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KNOWLEDGE MAP OF INFORMATION SCIENCE: IMPLICATIONS FOR THE FUTURE OF THE FIELD

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ABSTRACT

This collective paper incorporates eleven position papers on implications of the "Knowledge Map of Information Science," a Critical Delphi study conducted in 2003-2005 and published as a series of four articles (ZINS, 2007 a, b, c, d). The Delphi study captured the deliberations of 57 leading information science scholars from 16 countries to provide (1) definitions of the fundamental concepts of data, information knowledge and message, (2) alternative conceptions of the broad information science domain, (3) different classificatory mappings of the field, and (4) comprehensive mappings of information science. Overall, the Knowledge Map provides an early 21st century snapshot of the field that should help guide future research, educational programming, publishing, and other professional and scholarly thrusts. Future information science mapping research should be done periodically, including additional Delphi studies and assessments of the degree of the field's expansion and probable division into sub-fields. Alternative methodologies for mapping the expanding information science universe and its synergies with other fields of knowledge should also be explored.

Keywords: Knowledge Map; Information Science; Information Science Mapping Research; Delphi Method.

PROLOG

This collective paper incorporates eleven position papers that discuss the extensive Critical Delphi study, the "Knowledge Map of Information Science" (ZINS, 2007a, b, c, d)" and its implications for the future of the field. All eleven of this paper's contributors were actively involved in the study – Chaim Zins, who initiated and led the study, and ten panel members. The Knowledge Map study sought to explore the foundations and contemporary nature of information science. The Critical Delphi panel consisted of 57 leading scholars from 16 different nations. These 57 panel members were selected to represent the essential nature of the field and its sub-fields.

By way of background, results of the Knowledge Map Critical Delphi study have been published as a series of four articles. The first article of the series maps prevailing conceptual approaches to defining "data," "information," "knowledge," and "message," and provides 130 definitions of these concepts from 45 Delphi panel members (ZINS, 2007a). The second published article provides 50 alternative definitions of information science, discusses theoretical issues related to formulating a unified, systematic conception of the field, and synthesizes six alternative conceptions of the entire field (ZINS, 2007b). The third article documents the comprehensive and partial conceptual mappings of information science of 28 panel members; these mappings provide early 21st century baseline conceptualizations for future researchers and observers (ZINS, 2007c). The forth and final published paper of the Critical Delphi study, titled the "Knowledge Map of Information Science," presents comprehensive, systematic mappings based on collective panel deliberations. Zins' summative Knowledge Map presented therein (Appendix A) encompasses ten basic categories (foundations; resources; knowledge workers; contents; applications; operations and processes; technologies; environments; organizations; users). This Map should serve to support future efforts to develop and evaluate information science theories, educational programs, bibliographic resources and other related scholarly and professional thrusts (ZINS, 2007d).

The following papers, submitted by eleven of the Critical Delphi scholars (including Zins, who led the study), provide reactions about the overall Knowledge Map and its implications for future information science researchers and observers.

REFLECTIONS

Clare Beghtol

Knowledge Map of Information Science: Issues, Principles, Implications

To my knowledge, this is the first study of this kind in information science and one of the few in any discipline. The research offers a snapshot of this one field at this particular point in time. In that way, the study provides a baseline and a comparator for further studies, and we will be able to see over time what things change and what things stay the same.

Henry Evelyn Bliss, the creator of the first edition of the Bliss Bibliographic Classification, believed that classification systems should be based on the "scientific and educational consensus". Bliss thought science in the broadest sense included all knowledge and all disciplines — what we might call the sciences, the social sciences, and the arts. Bliss has been called the most scholarly of the major bibliographic classificationists, and he believed that knowledge should be organized in the way it was taught in institutions of higher education and in the way scholars thought their fields should be organized to be passed on to future generations. Bliss believed that knowledge was becoming more and more consensual and that the world was becoming more and more unified.. We don't share Bliss's vision, but we can see in the knowledge map of information science an attempt to discover the range of opinions and the extent of consensus in this one field.

The study itself provides a qualitative methodology for finding out what scholars, practitioners and educators in a field agree – and disagree – about. Where are the areas of contention and debate? What areas seem stable and consensual? Thus, the knowledge map provides one example of a knowledge organization system for information science as it is now. It also provides a basis for assessing changes in the

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field as it develops. In this sense, the knowledge map provides a practical look at Bliss's idea of consensus among scholars, educators and practitioners. It can also provide clues about when and in what areas knowledge organization systems should be revised. Any field can be assessed in this way and the process of classification revision can be based on empirical research instead of on more intuitive assessments.

Of course, there are also problems. One is that we don't know how long these findings will be valid. Another problem is the assumption that the people who participated in the study represent the field as it is now and as it will probably become. But these problems are not deal breakers. They bedevil every kind of quantitative and qualitative research involving human beings. We can refine and revise the methodology further until we have what we can call a "best practice" for gathering opinion and for measuring the contentious and the consensual areas of any of the fields in which it is our job to provide information retrieval.

In my view, then, the implications of this study are twofold. First, the study suggests that more empirical research needs to be done to ascertain the domain and scope of knowledge areas as seen by their researchers and practitioners. Presumably, this empirical research can show us what needs to be revised and what needs to be expanded in current knowledge organization systems.

