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Poster Abstract Book

Where Are You Hiding? Identifying Diabetes Researchers

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OBJECTIVES: There are two primary foci in translational research: (1) facilitating peer-to-peer collaboration and data sharing across disciplines or geographic boundaries, and (2) facilitating collaboration and communication between primary care clinicians and research communities with shared interests. For the first focus, facilitating peer collaborations, a leading barrier is the ability to discover potential collaborators. Various tools have been developed to support this process, such as Collexis, Academia.edu, 2collab, CiteULike and others. Each of these tools has limitations of excluding either certain domains or individual researchers. The leading disadvantage is the need for the potential collaborator to discover and opt-in to using the tool itself. Researchers from our campus community have limited representation in all these tools, and are thus "invisible" to searches.

This study proposes a methodology that works with existing public data to identify potential and actual peer collaboration networks. The findings will be used to inform policy and decision makers who are creating physical and virtual collaboration spaces for our target audience, the University of Michigan (U-M) diabetes research community. This will be achieved by clarification of the current status of cross-departmental collaboration on diabetes research at U-M by:

(1) Defining and validating a method to identify diabetes researchers in different fields;
(2) Identifying intra-institutional affiliations of diabetes researchers at U-M;
(3) Identifying cross-departmental collaborations through co-authorship analysis;
(4) Identifying "collaboration gaps" (areas that may obtain mutual benefits from collaboration, yet, collaboration has not occurred);
(5) Understanding barriers to collaboration through interviewing identified researchers.

METHODS: Diabetes research was selected because the topic is studied in many disciplines, ranging from social sciences to public health to life science and biomedical research. Large research universities such as the University of Michigan provide a favorable environment for conducting translational research because they host researchers from different disciplines. Personal communication and anecdotal reports suggest that even at a major academic medical center, researchers are challenged to discover appropriate collaborators.

The current project consists of comparing, analyzing and combining two strategies for eliciting collaborator discovery data from MEDLINE. Strategy One searches primary diabetes terms from MeSH (Medical Subject Headings) limited by primary author address. Strategy Two consists of name searches for researchers identified as affiliated with the University of Michigan diabetes research centers, again limited by institutional address of the primary author. Both searches were limited to the most current five years. Strategy One provides data regarding campus researchers working in core diabetes research who may not be identified as such through campus resources. Strategy Two provides data regarding diabetes-related research that is not identified as such through MeSH cataloging. Strengths offered by one strategy are the weaknesses of the other. Neither approach offers a comprehensive approach to discovery. Merging the datasets will allow the creation of preliminary data on co-authorship networks in the target community. Then we will conduct interviews with researchers who are core and well connected locally and those who are not. Comparing these two groups of researchers will clarify the barriers to collaboration.

RESULTS: Preliminary data shows that Strategy One discovered only a fraction of the diabetes researchers on campus, excluding topics such as beta-cell biology that are important to diabetes research, and excluding core individuals in campus diabetes research such as the Director of the Diabetes Research Center. Strategy Two is more effective at including important but diverse concepts, but failed to discover new potential collaborators from non-medical programs. Bringing together these two strategies combines the strengths and adjusts for the weaknesses of each strategy, enabling discovery of researchers not included in the existing tools for this purpose. Future directions for this research include enriched network analysis (ongoing), future interviews of researchers with rich local connections and those with less local collaboration.

11:05

Knowledge Integration and Creation in Interdisciplinary Science Teams: The Role of Team Dynamics and Communication

By: Maritza Salazar (U. of Central Florida, IST) & Theresa Lant (Pace U., Lubin Business School)

