Knowledge management for social science information: organizational and technical solutions to bridging disciplinary structures

Steven W. Witt
University of Illinois at Urbana-Champaign
Champaign, IL, USA

"Ever increasing specialization and fragmentation of scientific knowledge clearly involves communication problems of extraordinary dimensions" (Swanson, 1966)

"Real problems of society do not come in discipline shaped blocks" (Roy, 1979)

Meeting: **142 — *Libraries beyond libraries; integration, innovation and information for all* — Social Science Libraries Section**

Abstract:

This paper focuses on how libraries and librarians can support scholarly communication and bridge disciplinary boundaries. By reviewing contemporary thought on interdisciplinary research traditions as they relate to organizational structures and Don Swanson's work to place the problems of information science at the core of solving problems of fragmentation in academia, this paper discusses ways to target users outside of the social sciences for services while reflecting on opportunities to expand the role of social science librarians as knowledge managers.

Introduction

Questions about how to align the pursuit of knowledge through science with the needs and conditions of humanity are not new. In the late 20th Century, the manner by which science and technology could be marshaled to serve humanity as a whole arose in the context of systematic risk and the need for new methods for managing societal problems through technology and organizational structures in order to ensure the continued replication of society. These are clearly social science problems, but span disciplines into science, technology, and engineering. Discussions about the role of science, including social science, to solve social problems are permeated with notions of a socio-technical system that at once provides a basis for problem solving and a mechanism through which new risks to humanity and society are promulgated. A review of contemporary thought on disciplinarity and interdisciplinary research traditions as they relate to organizational and informational

structures leads to the transdisciplinary movement led by Erich Jantsch. It also leads to Don Swanson's parallel drive to place the problems of Information Science at the core of solving problems of fragmentation in academia. The analysis of these two scholars' drive to "re-organize" science provides a lens through which to view trends in library organization and information science and the extent to which LIS research and technical solutions reflect a larger discourse on the role of science, academia, and the disciplines in addressing societies problems. In particular, this provides an opportunity to reflect upon both the expanding role of librarians as knowledge managers and the notion of users as targets for services, collections, and information dissemination.

Disciplinarity, Interdisciplinarity, and Complex Problem Solving

Readings on disciplinarity suggest that disciplines focus research within a single paradigm, while paradoxically striving to expand their authority and domain. This complicates the use of disciplines as the means by which to organize knowledge, solve societal problems, and marshal library resources to support research on complex problems.

Traditionally, science and inquiry within the academic disciplines are focused on small or esoteric problems in order to "investigate some part of nature in detail and depth that would otherwise be unimaginable" (Kuhn, 1996, p. 24). This rationale forms the basis for disciplinary thinking and drives the organization of academic communities into disciplines. As Kuhn and others note, these structures serve a valuable function in maintaining the preconditions for research, which includes structures to ensure funding, dissemination, and the training of new scholars to continue work within the discipline. Without the shared knowledge, rigor, and avenues to support and disseminate research that disciplines provide, it is impossible to imagine the explosion of knowledge that humans have experienced in the past century.

As organizations, however, disciplines are also inclined to support and serve the social structures from which research communities emerge. This social layer creates an added level of complexity through which the logic of disciplinary objectives has the power to supplant the problem that originally informed the discipline. As Salter and Hearn note, disciplines also serve as registers which dictate "the manner in which information is understood, arguments are marshaled, and issues are discussed" (Salter and Hearn, 1996, p. 23). These disciplinary registers are characterized by a dominant set of methods or a paradigm; institutional recognition through departments; library collections and librarians; conferences and journals; a self-identified community; and methods of disciplining community members (Salter and Hearn, 1996).