Second, the study suggests, that in an age when more and more information is available and more and more changes appear to be needed more often, we can create and revise knowledge organization systems in an increasingly timely and relevant manner.

Michael Buckland

Models, Metaphors, and Metaphysics in Information Science

Dr Zins has done a good job of a difficult undertaking. My comments are not criticisms of what he has done, but an attempt to place his findings in context.

For all the differing perspectives assembled, I, too, was surprised by the degree of consensus that Dr Zins found in the Information Science community surveyed. Nevertheless, this agreement is, in part, an artifact of the population selected. If one

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had included, for example, participants at the Conferences on the Foundations of Information Science (http://www.mdpi.net/fis2005/ and http://fis.icts.sbg.ac.at/main.html) there would have been a wider diversity of opinion.

In the discussion at the ASIST conference panel session in Charlotte it was noted that the majority of the respondents subscribed, more or less, to a cognitive perspective and that they did not consider their position to be metaphysical. If so, this is a misunderstanding. The "cognitive turn" is both metaphorical and metaphysical. (This is matter of description and not a criticism). It is built on ideas that were imported from cognitive science and artificial intelligence, not constructed from within our field. These imported ideas are expected to be useful for practical purposes and are associated with a kind of engineering. The cognitive turn rests on an information processing model of mind, which has never been demonstrated and is questionable. It is a borrowing that is based on a metaphor and so it can properly be considered to be essentially metaphorical. The reason that the cognitive turn in Information Science is metaphysical is not because it is a borrowing, but because it is constituted by the reification of machine metaphors and a metaphor for communication, and lacks grounding. It is not clear that a cognitive model is necessary in Information Science or that its application in Information Science has contributed to Cognitive Science, as it should have by now if it were "physical" in the sense of being demonstrably a true representation of human cognition.

Dr Zins adopted the popular Data – Information – Knowledge (DIK) model. Some would add Wisdom. But he found it unsatisfactory because it could not accommodate Messages. The DIK(W) model has some utility as a way to make the point that information science is very much about process. Nevertheless, the DIK(W) model, a metaphor imported from data processing, is fundamentally problematic. Bits (D), texts (I), belief (K) – and good judgment (W) -- are different in kind, not a single ingredient cooked to varying degrees. Many of the participants provided highly qualified replies when asked about D, I, and K. Any model that cannot accommodate messages would seem to have little claim to a role in Information Science. A simpler dichotomy of Document and Belief appears to be simpler, more robust, and more apt, but all models and theories need to be considered in relation to the purposes they are intended to serve.

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Charles H. Davis

Thoughts about the Knowledge Map of Information Science

Participating in this study and reading its results reminded me of similarities between information science and other multi- and interdisciplinary fields, particularly my original field of chemistry. Although well established and better defined than information science, chemistry has major subdivisions: inorganic, organic, analytical, physical, and biological chemistry. It is often called the "middle science" because it is perceived as a bridge between physics and the biological sciences. Information Science might be called everybody's "middle science" in that it seems to impinge in one way or another on virtually everything we do. This study has uncovered a variety of subdivisions as envisioned by the participants and may pave the way toward classifying them.

It is possible that the "knowledge map" might provide a preliminary guide to building a solid undergraduate program leading to a Bachelor of Science degree that could serve as the field's first professional and academic degree. This has been the norm for chemistry and other science and engineering programs for a very long time. In fact, there are already experiments in this direction, one of them at Indiana University in what is now called a School of Informatics. Its current status is nascent and fluid. Moreover, many of the social and culture aspects are being explored simultaneously in the University's School of Library and Information Science, which has faculty who overlap with Informatics. In fact it was SLIS faculty member, the late Rob Kling, who started the Center for Social Informatics. In this connection, I note that the American Society for Information Science and Technology's Special Interest Group on Technology, Information and Society has changed its name to Social Informatics. It would seem, therefore, that "information" has strong roots as a descriptor in spite of the repeated use of "knowledge" during this particular study.

As a physical scientist, I gravitate toward taxonomies as defined by Dr. Zins: namely, schemes grounded on empirical data. Other classifications are also useful, of course: typologies, based on analysis of constituent concepts, and ontologies, which stress characteristics, facets, or key aspects of a given phenomenon. It may be *useful to consider the ongoing debate about whether Linnaean taxonomy should be replaced by schemes based on genomic analysis. I think it was in this connection that some wit said, "There should be a tax on attacks on taxonomy!"*

While I favor approaches that work from the bottom up, I do not believe that the term 'knowledge' – in spite of its apparent popularity with this particular group -- will supplant 'information' as an identifier for our emerging field. Some consider the multiple meanings associated with 'information' as a liability. I do not. It is precisely because of its inclusiveness that I prefer it. It can incorporate everything from data to wisdom, thereby representing all facets of the field: hard-core computer science, bibliometrics, social informatics, and so forth. By contrast, 'Knowledge Science' sounds vaguely pretentious – at least in English – and suggests a philosophical stance that differs from the pragmatic and empirical traditions to which we have become accustomed.