Knowledge creation in organizations has become increasingly important in organizations that are dependent on innovative knowledge to create value (Kim & Mauborgne, 1997) and to stay competitive (Powell and Snellman, 2004). To stimulate innovation, solve problems, and make decisions, organizations are increasingly reliant on teams (Ancona & Bressman, 2005; Homan, Kleef, De Dreu, Van Knippenberg, 2007; Nijstad & Paulus, 2003). This is particularly true in innovation-driven contexts (Brown & Eisenhardt, 1997; Hargadon & Sutton, 1997). Creating knowledge in organizations is challenging due to the limited opportunity for members with diverse knowledge to work together since people with similar specialized knowledge are often grouped together in divisions and groups (Ancona & Caldwell, 1992). To counter this tendency to group people with similar expertise together, firms often form overarching groups whose task is to integrate and combine the deeply-held knowledge of diverse members to create new knowledge (Northcraft, Polzer, Neale, Kramer, 1995). Although such diverse groups possess a promising distribution of collective knowledge that is both deep (in each member) and broad (across members), decades of empirical research and real-world experience indicate that this knowledge is likely to remain inert (Steiner, 1972; Hackman, 1990; Williams & O'Reilly, 1998).

We add to the understanding of the barriers and facilitators of innovation in diverse, interdisciplinary research (IDR) teams by examining team interaction and communication. We conjecture that team members perceive and assess the content of interaction, evaluating themselves, other team members, and the patterns of interaction in the group to determine the extent to which they will collaborate with experts from disparate parts of the organization to create new knowledge. Moreover, we suggest that the strength and influence of the high status team members will functions to shape the social structure of the IDR teams. The effect of the behaviors of these high status members may determine how knowledge is shared, exchanged, and created among IDR team members who hail from different professional work groups. We believe that variation in the content of interaction renders knowledge largely inert and underutilized in some IDR teams and sets the stage for knowledge creation in others.

We explore these ideas using data obtained from interdisciplinary teams working within a medical research and clinical care organization ("Metro Medical Center") located in a large metropolitan area of the United States. Recognizing that scientific innovation increasingly occurs at the interfaces of disciplines, the leadership at Metro Medical Center promoted the formation of interdisciplinary research teams whose task was broadly defined in terms of developing innovative research focused on the causes, prevention, and treatment of diseases. With the incentive of promised funding and resources for the interdisciplinary teams with the most innovative research proposals, employees interested in similar disease areas self-organized into teams, each of which focused on a different disease area (e.g., addiction, obesity, and skin cancer).

For this research we relied upon multiple sources of data to conduct a comparative case analysis of six interdisciplinary medical research teams. We began by using team rosters and CV's to measure the heterogeneity and range of knowledge within each of the IDR teams. Expert ratings of each the research proposals produced by the IDR teams were used to measure the innovativeness of ideas, the extent of knowledge integration between members' knowledge and the degree to which this new knowledge extended beyond current understanding in the field. From extensive qualitative data collected during observation of meetings and the qualitative interviews of group members, we identified various factors that influence the development of an IDR team social structure.

The influence of high status members on the content of interaction was determined by examining how their behaviors and communication (e.g., shifting, negating, clarifying, connecting, or extending responses) shape the group's creativity processes. Members experiences in the IDR team and their assessment of IDR team interaction, which takes into account their expectations about future interactions, is tightly related to their own identity, beliefs, and past experiences in the organization. Together, the content of interaction and members perceptions of the IDR team effects whether members break customary patterns of interaction to interact with members from other subgroups in the organization. This change in flows of knowledge and expertise seems to be highly related to the IDR teams' ability to integrate and extend knowledge. We identify how the shift in interaction can be illustrated by both the extent to which cross-boundary collaboration occurs within teams and the degree to which social integration emerges (see figure). Taken together, we believe this research begins to provide insight into the process factors that influence why some interdisciplinary science teams leverage their diverse knowledge better than others.

Title:
Engaging Many Minds - An Approach to Crowdsourcing Ideas & Collaborator Discovery

Authors: Katja Reuter, PhD, Rachael Sak, RN, MPH, Maninder Kahlon, PhD
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Abstract:
Enabling idea generation as a collaborative endeavor driven by input from a broad research community could transform the types of research questions that are generated and how teams are convened. Finding and leveraging the enormous potential of the 'collective brain' has a history outside of research typically refered to with terms such as 'crowdsourcing' and 'open innovation'. Large companies like IBM are leading the way, and bestselling books such as "Wisdom of Crowds" provide evidence and frameworks for the notion that larger groups can provide unique knowledge and problem-solving strategies.

