Can Knowledge Be Distributed?
The Dynamics of Knowledge in Interdisciplinary Alliances: Year Two Executive Summary

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The goal of the *Distributed Knowledge* project (*DK*) is to investigate distributed knowledge processes among multidisciplinary teams and the roles that technology and group context play in these processes. We focused our initial inquiry on the six scientific Applications Technologies teams of the National Computational Science Alliance, funded through NSF's PACI program. During Year One of the project (10/99-10/01) we focused on refining our research questions and methods, and conducting initial investigations. During Year Two of the project (10/00-10/01), we have expanded our inquiry into distributed knowledge to include other collaborative research efforts. We now have a growing set of publications and graduate student research that reflects our project focus and research findings.

The current document reports on the second year of the project. This summary describes project highlights (and challenges), updates our project team and methods, describes how our project focus has expanded, and lists project-related publications. We are working to establish the *Distributed Knowledge Research Collaborative* (*DKRC*) as a larger group encompassing both our project and others doing related research. The *DKRC* web site <http://www.dkrc.org>, which we have developed, is the most comprehensive repository for our research projects, including biographies, bibliographies, project summaries, calls for papers, publications, as well as password-protected document and collaboration spaces for the *DK* group itself.

Project Highlights

In this section we list a few highlights from the second year:

- Six *DK* researchers presented an all-day workshop on Distributed Knowledge Processes to students and faculty at the University of Illinois at Urbana-Champaign (Feb. 1, 2001). See <http://www.dkrc.org/seminar.shtml>.

- Three *DK* researchers (Geof Bowker, Caroline Haythornthwaite, and Katie Vann) have taken part in a working group on scientific collaboration headed by Professor Edward Hackett, and funded by National Center for Ecological Analysis and Synthesis (NCEAS). Details from the proposal, *Ecology Transformed? A Proposed Working Group to Study New Forms of Scientific Collaboration,* and names of other project participants can be found here: <http://www.nceas.ucsb.edu/fmt/doc?https://www2.nceas.ucsb.edu/admin/db/web.plist>.
- Geof Bowker was named to the Organisation for Economic Co-operation and Development (OECD) group on international data sharing in science.
- Geof Bowker was invited to contribute to the United Nations Educational, Scientific and Cultural Organization (UNESCO) encyclopedia on scientific infrastructure <http://www.eolss.co.uk>.
- Alaina Kanfer is providing strategic consulting for an online university.
- Special issue of the *American Behavioral Scientist* on *The Internet in Everyday Life,* co-edited by Haythornthwaite with Barry Wellman, received notice in a *New York Times* (Circuits section) article on July 26, 2001 entitled, "Cyberspace isn't so lonely after all."
- DK researchers foster global knowledge relations (Chip Bruce presented work in Tawain and Nick Burbules gave talks in Belgium. Geof Bowker is hosting the International Distributed Scientific Practice conference.).
- Geof Bowker (with Leigh Star) has been invited to participate in a prestigious "Author Meets Critics" section at the next meeting of the Society for the Social Studies of Science, in Boston.
- The Inquiry Page <http://inquiry.uiuc.edu>, an outreach effort for the *DK* project, was awarded first place in the Technology Design Competition at the Computers and Writing 2001 conference for the category of "Rhetoric and Writing in K-12 Education." Systems were judged on design, operation, and educational value.
- Distributed Knowledge Seminar, a web-supported course <http://www.lis.uiuc.edu/~chip/teach/courses/dk/sp02/> -- This site contains the materials we are developing for a course scheduled for Spring 2002. These materials may be used by others in their courses, copied, redistributed, and modified under the terms of the Open Publication License (Version 1.0) <http://opencontent.org/openpub/>.
- The entire *DK* group is collaboratively developing a symposium for the Academy of Management Conference.
- Haythornthwaite, Kazmer and Robins of DK, along with co-author Susan Shoemaker, were featured in the *Chronicle of Higher Education* regarding their paper on community development among distance learners.

Graduate Assistant Updates

Graduate students working on the project have had many accomplishments in the past year, among them:

- The first *DK* graduate assistant (Katie Vann) completed her Ph.D. in Communications and joined the *DK* as a postdoctoral fellow on a *Values into Infrastructure* grant (NSF 0094632).
- Joyce Brown passed her qualifying exams in Social Psychology and began a dissertation on knowledge transfer and discovery.
- Karen Lunsford was named a John Bardeen Scholar in the Center for Advanced Study at the University of Illinois and has received an English Department Fellowship. She passed her qualifying exams and proposal defense in Writing Studies/English.
- Sarai Lastra is putting the final touches on her dissertation in Library & Information Science, "Making Sense of Community Informatics: Exploring a Framework for Community Inquiry."
- Harald Fischer passed his qualifying exams in Management and is beginning his dissertation, tentatively titled, "Learning and Social networks within the Firm: Replacement and Retention of Acquired Personnel."
- Michelle Kazmer was named a University of Illinois Fellow and passed her proposal defense in Library & Information Science.
- Steven Poulakos and Xueqing Wang have recently joined the project.