Anthony Debons

Reflections on the Study

Dr. Zins seminal work advises me on several points of emphasis among many. First, that information science, in its diversity, needs to agree in the language it uses, or, at least, in the variations thereof. We need a lexicon we can rely and refer to when presenting our convictions and work. My second point derived from the study relates to the object to which the language directs its attention. There are libraries and library systems; there are computers and computer systems. There are many forms of media that define communication and in the broader sense, communication systems Dr. Zins' map (ontology) clearly points to this broad scope of the science. At this level of diversity, a degree of clarity as to what system we are engaged (or relations thereof) is suggested. They call this the "systems point of view". Thus, like all sciences, information science is seen as a science of exchanges, reflections, work, clients, environments and convictions the amalgamation of which offer numerous challenges. To me, the Zins' study has shown the full breath of the science and its diverse complexity. To this extent, the Zins' study has contributed significantly to an understanding of the universe and diversity implied in information science as an *interdisciplinary and the requirements for its future challenges and development. Now, the business ahead is to direct our attention to insure that this significant effort can be applied to the education of future information scientists.*

Gordana Dodig-Crnkovic

Information and computing seen as information processing

The present-day informatising of the society is the result of the ubiquitous use of computers as information and communication technology. Information is to replace matter/energy as the primary constitutive principle of the universe, as (VON BAEYER, 2003) suggests. It will provide a new basic unifying framework for describing and predicting reality in the twenty-first century. That informational universe is described, re-constructed and predicted by computational models. Universe is conceived as huge computing machinery whose mere physical existence might be conceptualized as computation or information processing that happens as a consequence of the natural laws. The leading computational paradigm tells us thus that the information and its processing can be used to describe the universe, including humanity as a whole, as a system of interacting information-processing units.

At a fundamental level information can be said to characterize the world itself, for it is through information we gain all our knowledge - and yet we are only beginning to understand its meaning (VAN BENTHEM, 2005) Here is the attempt to define some basic concepts constituting and relating to the idea of information, in the sense it is used in the field of computing (DODIG-CRNKOVIC, 2005).

***Raw data** (sometimes called source data or atomic data) is data that has not been processed for a given use. [In the spirit of Tom Stonier's (1997) definition - Data: a series of disconnected facts and observations] Here "unprocessed" might be understood in a sense that no specific effort has been made to interpret or understand the data prior to use. They are recorded as "facts of the world"; either given/chosen on the outset, the result of some observation or measurement process, or the output of some previous data generating process (as often is the case for computer input data). The word "data" is the plural of Latin "datum", "something* *given", which one also could call "atomic facts" that can not be made any simpler (primitives).*

Theory laden. *It is very true that all data are theory laden. That does not mean that you can not produce new data which in the next step will lead to the theory revision, and that new, corrected theory will be the basis for producing new data which after a while will lead to the correction of the existing theory. We use our theory-laden data to improve or refute theories!*

Information *is the end product of data processing.*

Knowledge *is the end product of information processing. In much the same way as raw data are used as input, and processed in order to get information, the information itself is used as input for a process that results in knowledge.*

Data-Information-Knowledge-Wisdom. *According to Stonier (1997), data is a series of disconnected facts and observations. These may be converted to information by analyzing, cross-referring, selecting, sorting, summarizing, or in some way organizing the data. Patterns of information, in turn, can be worked up into a coherent body of knowledge. Knowledge consists of an organized (structured, systematized) body of information. Such information patterns are forming the basis of insights, judgments and attitudes which we call wisdom. The above conceptualization may be made concrete by a physical analogy (STONIER, 1993): consider spinning fleece into yarn, and then weaving yarn into cloth. The fleece can be considered analogous to data, the yarn to information and the cloth to knowledge. Cutting and sewing the cloth into a useful garment is analogous to creating insight and judgment (wisdom). This analogy emphasizes two important points: (1) going from fleece to garment involves, at each step, an input of work, and (2) at each step, this input of work leads to an increase in organization, thereby producing a hierarchy of organization." I would add that this input of work added at each subsequent higher organization level at the same time is input of new information to the existing lower level of organization (DODIG-CRNKOVIC, 2005).*

Conceptual work is the greatest and most constant challenge for many researchers. The study "Knowledge Map of Information Science" purports to facilitate theory building and use, by exploring the theoretical foundations of information science (IS), mapping conceptual approaches for defining basic concepts, portrays the profile of contemporary IS, and develops a systematic and scientifically based Knowledge Map of the IS, grounded on a solid theoretical basis.

Having in view the contribution of 57 leading scholars from 16 countries resenting nearly all the major sub-fields and important aspects of IS, as well as the Critical Delphi methodology of the study, I am convinced this knowledge map will shape the future of IS. In addition, this research study provides an integrative international perspective of IS knowledge domain and stimulates interdisciplinary and international co-operation in the field of IS.

In my opinion, the implications of the study for the future of IS are at least the following: (1) Formulating standardization of IS terminology through clarifying basic concepts, and (2) Strengthening the role of IS within the Information Society. I believe this study will be helpful to researchers, students and practitioners - from many countries - as a ready reference guide to conceptual framework relevant to IS field.