Here we present a communications approach coupled with a web-based *Open Forum* tool that crowdsourced new connections and collaborations among clinical & translational researchers at the University of California, San Francisco (UCSF). The tool provided the substrate to achieve several goals: It supported community building, team assembly, innovation management, collaborative idea generation and team work on proposals.

What we did: Within a 6-month period, 3 pilot projects were launched. They were focused on enabling the submission of the best projects for both internal UCSF funding as well as for funding appropriated through the American Recovery and Reinvestment Act (ARRA). The ideas solicited from increasingly larger groups through all three pilots focused on research infrastructure and novel approaches to improve the translation of basic discoveries into health benefits for the community, known as clinical & translational research. As part of the process, CTSI leadership evaluated and triaged the submitted ideas, providing continual feedback online and via discrete physical networking contexts, and the tool itself was iteratively improved based on user input. In addition, promising ideas that could not be funded initially were transferred to the subsequent Open Forum initiative allowing further idea development and cross-pollination among other virtual communities.

What we learned: A much larger group of contributors were engaged in the idea generation process than could have been identified otherwise. Overall, 98 ideas, 429 comments and 184 'votes' were submitted, resulting in reader-contributor conversion rates of 1.7-3.7 %. The sharing of ideas transparently between otherwise seemingly competitive proposals was received well, given careful attention to framing of the approach in all communications, virtual and real-world. Through this process, several projects were seeded with investigators who identified collaboration partners and submitted more comprehensive proposals than otherwise individually possible.

These pilots show that the 'wisdom of crowds' can indeed be harnessed within a biomedical research environment and c can enable the generation of novel ideas and teams.. Future work will aim at reaching broader more distributed audiences, as well as apply the lessons learned to the crowdsourcing of ideas to address pressing biomedical research questions.

04

Digital Vita: Designing a Social Infrastructure for Team Science

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In diverse and multidisciplinary collaborative teams the boundaries between social networking and information use are often blurred. Researchers often turn to literature search tools to find collaborators and rely on colleagues for content referrals. However, social networking systems, personnel directories, and content repositories remain largely disconnected silos based on irreconcilable principles and interfaces. As the importance of team science grows, so too does the need for technologies which support integrated exploration and exploitation of social networks and content repositories.

Social infrastructure technologies compete with deeply ingrained, established practices for managing social and information resources. The benefits of system use are affected not only by technology characteristics but also by factors such as researcher seniority, openness to new collaborations, and the degree of coverage of personal networks and other relevant communities. As such, design and deployment of these technologies is dependent on careful study of users' current practices.

The goal of the Digital Vita project was to define requirements for, design, implement and formatively evaluate a web-based infrastructure to support management and use of researchers' social networks and personal information repositories. A multi-method, user-centered approach was used to develop a scientific social networking infrastructure based on faculty curricula vitae (CV). Initial requirements were identified through semi-structured interviews with 30 biomedical research faculty and contextual inquiry exercises with 10 researchers.

Digital Vita differs from typical scientific social networking systems inasmuch it incorporates full CVs to represent users, instead of only publications and grants. In addition, its social network representation extends beyond mere coauthorship by including collaborations on grants and abstracts, as well as user-specified relationships. In its current form, Digital Vita combines support for the critical practice of CV management, social networking, and basic research team management functions.

Digital Vita integrates CV management with scientific social networking and basic research team management functions to support:

- management of complete academic CVs;
- output of CV information in various formats (e.g. NIH biosketches; full vita, etc.)
- construction of social networks based on publications, grant records, and explicit "colleague requests"
- grouping of colleagues into research teams

Version 1 of the system was developed over a 1-year period and extensively pilot-tested with over 30 individuals prior to production rollout. Digital Vita is implemented as a Web-based application using HTML, Ajax and JavaScript for the user interface, and a set of layered Java-based Web and database services as well as an Oracle database as the backend.