Project Challenges

The challenges we have faced in exploring collaboration in interdisciplinary processes are common problems seen in multidisciplinary projects heavily dependent on new technologies. One contribution we hope to make is an article identifying the issues and ways of addressing them. Some of the challenges we have identified include:

- Changes in the nature of our study subject:
  - Changing goals in the research groups we are studying
  - Changes in the composition of these research groups.

- Our distributed nature:
  - Our becoming distributed and learning to work at a distance through new information and communication technologies (most notably, videoconferencing)
  - Additional administrative overhead
  - Social network overload.

- Dependence on physical infrastructure:
  - Equipment problems, e.g., server failure
  - Personnel changes
  - Changes in technology, e.g., multiple videoconference systems over the last two years.

- Data collection and reporting:

- o Being perceived as evaluative when we are studying variation
- o Acquiring data – even acquiring CVs has been difficult.

- Methodological challenges:
  - o Challenges with interdisciplinary research (e.g., what data to share and how)
  - o Expansion to new subject group to study in response to dissolution of other groups.

Project Team, Methods & Challenges Met

Our core research team continues with the same seven original co-PIs, and six of the graduate assistants as in Year One (with the exception of one GA graduating and joining as Post-doc). In addition we have two new graduate assistants (Steven Poulakos and Xueqing Wang) and have invited numerous colleagues to participate in our discussions, e.g., Paul Prior (English), Les Gasser (Library & Information Science), and Carole Palmer (Library & Information Science).

Our team is itself multidisciplinary. Our investigators come from disciplines including sociology of scientific knowledge, social psychology, computer science, philosophy, education, information science, management science, and writing studies. Our team is distributed geographically as well. In addition to studying others, we are also reflecting on our own use of communications technologies and our own distributed knowledge processes.

Over the past year we have found that our weekly one-hour meetings were too frequent and too short. This seems to be a result of our distributed nature. Therefore we have adopted two-hour monthly meetings. In addition, we have made a concerted effort to meet face-to-face four rather than two times per year, taking advantage of conferences where many of us have an interest, such as Academy of Management, Internet Researchers, and Computers & Writing.

We have now collected a substantial amount of quantitative and qualitative data. In addition to the methods described in the Year One report (Ethnography, Structured Interviews, Textual Analysis, Social Network Analysis and Bibliometric Analysis), *DK* researchers have also employed discourse interviews, web site analysis and conceptual critique. Additional data collected include the following:

- 24 semi-structured interviews with members of an educational collaboration
- 12 semi-structured interviews with professionals outside of the Alliance
- reviews of AT team articles and web sites for each of the teams and individual team members
- social network interviews and charts from a complete AT team
- year-long ethnographic interviews and observations of an AT team's practices.

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A major step for our project has been the collaboration between those of us working with quantitative and bibliometric methods, and those of us working with more qualitative and ethnographic methods. This required establishing new methods and understandings of the collaborative processes in various teams, as well as talking regularly to build enough shared language to undertake a multi-method analysis. The team will focus on the risk-return tradeoffs in alliances, through a comparison of the cosmology and environmental hydrology teams. These two teams have different collaborative and disciplinary backgrounds, and different publication patterns. Our approach will combine the use of ethnographic and qualitative content analyses together with more quantitative network and bibliometric assessments.

Expanded Project Focus

Year one of the project was spent identifying specific research questions and planning detailed data collection methods (see http://www.dkrc.org/inprogress.shtml). During year two, we have made progress in collecting data as well as in documenting challenges to collecting data. Moreover, we have found opportunities to study multidisciplinary distributed knowledge processes in other settings. Therefore, during year two, our project focus has expanded. Some of the primary new project areas are:

eLearning
Over the past year, our research on distributed knowledge has highlighted the importance of individual and organizational learning. Accordingly, several *DK* projects study how learning takes place, and how that learning is mediated through technologies. Our studies involve several aspects of learning and distributed knowledge practices: 1) We examine how new ways of learning—by both individuals and organizations—are developing as people adopt and implement new technologies. We are studying how different models of learning (hierarchical presentations, cooperative learning, inquiry-based learning) affect how knowledge is co-constructed, and how new technologies affect these models. 2) We have assumed that learning takes place not only in educational settings, but also in research labs and professional environments. As a result, we are concentrating not just on student-teacher exchanges, but on how scientists and professionals themselves learn. These studies thus reflect our interest in how knowledge can be mobilized. 3) We are interested in networks of learners, and how individual learners are positioned within these networks, and who learns from whom in a network. For instance, we have found that embedded knowledge is typically transferred when graduate students and post-docs are exchanged among laboratories.