My country, Romania, is facing now the double challenge of moving towards EU accession and Information Society building. Consequently, we need simple, clear and agreed – if possible standardized - approaches of IS basic concepts and principles. But in EU Member States – as well as in Romania – the concept "Information Science" is formally included in "Information and Communication Sciences" concept or in "Information Science and Technology" concept. In Romania, Information Science is taught only in two universities, while Communication Science is taught in more than dozen universities. There are a lot of confusions, for example, "information professionals" are generally computer and mass media experts. This is mainly because some basic concepts – such as "data", "information", "knowledge", "Information Science", and "Communication Science" - have many definitions.

However, more and more Romanians are aware that Information Science – as a pillar of the Information Society - could help them to ensure the optimum accessibility and usability of information, to optimize the decision-making and problem-solving *processes, to improve the quality assessment of data, information and knowledge, to facilitate the paperwork reduction, to reduce the textual harassment, and to bridge the Digital Divide.*

Glynn Harmon

The Knowledge Map of Information Science: Some Future Research Directions

The Knowledge Map provides us with a foundational overview of the field and suggests a number future domain mapping directions. Below are some future domain research questions:

1. How do various disciplines evolve over the centuries and do they evolve with other disciplines concurrently and in a complementary fashion? The humanities acquired formalized domain status broadly during the 1500s and 1600s, the physical sciences during the 1600s and 1700s, biological sciences during the 1700s and 1800s, and the social sciences during the 1800s and 1900s. The behavioral/communication/information sciences formalized during the 1900s (HARMON, 1973, p.67-85). Thus, we have seen one group of disciplines formalize through each recent century to make up our contemporary encyclopedic universe of knowledge. If information science is but one of a set of cognate 20th century disciplines, what are these disciplines, and how might their interactive dynamics be viewed profitably for different analytical purposes? What new disciplinary groups might form during the 21st century and after? What new knowledge gestalts will emerge, so that their disciplinary parts may be seen vis-à-vis the whole knowledge universe? What roles will information science play therein?

2. Can information science be defined appropriately through the use of legacy (previous century) categories, such as the social, biological, or physical sciences, or the humanities? Or, might we best struggle through the present disciplinary fog to define provisionally our newly emergent fields in terms of their unique features and originality? It can be all too easy to lapse into viewing new things through old lenses. Additional mapping research might incorporate futures research methodology based on a middle ground between deterministic premises (the future is determined and we *must "predict" it via trend extrapolations, cyclical analysis, etc.) and anti-deterministic premises (we will invent and actualize the future).*

3. Should information science possess a fixed definition, a stable locus, and a well- circumscribed scope? Kaplan (1964, p.46-82) argues for making definitional, locus, and scope parameters sufficiently open-ended, abstract, and provisional to host new findings and resolve dialectical conflicts. Future domain research might well optimize such parameters.

4. Is the human-centered (anthropocentric) locus sufficiently inclusive? Bioinformatics, for example, now focuses on data about DNA protein sequences and structures, genomes etc., of plant and animal species (BENOIT, 2005, p.179-218). Clearly, cells, organs, organisms and groups of all species process information and genetic knowledge. Future domain research might expand to cover all organisms and their interrelations.

5 Is the living organism locus sufficiently inclusive? Information is now a hot topic in cosmology (e.g., in relation to black holes in the universe), and is embedded in notions of quantum phenomena (HOFKIRCHNER, 1999) Dichotomous distinctions between living and non-living entities have been breaking down in the natural sciences for some time. Future domain research might well expand accordingly.

6 Is the predominantly Occidental approach to information science domain research sufficiently inclusive? The inclusion of Oriental and other major cultural approaches might serve to enrich information science research. For example, oriental notions of Qi bear resemblance to Occidental notions of information and energy. Qi is one of the most deeply rooted intuitions of Chinese civilization. Qi embraces collectively such Western notions as "life force," matter-energy, the subtle impetus behind transformational change of organisms and objects through internal-external pulsation and resonance, states of being, and combined cause-effect (KAPTCHUK, 2000, p.43-52).

7. Should future information science research focus on the extensive impact of human short-term memory limits on hierarchical spans of recorded human knowledge at various classificatory levels (sub-disciplines, disciplines, disciplinary groupings, or encyclopedic representations)? Short-term memory limits act to constrain the number of cognitive chunks that we can process to about seven, plus or minus two (Miller;

1956; Harmon, 1973). For example, the 28 Classification Schemes in the Knowledge Map have between 2 and 14 subsections each, with a mean of 7.43 subsections (SD=3.64, SEM=0.69; 99% CI=5.52 to 9.33).

Donald H. Kraft

A Delphic-Like Study of Information Science: Its Implications to the Information Science Discipline

In 2004-5, Dr. Chaim Zins led a study of the nature of information science. This study was analogous to a Delphi study in that several information science colleagues and practitioners were asked to answer a series of questions, and then respond in rounds to those answers. This has led to a four-part article submitted to the Journal of the American Society for Information Science and Technology (JASIST), of which I am the current Editor, as well as a panel discussion session at the 2005 ASIST Annual Meeting last fall.

