recognizing opportunities and coping with problems in individual life
- o preparing societies for meaningful transformations
- o using environmental resources wisely
- o making the right choices in technology.

In this broad framework, the open-endedness and flexibility of theoretical knowledge in information science/informatics can work to the advantage of the social impact of information theories. It can attract researchers from different disciplines. It can accommodate the diversity of future research on the role of information in individual-society-environment-technology relationships, and it may produce models relevant to the changeable world of reality.

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