Others take a more provocative approach to disciplinary behavior and its impact on knowledge production. Gieryn characterizes disciplines as protecting their boundaries from both inside and outside the academy by expanding their domains of authority, monopolizing knowledge and resources, and protecting its members from external scrutiny (1983). Damrosch takes a more negative view of the consequences of organizational disciplinarity when he uses of the metaphor of free market competition among nation states to depict disciplines in a state of constant competition for ideas, eroding the sense of communities of inquiry and fostering greater divides amongst the disciplines (1995).

Although the disciplines have erected strong mechanisms of control to sustain work in a problem area, the nature of science and problem based inquiry lays the foundation for a constant state of disciplinary change. Klein attributes this constant state of change to six drivers of permeation:

1. the epistemological structure of a particular discipline
2. relations with neighboring disciplines
3. the pull of powerful or fashionable new tools, methods, concepts, and theories
4. the pull of problem-solving over strictly disciplinary focus
5. the complexifying of disciplinary research
6. redefinitions of what is considered intrinsic and extrinsic to discipline

(Klein, 1993, p. 187).

Klein's analysis of the permeation of disciplines highlights the paradoxical role that the disciplines play in creating increasingly miniscule research problems and their accompanying new disciplines while simultaneously fostering more cross-disciplinary exchange through the drawing of new borders to be protected and crossed. The nature of disciplines as described by Klein and others suggests an internal structural weakness that has the potential to inhibit work on complex problems that do not fit within one domain. As Roy notes in his plea to develop permanent interdisciplinary units on campuses dedicated to social problems, "real problems of society do not come in discipline-shaped blocks" (1979, p. 165).

It is this notion of fragmentation within the disciplines and scholarly communication that prompted much discussion in the late 20th Century.

The Evolution of Inter-disciplinarity and Trans-disciplinarity

Interdisciplinarity

Research on interdisciplinarity focuses largely on knowledge production and organization as it occurs outside of the traditional disciplines. As alluded to by Roy, interdisciplinarity is often seen as the answer to fostering research that draws from the knowledge produced by disciplines to focus upon societal problems such as climate change, ethnic and religious conflict, global health, and food security. This makes understanding interdisciplinary practices and scholarly communications a key ingredient to learning more about how research on complex problems is conducted.

Salter and Hearn (1996) provide a good map of interdisciplinarity as it is practiced and viewed by its practitioners. These are broken down into three forms: an instrumental view of knowledge, new synthesis of knowledge, and critical interdisciplinarity. The *instrumental view of knowledge* is problem centered and responds to external demands. This represents research and structures such as thematic research centers advocated for by Roy, which don't challenge existing paradigms and draw upon disciplines for expertise. N*ew synthesis of knowledge* challenges existing structures by developing novel conceptual frameworks and methodologies, leading to a new discipline. C*ritical interdisciplinarity* views both as trapped within the logic of disciplinarity and operating under disciplinary control mechanisms when classifying and categorizing interdisciplinary work.

Woven through these three types of interdisciplinarity is the core of scientific inquiry: problem solving. Much of the research on interdisciplinarity focuses its role to address problems that exist beyond the confines of Kuhn's "Normal Science." Mote's research on the information needs of scientists paves the way for understanding interdisciplinary research as a means to solve complex problems that fall outside the limits of a single subject. Mote identifies three groups of scientists, each working within wider and increasingly variable subject areas, arriving at the third group, through which information must be synthesized from a non-organized literature that relies upon more than one specialist literature (1962, p. 171). Although Mote does not address interdisciplinarity directly, he concludes that these researchers need more informational support and thus require more resources by virtue of their existence outside the disciplinary support structures that sustain the organization of literature and research.

As reported by Klein, research on interdisciplinary and knowledge production later yields conclusions that build on Mote. Reynolds' three types of problems overlap with Mote's while adding to it "*problems of the third kind"*, which are "generated increasingly by society . . . and [call for] policy-action results [or] a technological quick fix (Reynolds in Klien, 1999, p.13). These paradigms of interdisciplinarity fall within the traditional social framework of science through which interdisciplinary work is carried out amongst the disciplines.