Issues of the meaning of the term "Information Science," leading to the idea of taxonomy of the discipline were raised. This is especially interesting in that the American Society for Information Science and Technology (ASIST) recently announced that they had a digital library, including JASIST, the Bulletin of ASIST, the Annual Review of Information Science and Technology (ARIST), and the Proceedings of the ASIST Annual Meetings. These publications being available can mean a lot to the members of ASIST and beyond to international colleagues and to practitioners. Part of that digital library was a thesaurus, which meant an update to what was then an older, print version of a thesaurus for the information science discipline. Thus, the idea of people investigating how we organize and classify the discipline has great implications for being able to define our field, let alone be able to search the literature of our field properly.

Another set of issues that this study can impact includes what should be included in the discipline of information science. Six years ago, the American Society for Information Science (ASIS), which had formerly been called the American Documentation Institute (ADI) since its beginnings in 1937 until 1970, added the phrase "and Technology" to its name. The reasoning behind this change centered *upon adding a set of topics to the discipline via the Society in order to modernize and to attract a broader audience of scholars and practitioners. While the Society has always sought on a broad range of topics and issues with which to consider within the discipline and beyond, this name change indicated a new sense of commitment to topics and areas that were not always considered mainstream to the discipline of information science. This study certainly will have an impact in the future for the Society and for the discipline in terms of what is part of information science and what is not.*

Finally, the Society's publications, especially its scholarly journal, JASIST, are vehicles for expressing the work done by and for members of the information science discipline. What the areas to be considered of interest by these publications is an important concern that impacts the boundaries of our field. This study will, no doubt, play a role in determining the future of the field, and that future will be reflected in such publications, no doubt.

Roberto Poli

Reflections on Information Science

Increasing attention is being directed to the problems of knowledge organization, knowledge sharing and knowledge integration. Any information about where the fields of knowledge or information is heading may therefore play a positive role, either for further facilitating its subsequent development or for trying to modify the situation in case it is viewed as heading in the wrong direction. For these reasons, the Delphi you have done is clearly relevant. However, I think that the data so far provided should be integrated with at least three types of information.

Firstly, not all the positions so clearly reported by your papers are suitable to be developed in such a way as to become a fully articulated vision of the field. Some of the positions are more or less explicitly linked to specific needs or peculiar types of expertise. Nothing bad, obviously. However, distinguishing "local" viewpoints from "global" ones may prove methodologically and scientifically beneficial.

Secondly, from the reports I have so far seen I am unable to distinguish personal and in some sense unique positions from position shared by more or less wide *groups of practitioners. Furthermore, I cannot say whether the most widely accepted proposals are uniformly distributed according to, say, geographical and professional criteria.*

Thirdly, I wonder whether there could be any way to extrapolate dynamical information from your survey. As I already wrote above, individuating the directions the field is heading may provide further types of information. Trying to answer to any of the following questions would be great: What has been done during the past five years? Which bottlenecks have been individuated? What could be done to remove those bottlenecks? What could reasonably be achieved in the next five to ten years?

This said, let me go back to my own position in order to call your attention to something that apparently is lacking from what I have so far seen. Needless to say, I am aware that I may be entirely wrong. However, here are my two cents.

The most striking problem is possibly the fact that we seem to have systems rich in information but poor in knowledge (I do not repeat here my distinction among data, information and knowledge). Providing that my claim is correct, we should elaborate a framework in which information and knowledge could be properly integrated. My initial hypothesis is that passing from information to knowledge involves the elaboration of a well-structured theory of semiotic units. The latter could be codified by a three-fold structure comprising expressions, contents and ontological components. Expressions and contents together give rise to the symbolic component of the semiotic unit. The three components are all further sub-dividable into types and kinds.

Here come the two main obstructions, one conceptual and one formal. The conceptual obstruction is the poor and vanishing contemporary understanding of ontology. It is well known that philosophers have been working on ontology and ontological problems for some twenty-five centuries. The history of philosophy may therefore offer ideas of use for contemporary developments and indicate the options that may lead into dead ends or nowhere at all. The classical Aristotelian distinction between categories and principles (or trans-categorical analysis), or the Husserlian emphasis on parts and wholes, and his idea of regional ontologies as distinguished and opposed to formal ontology can still bear fruits. However, for most of the twentieth century both analytic and continental philosophers have preferred

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epistemological to ontological inquiry. A new renewed interest (and expertise) in ontology may pave the way for addressing some of the problems infecting information science.

The latter obstruction can be presented as follow. The intertwined relationships among the components of the semiotic units become easier to elaborate if we find a uniform way to represent the various components. Unfortunately, most of the usual formal tools seem structurally unable to develop the formal framework appropriate to such a task. As a matter of fact, my fear is that such a general address requires formal tools as sophisticated as those provided by category theory. The reason is essentially that other operators beyond the usual logical operators should be used, namely the 'geometric operators' of category theory (for instance those of product, co-product and exponentiation). Unfortunately, most scholars in the field of information science have only a dim mathematical expertise and usually no real knowledge of category theory. Most of the computer-based frameworks used for storing, retrieving, sharing and integrating information are – when they are – based on some baby logic, too limited for addressing the problems mentioned above.