Co-construction of a database: Social processes in shared database construction
Our studies of distributed knowledge consider how artifacts and technologies, such as email or shared data repositories, interact with knowledge

processes. Definitions of the content, use and form of such information and communication technologies play an important role in the way in which knowledge is transferred and what knowledge is transferred. Often, definitions of what knowledge is considered within the scope of a project may be instantiated into artifacts such as databases. This new *DK* initiative explores the processes of negotiation and definition of the form and content of a database of educational materials.

We are examining the social construction of a database by a university-community research initiative of the "ECAT" group (a pseudonym). Funded by U.S. government grants, the database gathers and provides online access to original academic and applied articles in the education field, commentaries on the articles, and practitioner materials. Those participating in this co-construction include university faculty, graduate students, board members, field practitioners, and professional database developers. Co-construction includes defining the scope of the database, guidelines for determining appropriate materials, procedures for acquiring materials, strategies for reviewing materials, and the design of the database system itself. This *DK* initiative illuminates the collaborative processes leading to the development of such shared databases, and how different interests are negotiated and resolved in the construction of such a database. It explores the important role of social processes in the technical definition of a database. This investigation includes a series of semi-structured interviews focusing on the negotiation of the database definition, and discourse interviews focusing on the development of shared meaning and use of terms in documents, discussions, and database names.

Outreach projects

In order to make our studies broadly useful, we have begun to translate them into practical applications as outreach projects. For example, several *DK* members have opened negotiations with a textbook publisher to write a guide for students involved in distance education programs. Other *DK* members have initiated and supported the Inquiry Page <http://inquiry.uiuc.edu/>, a web site and database designed to facilitate inquiry-based learning in whatever environment it may occur. The Inquiry Page project is composed of a diverse, evolving group of educators, learners, professionals and community members. The group has come together to create tools, develop research opportunities, and build social and professional networks for discussing, understanding and fostering inquiry-based learning. The Inquiry Page web site embodies many of the lessons the *DK* group has learned as we have studied scientific, collaborative inquiry. It also incorporates new software and technologies developed by other research groups (such as VIBE and VISIT, two new database interfaces). This award-winning web site thus provides a framework for engaging in collaborative, multidisciplinary research and education.

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In another outreach effort, the *DK* has played a central role in founding a new Information Systems Research Laboratory (ISRL) at the University of Illinois at Urbana-Champaign. Not only does the project help support technologies to be shared with other research and educational groups, but also several *DK* members have actively helped design and set up the lab space. The ISRL is experimenting with an Open Source model of how research projects might interact to the benefit of all the projects. In addition, *DK* researchers both attend and present at weekly ISRL functions.

Publications

The topics of our own distributed knowledge, as well as some of our research results are evidenced in a wide range of publications. Some of the year two publications are listed below. A complete list of publications and the full text for many of these is available online <http://dkrc.org/publications/pub_index.shtml>.

Bowker, G. C. (in press). The knowledge economy and policy issues. In *Encyclopedia of Life Support Systems (EOLSS)*. Paris: UNESCO.

Bowker, G. C. (book manuscript). *Memory practices in the sciences, 1830 - 2000.*

Bowker, G. C. (in press). The politics of granularity - or when do dimples have intentions? In *Social Studies of Science.*

Bowker, G. C. (2001). Biodiversity datadiversity. In *Social Studies of Science, 30* (5), 643-684.

Bowker, G. C. (with Kaghan, W.H.). (in press). Crossing boundaries and building bridges: Irreductionist "frameworks" for the study of sociotechnical systems. To appear in a special issue of *The Journal of Engineering and Technology Management* entitled *Beyond Sociotechnical Systems.*

Bowker, G. C. & Star, S. L. (in press). The sociology of infrastructure. In L. Lievrouw & S. Livingstone (Eds), *Handbook of the new media.* London: SAGE.

Bowker, G. C. & Star, S. L. (in press). Some theoretical issues in the design of collaboratories: Customized software for community support vs. large scale infrastructure. In Gary Olson and Thomas Malone (Eds.) *Collaboratories.*

Bowker, G. C. & Vann, K. (in press). The knowledge economy and policy issues. Invited chapter in *Encyclopedia of life support systems (EOLSS)*. Paris: UNESCO.