Gibbons, however, articulates a level of research that is abstracted one level further from what might be seen as traditional interdisciplinarity. Gibbon's Mode 2 Knowledge Production again mirrors Mote and Reynolds yet adds another layer of complexity by describing a means of knowledge production that not only focuses on problems driven by social need but also includes the emergence of new non-university/non-disciplinary actors in identifying problems, finding solutions, and articulating research based policy (Gibbons et al, 1994; 2006). This research paradigm represents a shift away from disciplinarirty and even interdisciplinarity by breaking down traditional boundaries between science and society and creating new configurations of research and accountability that even moves beyond the university-corporate-government structure (Etkozwitz, 2007).

Transdisciplinary Movement

What is described by Gibbons as Mode 2 Knowledge Production has its intellectual roots in what might be called the Transdisciplinary Movement and is often traced to the work of Erich Jantsch in the early 1970's. Although generally referred to as a footnote to current discourse on ways to describe or implement transdisciplinary research regimes (Klein et al, 2001), Jantsch's work on the topic resonates with what were then developing theories of risk through socio-technical systems. In addition, the problems described by Jantsch and colleagues echo the knowledge problems created by fragmentation.

Jantsch was an Austrian astrophysicists who began work on what he termed a systems approach to innovation while on a visiting appointment at MIT. Publishing a series of articles on the theme in journals such as *Higher Education*, *Policy Sciences*, and integrated into reports to the OECD and the Alfred P. Sloan School of Management at MIT between 1969 and 1972, Jantsch sought to orient "science, education, and innovation toward an overall purpose – a purpose of mankind" (1972, p. 213). This re-organization involved creating a system through which higher education might develop a coordinated structure that

mitigates the negative impacts of technologies on society through transdisciplinary approaches to science and the implementation of new technologies.

> Jantsch described transdisciplinarity as:
> the coordination of all disciplines and interdisciplines in the education/innovation system on the basis of a generalized axiomatics and an emerging epistemological pattern (1972, p. 106).

Much of the context for Jantsch's theories of transdisciplinarity can be found in his 1972 book titled *Technological Planning and Social Futures.* In this work, Jantsch attempts to introduce institutional roles for technology in order to better organize science and technology toward a human purpose or "a long-range purpose of mankind" (p. 5). His thesis is based upon the assumption that science and technology have assumed predominant factors in both economic and social development, noting that

> "it is becoming increasingly evident that social change through technology also needs external stimulus and guidance to make use of the tremendous opportunities offered, as well as to avoid the pitfalls and dangers of a technology-dominated world" (p. 216).

Through this, Jantsch proposes a systems approach that "considers science, innovation, and education . . . as instances of purposeful activity, whose dynamic interactions have come to exert a dominant influence on the development of society and its environment" (p. 218). Through this system, interdisciplinarity becomes an organizing principle that yields an overarching "transdisciplinarity", providing "multi-level co-ordination" of the entire innovation system.

Janstch's systems approach simultaneously relies upon disciplinary practices to create knowledge, yet also "conceive(s) transdisciplinarity as a theoretical unity of all of our knowledge, which [is] . . . needed to respond adequately to knowledge demands for problem solving in the life world" (Hadorn et. al, 2008, p. 29). Or to paraphrase Leo Apostel, a contemporary of Janstch who also advocated transdisciplinarity, we must bring the fragments created through traditional science together in continuous interaction to construct new worldviews (1972).

Janstch asserted that such a system would create a new policy or political role for universities, making them central to governmental and corporate decision making. In making this assertion, Janstch describes what would later be referred to as the university-government-corporate triangle of research and development that is prominent in current notions of Mode 2 Knowledge Creation and critiques of the political economic factors that incfluence knowledge production (Gibbons et al, 1994; Etkozwitz, 2007). Central to Janstch's system for multi-coordination of knowledge within the university setting was the notion of three types of institutional units: systems design laboratories, function-oriented departments, and discipline oriented departments. Of these, the systems design laboratories serve as the mechanism for bringing together functional and discipline oriented work in what Janstch describes as "socio-technical systems design laboratories" that will have the task of "long range forecasting, identifying aspects and boundaries of systems . . . [and] provid[ing] through-flow of professionals" (p. 235). In other words, these units become what could be considered knowledge management organizations for universities, bringing together institutional resources, information, and research methods and technologies that have a bearing on any given research or societal goal of the university.