Richard P. Smiraglia

Implications of the Study for the Future of the Field

***On metaphysical vs. non-metaphysical approaches**. It is curious that you say the scholars seem to zoom into non-metaphysical approaches. And you conclude that the discipline is centered in a pre-experiential constitutive concept, which suggests to me an element of metaphysical perception over and above any purely empirical perception. My impression is that there is a metaphysical strand apparent; many conceive of knowledge as somehow representing an ideal state of information. Information is often described in social terms, which also stems from a metaphysical perception I think. And knowledge organization is largely a metaphysical enterprise. I think there is a strongly metaphysical aspect to the theoretical bases of the discipline; this study did not adequately uncover it. A question for further study perhaps …*

***On Social Epistemology.** I had some trouble with the distinction between "cultural" and "living and physical" worlds. I had to decide whether you were*

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suggesting a sequence, such that culture is a portion of the human world, or whether you were postulating six domains which are different from each other altogether. We embrace the cultural domain because it is an epistemological rationale for our empirical science. That is, information phenomena merit study for the role they play in culture and its dissemination. This goes to the theory of social epistemology (cf. Egan, via Furner 2004 for example). The milieu in which information phenomena operate is clearly a living world. This broadens the field quite a lot beyond documents and machines. It also indicates rather more qualitative and sociometric research will be required depending on the model that persists. If the cultural model is pervasive, that raises a question in my mind whether this is a shifting paradigm, in which case there is movement from the origins in documentation and machine-science to a paradigm in which D-I-K-M are seen as central life phenomena.

What price further convergence? Which goes to my earlier question, is this a shift, or a shifting, or a quagmire, or a slippery slope? If I insist knowledge organization be grounded in cultural considerations, does that go toward convergence? What about empiricism? We have insufficient empirical evidence about almost everything.

***On the Name of the Field**. One wonders why there haven't been rounds of similar Critical Delphi study before this but here we are. The field is not so new that it has no intellectual foundations and yet it is new enough that its foundations are not very secure. I like to subscribe to Rayward's notion (1993) that documentation and library science converged into a 'library-and-information science,' now called 'information science' or simply 'information.'*

If one accepts this historical premise, then one has to cease calling the field or any part of it 'library science,' and has to teach others also to accept this premise. It seems to me we have not taken this path. And one result is that we have those who still insist there is a science of "libraryness" (not the least of whom are its practitioners who hold degrees with those words), while others, at some opposite pole, insist that the science of information is all about computer technology. The rest of us working away in the middle are concerning ourselves with the properties of information, with the relationship between data, information, and knowledge and the role of the message in that relationship, not to mention the role of the sign as well.

When asked "what is that?" about my field, I usually reply that it is the study of the properties of information and of the contexts in which information (or informing activity) takes place. But our field lacks the sort of identity that Chemistry or Botany have, wherein folks know one has to do with substances and the other with plants and that scientists study it. But we have in this study 57 definitions of D-I-K. The question arises how we are to synthesize this knowledge in a manner useful for the present, as well as synthesize it for the future. And yet if we do not, we will not resolve the lack of identity, either among ourselves or in the larger cultures we inhabit.

The name 'Information Science' is clearly inadequate. What then? Changing the name to Knowledge Science? Well, do not change it to another X Science, but rather find the constitutive concept and name it for that. Botany, Biology, Chemistry, Sociology, ergo .. what?

Chaim Zins

Implications of the Study for the Future of the Field

While reflecting on the study seven implications have emerged.

***Terminology**. It is clear that information scientists do not use the same terminology; meaning, usually we use the same terms but we ascribe different meanings to them. Words can be misleading. Consequently, we need to clarify the basic terminology, and adopt ad-hoc consensual meanings.*

***Conception**. This is relevant to the conception of the field, as well. Words can be misleading. It is clear that information scientists ascribe different conceptions to "Information Science." This means that we explore different fields that carry the same name "Information Science." Consequently, we need to clarify the diversified conceptions of the field, and adopt an ad-hoc consensual conception.*

***The name of the field**. Clearly, the name "Information Science" does not cover the various aspects of the field. It seems that the time has come to change the name from "Information Science" to "Knowledge Science."*

***Knowledge mapping**. Evidently, knowledge mapping is a powerful tool for clarifying our basic terminology, and the various conceptions of the field. In the light*

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of the current condition of Information Science I would suggest to periodically update our knowledge maps.

Research agenda & Academic programs*. While updating our knowledge maps we need to update the research agenda of IS and its sub-fields, as well as IS academic programs and professional education.*

Critical discussions*. Finally, this Critical Delphi study stresses the invaluable and indispensable contribution of critical discussions among scholars and practitioners aimed at clarifying the foundations of the field, mapping its knowledge domain, and updating its research agenda and academic programs.*

EPILOG

To summarize, the above position papers reveal a considerable degree of interpretative convergence about the implications of the study, along with a few divergent observations. Chaim Zins, who formulated and led the Critical Delphi study, notes an ongoing need for a more rigorous development of basic information science terminology, especially for information itself. He calls for further critical discussion and periodic updating of the map and notes the need to re-evaluate research agendas and academic programs via updated mappings. Zins favors renaming the field from "Information Science" to "Knowledge Science."

Anthony Debons likewise argues for a more systematic lexicon to embrace the variegated facets of information science at large; he eloquently states how the language objects of information science are embedded in social exchanges, clientele, work processes, reflections, convictions, and environments—all of which fall into a systems theory purview.