Bowker, G. C. & Vann, K. (in press). Managing disparate knowledges of water. In *Journal for the American Society of Information Sciences, Special issue on Knowledge Management.*

Bruce, B. C. & Levin, J. A. (in press). Roles for new technologies in language arts: Inquiry, communication, construction and expression. In J. Flood and D. Lapp (Eds.), *Handbook of research on teaching the language arts.* New York: Macmillan.

Burbules, N. C. & Bruce, B. C. (2001). Theory and research on teaching as dialogue. In V. Richardson (Ed.), *Handbook of research on teaching, 4th Edition* (1102-1121). Washington, DC: American Educational Research Association.

Copher, J., Kanfer, A., & Haythornthwaite, C. (Under revision). Media use of heavy and light email users: A comparison of actual communication behaviors across context, content and media. Under revision for *New Media and Society.*

Haythornthwaite, C. (in press). Building social networks via computer networks: Creating and sustaining distributed learning communities. In A. Renninger & W. Shumar (Eds.), *Building virtual communities: Learning and change in cyberspace.* Cambridge University Press.

Haythornthwaite, C. (2001). Exploring multiplexity: Social network structures in a computer-supported distance learning class. *The Information Society, 17*(3), 211-226.

Haythornthwaite, C., Kazmer, M.M., Robins, J. & Shoemaker, S. (2000). Community development among distance learners: Temporal and technological dimensions. *Journal of Computer-Mediated Communication, 6(1).* Available online: http://www.ascusc.org/jcmc/vol6/issue1/haythornthwaite.html

Haythornthwaite, C., & Wellman, B. (Eds.) (2001). *The Internet in everyday life. Special issue of the American Behavioral Scientist, 45*(3), whole issue.

Kanfer, A., Haythornthwaite, C, Bruce, B., Bowker, G., Burbules, N., Porac, J. & Wade, J. (2000). Modeling distributed knowledge processes in next generation multidisciplinary alliances. *Information Systems Frontiers, Special issue on Knowledge Management, 2(3/4)*, 317-331.

Kazmer, M. M. (2000, September). Coping in a distance environment: sitcoms, chocolate cake and dinner with a friend. *First Monday, 5* (9).

Bowker, G. C. & Vann, K. (in press). Managing disparate knowledges of water. In *Journal for the American Society of Information Sciences, Special issue on Knowledge Management.*

Bruce, B. C. & Levin, J. A. (in press). Roles for new technologies in language arts: Inquiry, communication, construction and expression. In J. Flood and D. Lapp (Eds.), *Handbook of research on teaching the language arts.* New York: Macmillan.

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Kazmer, M. M. (2000, September). Coping in a distance environment: sitcoms, chocolate cake and dinner with a friend. *First Monday, 5* (9).

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Lievrouw, L., Bucy, E., Finn, A.T., Frindte, W., Gershon, R. Haythornthwaite, C., Kohler, T. Metz, J.M., & Sundar, S.S. (in press). Current new media research: An overview of communication and technology. *Communication Yearbook, 24.*

Lunsford, K. J. (2002, January, in press). Contextualizing Toulmin's model in the writing classroom: A case study. *Written Communication, 19.*

Lunsford, K. J. & Bruce, B. C. (2001) Collaboratories: Working together on the web. *Journal of Adolescent and Adult Literacy, 45 (1).* 52-58. Available online: http://www.readingonline.org/electronic/jaal/9-01_Column/index.html

Neumann, L., Bowker, G. C. & Star, S. L. (in press). Transparency beyond the individual level of scale: Convergence between information artifacts and communities of practice. In A.P. Bishop, N.A. Van House & B. Buttenfield (Eds.), *Digital library use: Social practice in design and evaluation.* Cambridge, MA: MIT Press

Vann, K. & Bowker, G. C. (in press). Constructing the "collaborative": Discursive resources and social formations. In *Social Studies of Science, Special issue on Scientific Collaboration.*

Vann, K. & Bowker, G. C. (in press). Instrumentalizing the truth of practice. In *Social Epistemology, Special issue on the Commercialization of Epistemology.*

Vann, K. & Cole, M. (in press). Method and methodology in sociocultural studies of cognitive life. In Z. Todd, B. Nerlich, S. McKeown & D.D. Clarke (Eds.), *Mixing methods in psychology.* London: Routledge.

Wang, X. C., Hinn, D. M., & Kanfer, A. (2001). Potential of computer supported collaborative learning (CSCL) for learners with different learning styles. *Journal of Research on Computing in Education.*

Wang, X. C., Kanfer, A., Hinn, D. M. & Arvan, L. (2001, June). Stretching the boundaries: Using ALN to reach on-campus students during an off-campus summer session. *Journal of Asynchronous Learning Networks, 5(1).* Available online at http://www.aln.org/alnweb/journal/jaln-vol5issue1.htm