Through these notions of transdisciplinarity, Jantsch and his colleagues take a stand against positivism and its impacts on the dominant academic structures by moving from a "world of empirical facts to a world of intelligible relationships and the focus of scientific activity to the study of structural interactions" (1972, p. 98).

Jantsch's work also complements in some sense the Risk Society theories of Ulrich Beck by asserting a move to "a post-industrial society that is facing growing complexity and uncertainty and a seemingly amorphous, disquieting world *problematique*" (1972, p. 98). Through this view emerges a larger socio-technical system in which all knowledge becomes relevant in a unified system that must take into account multiple perspectives and research traditions to implement technologies that will impact humanity regardless of economic status or geographic location. As noted by both Jantsch and Beck, not taking into account the long-range impacts of technologies on society places society at peril.

Reflexive Problem Solving in LIS

Don Swanson of the University of Chicago shares many of the concerns regarding what is described as the fragmentation of knowledge, yet does not appear to harbor the same reservations about Positivism and the unintended consequences or potentially negative social impacts of a socio-technical knowledge system. In his 1965 address given at Columbia University and later published in both the *Bulletin of the Atomic Scientists* and *Library Quarterly*, Swanson takes on the need to improve communication among scientists. Through this piece, Swanson bristles at the explosion of accumulated knowledge and the extraordinary problems created within scientific communication by the "implied prospect of ever increasing specialization and fragmentation of scientific knowledge" (1966, p. 79). Swanson's answer to this problem, like Jantsch, is to focus on "increased organization of human activities rather than a facile extrapolation of technological progress" (p. 79). The organization that Swanson advocates is limited to the realm of library services, yet takes on may of the objectives of Jantsch's systems design laboratories. Swanson presses for the identification of invisible groups through analysis of citation patterns to identify researchers within a given field and facilitate communication. In addition, Swanson notes the need for selected dissemination of information and providing reviews of scientific information to increase the flow of knowledge that may otherwise be limited to small research groups. Finally, Swanson advocated for a "new pattern for information centers" that is very much in sync with Jantsch. The purpose of these centers would serve as knowledge management centers to broaden the pattern of information dissemination of scientific information.

Where Swanson differs from Jantsch, however, is in his presumption that "large-scale activities, including scientific communication practices, are driven somehow toward desirable goals" (p. 79). For Swanson, the problem is fragmentation and not the knowledge system that underlies the increased specialization of knowledge. It is for this reason that Swanson's articulated vision of organizational change might be limited to the services provided by libraries and not a wholesale reorganization of the academy with information services and knowledge circulation at the core of activities and purpose.

Swanson continues to pursue communication problems within the sciences through a series of projects, which culminate in a conference on "Libraries and the Growth of Knowledge." Leading-up to this conference, Swanson published a piece in *Library Quarterly* that outlines the means by which to improve libraries and facilitate the growth of knowledge.

Swanson continues to focus his attention on how to cut across the boundaries of disciplines and subject-based organization to bring problem solving information to light. He notes that:

> "because the growth of knowledge through problem solving does not tend to respect the boundaries of subjects or disciplines, we are led to ask what implications this disrespect of boundaries might have for methods and problems of providing effective access to recorded information" (1979, p. 8).