Clare Beghtol stresses the classificatory notion that the Knowledge Map brings to us a reasonable degree of scientific and educational consensus about the field, while accommodating differences and focal points for debate, and provides a baseline snapshot for future research. She observes the need for a stronger empirical basis for corroborating and successively revising the Knowledge Map as well as other knowledge systems at large.

Michael Buckland observes a surprising degree of consensus among Delphi participants but stresses the need for wider participant sampling and detection of underlying theoretical biases (such as an implicit reliance on the cognitive perspective and use of the information processing model; the reification of machine metaphors; automatic assumptions about the homologous nature of the data-information-knowledge-wisdom hierarchy).

Charles Davis characterizes information science as “everybody’s middle science” and views information itself as a highly inclusive and reasonably well-established concept that pervades all areas of knowledge. Accordingly, there appears to be no need to adopt the relatively vague name of “Knowledge Science.”

Gordona Dodig-Crnkovic presents an unusually abstract notion of information processing, one that pervades society and the entirety of nature itself. Information can potentially displace matter and energy as a universal, “primary constitutive principle.” Raw data are theory laden and can be processed into information, organized knowledge and ultimately wisdom.

Nicolae Dragulanescu argues that the Knowledge Map is significant in that it provides views of scholars from various disciplines and countries, and serves to clarify basic concepts, standardize terminology, and strengthen the role of information in society through improved problem-solving and decision-making, reduced paperwork, and the bridging of digital divides.

Glynn Harmon poses several future research directions. Information science might be viewed as a 20th and 21st century body of emergent knowledge that is relatively new, and can be viewed from a multi-century perspective vis-à-vis the predecessor areas of the humanities and the physical, biological, and social sciences. The use of legacy lenses (e.g., those of the social sciences) can hinder appropriately original mappings of information science. Future maps of information science might well be somewhat provisional and open-ended, might transcend anthropocentrism, extend to physical (non-living) as well as biological phenomena, and incorporate oriental thought (e.g., the notion of *Qi*). In any case, human

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knowledge mappings are constrained by human short-term memory limits of about seven chunks, plus or minus two.

Donald Kraft points out that the findings of the current Knowledge Map study can impact information science thought generally as well as the classificatory schemes used by various information science journals, bibliographic databases, and the structuring of professional organizations and their thrusts, particularly those associated with ASIST.

Roberto Poli observes that the Knowledge Map can serve as a compass for the field, but that the mapping should distinguish local, personal and specialized participant perspectives from those that are more general, consensual and global. Future mappings might be limited to the past and future five to ten year time horizon. Because our current information systems tend to be information rich but knowledge poor, we must draw on the work of scholars in ontology, semantics, semiotics, mathematics, and epistemology to assure the production of knowledge richness.

Richard Smiraglia suggests that there is a strong metaphysical side of information science that should be intensively explored, as well as the non-metaphysical side favored by many Delphi participants. He notes a shifting information paradigm that has progressed from documents and machines to social and cultural concerns, to all living organisms, and to abstract notions of data/information/knowledge/messaging. Overall, the field needs further convergence and to find its most constitutive concept, rather than to change its name to some X-Science.

Overall, there appears to be a reasonable degree of consensus among the above authors on a several key points. First, the Knowledge Map does provide an up-to-date set of alternative conceptualizations of the broad field we call information science. In the words of authors, the Map provides a compass and comparator baseline for revision of research, educational and professional agendas and overall progress. Nevertheless, a lot more classificatory and definitional work remains to be done to provide successively better mappings and lexicons.

Second, the Map leaves little doubt that the domain of information science has expanded significantly during its few decades of existence, from such pragmatics as document handling and computer processing to concerns with broader social and

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cultural realms and throughout the broader biological realm. At present, information concepts are being extended to, or incorporated into, non-living, physical realms via inquiries in cosmology and quantum physics. Information is being viewed therein as something embedded with matter/energy processes and exchanges. Information and informatics concepts now pervade virtually all fields of organized knowledge.

Third, the Knowledge Map demonstrates that the information elephant can be viewed from multiple perspectives, each of which might be more or less “correct.” Information science might simultaneously regarded as a mono-discipline, a meta-discipline, a meta-physical or non-meta-physical area of inquiry, or a 21st century set of convergent but still emergent disciplines (akin to the manner of earlier evolution of the social or physical or biological science groupings). It remains difficult to assess the outlines of one or more areas of knowledge that appear to be still emerging and quite dynamic. Time should tell us more.

Fourth, the Knowledge Map can be regarded as a methodological as well as a substantive contribution. The Critical Delphi study was conducted interactively online, had a global reach, brought forth a variety of expert opinions, and provided time for adequate reflection and deliberation among participants.