At this stage, however, Swanson's solutions move more toward purely technical answers to problem-based access to knowledge and fragmentation. In fact, Swanson rejects hope for organizational structures that will yield "advances in indexing, classification, information retrieval, and bibliographic control" (p. 12). Swanson rather looks to the growing potential for technologically driven systems that can gather citations, centralize bibliographic access through electronic records, and develop full-text searching systems. Swanson's vision for technical solutions to problem solving research amidst complexity within science calls for new mechanisms to transcend the knowledge production structures rather than endeavoring to change the structures. By moving in this direction, Swanson creates a notion of virtual flows of knowledge and collaboration that focuses upon the Popperian objective notion of world three knowledge. From these notions, emerge an emphasis on reorganizing citations through bibliometric work to meet transdisciplinary demands.

Swanson's push toward bibliometric solutions to providing access to problem based and transdisciplinary research persists through the continued preference for technical answers to problems of knowledge production and organization that abound within Information Science.

For example, Schummer's research on patterns of research in nanotechnology, provides various rationales and descriptions of four bibliometric approaches, which include co-currance, co-classification, journal classification analysis, and citation analysis (2003). He concludes that the use of co-author, a type of co-currance analysis, allows one to map geographical, organizational, and disciplinary affiliations to "understand interdisciplinarity as a combined cognitive and social phenomena," which is important in ambiguous fields. Similar uses of co-author analysis are used to identify and visualize similar research groups (Perianes-Rodriguez et al, 2009).

In each of these instances co-author analysis is used to reveal social linkages among scholars across disciplines, organizations and regions.

Schwechheimer and Winterhager address the problems of climate research and retrograde amnesia in two studies that use keywords to cluster co-cited publications in order to expose new research fronts or "highly dynamic specialties," following directly the work of Small and Griffith yet applying it to current transdisciplinary problems (1999; 2001).

The range of bibliographic or scientiographic methods employed to graph transdisciplinary knowledge production and their social milieu, allows for several routes to explore research on complex social issues. Each of the noted methods use exclusively quantitative methods to expose the social and organizational dynamic of the problems on which they focus. These methods continue to follow Swanson's lead toward focusing upon library or information based solutions while avoiding the larger and systemic issues that continue to relegate complex problem solving into the border regions of the disciplines. Although effective, this approach serves to confirm disciplinary behaviors as much as it

resolves the problem of knowledge organization and production within complex areas of research. In addition, it suggests that the development of these methods within LIS presume that library and information science merely serves science in what ever structure it takes rather than fully participating in the societal implications engendered in the fractures within the scientific system of knowledge production.

Notions of Knowledge Management for Social Science Libraries

Looking at library services within the social sciences from a perspective that encompasses both Swanson's concern for scientific communication under conditions of increased fragmentation and Jantsch's notion of a transdisciplinary systems approach to knowledge creation provides an opportunity to expand upon disciplinary notions of library services and knowledge organizations. This is especially true when one considers central role of social science knowledge to solving global problems. How then can social science librarians channel the vision of scholars such as Jantsch and Swanson to re-examine how to expand services and collection use to encompass researchers and students in non-social science disciplines that require the context social science knowledge can provide to help solve complex problems? At the same time, how can the institutional knowledge of librarians be better deployed to improve communication within research organizations? How the practice of knowledge management and its emphasis on systemic coordination of people, technology, and knowledge be adapted to the social science library?

References

Beck, Ulrich. (1992). *Risk Society: Towards a new modernity*. London: Sage.

Börner, K., & Scharnhorst, A. (2009). Visual conceptualizations and models of science. *Journal of Informetrics*, *3*(3), 161-172.

Damrosch, D. (1995). *We scholars: changing the culture of the university*. Cambridge: Harvard University Press.

Etzkowitz, H. (1997). *Universities and the global knowledge economy : a triple helix of university-industry-government relations*. New York: Pinter.

Gibbons, M. et al (1995). *The new production of knowledge the dynamics of science and research in contemporary societies*. London: Sage

Gibbons, M. et al (2006). *Re-thinking science : knowledge and the public in an age of uncertainty*. Cambridge UK: Polity.