Of course the study had its limitations, and the above authors were not shy about pointing them out. The study dealt with participant perceptions rather than “empirical reality,” but this is the nature of Critical Delphi investigation. Obviously, the Critical Delphi study could be complemented with something like a citation mapping the field (keeping in mind that many citation parameters can be products of biased human judgment). While the study did bring out significant agreement among participants about the outlines and nature of information science, it evoked disagreement on several issues (e.g., about changing the field’s name to “Knowledge Science;” the adequacy of the D-I-K-M locus and how or whether these objects are truly homologous; which set of underlying assumptions or paradigmatic views are most fitting; the adequacy of the study’s geographic, demographic and time sampling frames; the need to call on ontology experts; etc.). However, the Critical Delphi method was designed to do just this-- to bring out issues and differences in addition to identifying areas of consensus. In some respects, then, some of the study’s weaknesses comprise also its strengths. Future attempts to map the information science area, then, might replicate the above study in a few years to extend and challenge the Knowledge Map. Additionally, different approaches and methods can be deployed to gage the ongoing expansion of information science's epistemic universe vis-à-vis total human knowledge.

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Appendix A: Knowledge Map of Information Science

Domain	Foci	Main Categories (1st division)	Sub-Categories (2nd division)	Sub-Categories*/Examples & Explanations** (3rd division)	Exemplary Fields
Meta-Knowledge	Knowledge on the field of IS itself	**1. Foundations**	**Theory**	**A. Conceptions** **B. Disciplines** (e.g., Anthropology (e.g., "culture"), Arts (e.g., "design"), Communication (e.g., "communication", "media", "message"), Computer science (e.g., "computer language"), Economics (e.g., "information economics"), Education (e.g., "learning"), Engineering (e.g., "information technology"), History (e.g., "primary source", "secondary sources", "tertiary source"), Law (e.g., "intellectual property", "copyright"), Linguistics (e.g., "language"), Philosophy (Epistemology (e.g. "knowledge"), Ethics (e.g., "information ethics", "professional ethics"), Political Science (e.g., "democracy"), Psychology (e.g., "cognition"), Research Methodology (e.g., "evaluation", "research", "research methodology"), Semiotics (e.g., "sign"), Sociology ("e.g., "society") **C. Theories**	Theory of IS
			Research	**A. Theoretical** **B. Empirical** **1. Quantitative** **2. Qualitative**	Research Methodology
			Education	Academic education and to professional training: theoretical knowledge and practical knowledge.	LIS Education
			History	Historical accounts of the field.	History of IS

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Subject-based knowledge	Knowledge on the explored phenomena (i.e., the mediating aspects & conditions of human knowledge)				**2. Resources**	**Issues**	quality information (resources), information (resources) quality	Information Quality Information Systems
						Types	Primary resources (i.e., the human originators), secondary resources, tertiary resources	
		⇧⇧⇧⇧⇧⇧⇧⇧⇧⇧ Mediating factors ⇧⇧⇧⇧⇧⇧⇧⇧⇧⇧	Who?	mediators	**3. Knowledge Workers**	**Issues**	**A. Personality traits** **B. Theoretical knowledge** **C. Applied knowledge and practice**	Information Ethics LIS Education
						Types	Taxonomies of professional workers by fields of expertise (e.g., medical informatics), and organizational sector (e.g., librarians, archivists)	
			What?	matters	**4. Contents**	**Issues**	Content related issues (e.g., What is a subject?)	
						Types	Taxonomies of structures (e.g., knowledge maps, subject classifications schemes, thesauri), classification systems (e.g., LCC, DDC, UDC, CC, BC), subjects (i.e., Archeology, biology, Computer Science) and the like.	
			Why?	Motives	**5. Applications**	**Issues**	Issues related to the development of application oriented systems.	
						Types	Taxonomy of applications (e.g., (information) searching, shopping, socialization and socializing).	
			How?	methods	**6. Operations & Processes**	**Issues**	Issues related to the various operations and processes involved in mediating human knowledge.	
						Types	Taxonomy of operations and processes: documentation, representation, organization, processing, dissemination, publication, storage, manipulation, evaluation, measurement, searching, and retrieving knowledge.	
				Means (media)	**7. Technologies**	**Issues**	Technological related issues (e.g., user-interface design).	
						Types	Taxonomy of knowledge technologies and media: electronic-based technologies (e.g., computer-based information systems, Internet), paper-based and printing-based technologies (e.g., books), communication-based technologies and media (e.g., cellular phones, MP3).	

			Where and when?	milieus	**8. Environments**	**Issues**	Social issues (e.g., Information policy, information accessibility), including ethnic and cultural issues, professional issues related to the settings, as well as legal issues (e.g., Intellectual property, privacy), and ethical issues (e.g., privacy vs. public interests).	Information Ethics Social Informatics
						Types	**A. Ethnic & Cultural environments** **B. Settings** (e.g., Education, Health)	
					9. Organizations	**Issues**	Issues related to the organizational settings (e.g., managing knowledge in business organizations)	
						Types	**A. Organizational Type:** **1. Governmental Sector** **2. Public sector** **3. Private sector** **B. Functional type** **1. Memory organizations** **2. Information services**	
		10. Users				**Issues**	User related issues (e.g., user information needs, user behavior, user search strategies)	User Studies Information Behavior
						Types	**A. Individuals** **B. Groups and Communities** **1. Gender-based** **2. Age-based** **3. Culture & ethnicity-based** **4. Need & interest based** (e.g., division by profession)	

* The words in **bold** are categories.
** The other terms are exemplary terms (entries).

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