Gieryn, T. F. (1983). Boundary-Work and the Demarcation of Science from Non-Science: Strains and Interests in Professional Ideologies of Scientists. *American Sociological Review*, *48*(6), 781-795.

Hadorn, G. H., Hoffmann-Riem, H., Biber-Klemm, S., Grossenbacher-Mansuy, W., Joye, D., Pohl, C., Wiesmann, U., et al. (Eds.). (2008). *Handbook of Transdisciplinary Research*. Dordrecht: Springer.

Heimeriks, G., Hörlesberger, M., & Van Den Besselaar, P. (2003). Mapping communication and collaboration in heterogeneous research networks. *Scientometrics*, *58*(2), 391-413.

Jantsch, E. (1970). Inter- and Transdisciplinary University: A Systems Approach to Education and Innovation. *Policy Sciences*, *1*(4), 403-428.

Jantsch, E. et. al. (1972). *Interdisciplinarity Problems of Teaching and Research in Universities.* OECD, Washington, D.C.

Jantsch, E. (1972) *Technological planning and social futures*. New York: Halsted Press.

Klein, J. (1993) "Blurring, Cracking, and Crossing: Permeation and the Fracturing of Discipline." In Messer-Davidow, E. (Ed.), *Knowledges :historical and critical studies in disciplinarity.* Charlottesville : University of Virginia Press.

Klein, J. (1996). *Crossing boundaries : knowledge, disciplinarities, and interdisciplinarities*. Charlottesville: University Press of Virginia.

Klein, J. (1999). A Conceptual vocabulary of Interdisciplinary Science. In Stehr, N. Ed. *Practising interdisciplinarity.* Toronto: University of Toronto Press.

Klein, J. et. al. Eds. (2001). *Transdisciplinarity: joint problem solving among science technology, and society*. Basel, Switzerland: Birkhauser.

Nowotny, H., Scott, P., & Gibbons, M. (2003). Introduction: `Mode 2' Revisited: The New Production of Knowledge. *Minerva*, *41*(3), 179-194.

Perianes-Rodríguez, A., Olmeda-Gómez, C., & Moya-Anegón, F. (n.d.). Detecting, identifying and visualizing research groups in co-authorship networks. *Scientometrics*.

Rossini, F. A., & Porter, A. L. (1979). Frameworks for integrating interdisciplinary research. *Research Policy*, *8*(1), 70-79.

Roy, R. (1979). Interdisciplinary Science on Campus: That Elusive Dream. In *Interdisciplinarity and higher education*. University Park: Pennsylvania State University Press.

Salter, L., & Hearn, A. (1996). *Outside the lines : issues in interdisciplinary research*. Montreal: McGill-Queen's University Press.

Schummer, J. (2004). Multidisciplinarity, interdisciplinarity, and patterns of research collaboration in nanoscience and nanotechnology. *Scientometrics*, *59*(3), 425-465.

Schwechheimer, H., & Winterhager, M. (1999). Highly dynamic specialities in climate research. *Scientometrics*, *44*(3), 547-560.

Schwechheimer, H., & Winterhager, M. (2001). Mapping interdisciplinary research fronts in neuroscience: A bibliometric view to retrograde amnesia. *Scientometrics*, *51*(1), 311-318.

Small, H., & Griffith, B. C. (1974). The Structure of Scientific Literatures I: Identifying and Graphing Specialties. *Science Studies*, *4*(1), 17-40.

Swanson, D. R. (1966). Improving Communication Among Scientists. *Library Quarterly*, *36*(2), 79-87.

Swanson, D. R. (1980). Libraries and the Growth of Knowledge. *The Library Quarterly*, *50*(1), 112-134.

Van Raan, A. (1999). "The Interdisciplinary Nature of Science: Theoretical Framework and Bibliometric-Empirical Approach. In Stehr, N. Ed. *Practising interdisciplinarity*. Toronto: University of Toronto Press.