Three months after a "soft" production rollout in September 2009, Digital Vita contained data on over 150 active users, 3,800 publications, 620 grants and 610 presentations. Cumulatively, 92% of all publications in the system have been imported from MEDLINE while 8% have been manually entered. Informal feedback indicates that users value DV's labor-saving functions for CV management and are actively generating NIH biosketches.

In addition to supporting research activities, Digital Vita's data stores and user portal also provide a foundation for ongoing efforts to support and study collaborator discovery; enable targeted dissemination of published work; and generate personalized recommendations of research-relevant content and funding opportunities.

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05

Harvard Catalyst Profiles – An Open Source Research Networking System

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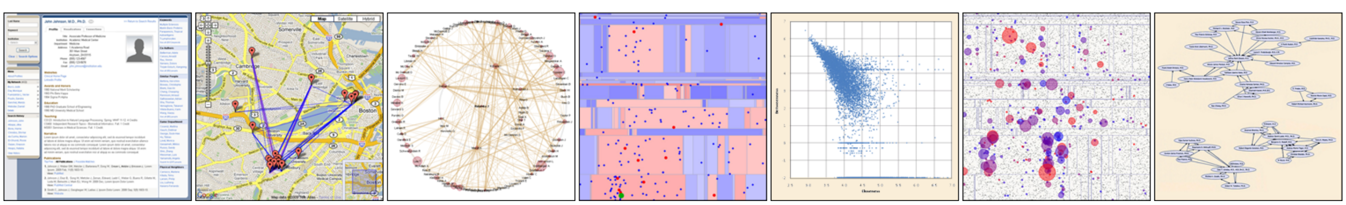
“Profiles” is a research networking system created for Harvard’s Clinical and Translational Science Award (CTSA) program, the Harvard Catalyst. It was developed not only to help users learn about the areas of interest and expertise of the faculty, but also to illustrate how these faculty are connected into large networks. The goal of Profiles is to create new collaborations and facilitate the formation of interdisciplinary teams.

<u>Active & Passive Networking</u>. We created investigator profiles for more than 20,000 faculty across 33 institutions affiliated with our CTSA using a variety of data sources including PubMed, CRISP, ISI Thomson Web of Knowledge, and internal Human Resources and administrative databases. These profiles are linked together through Passive Networks, which are automatically generated based on information known about investigators. For example, publications in PubMed are associated with MeSH terms, which we can use to map keywords to individuals. By comparing the keywords of each person to every other faculty member, we can automatically create networks of people with similar interests. Users can also create Active Networks, by looking up people they know and manually describing their relationships to them, such as “collaborator” or “past advisor”. Faculty, students, and administrators have discovered many uses for the networks in Profiles, including finding collaborators for grants, forming review committees, inviting speakers for conferences, locating mentors, and “egosurfing” to see how they compare to their peers.

<u>Disambiguation & SNA</u>. The heart of Profiles is a collection of algorithms used to assemble and analyze the network data. We developed a probabilistic author disambiguation method that uses names and article titles, keywords, affiliations, and co-authors to determine the likelihood that a publication is matched to an individual. We balance the sensitivity and specificity of the algorithms to maximize the number of correctly matched publications while minimizing false matches. Multiple tools are available in Profiles to allow researchers or their proxies to manually correct any mistakes or enter missing publications. Social network analysis (SNA) is performed automatically each night in Profiles. Novel visualizations (see below) were developed to display the results of SNA at both the individual person level and in aggregate across departments, disciplines, and faculty demographics. We use the results to understand the collaborative nature of our CTSA, track changes over time, and analyze the applicants of Pilot Grants to assist with selecting the awardees.



<u>APIs & Open Source Code</u>. We share Profiles in two ways. 1) An XML-based web service API allows other applications to access the data and network information in Profiles. This is used within Harvard to feed other modules of our Catalyst Portal and to act as a University-wide repository for faculty data. The API also enables federated queries across different CTSAs using Profiles or similar platforms. 2) An open source license makes Profiles code free to other institutions and allows redistribution of derivatives and commercialization. UCSF is our first external adopter. We plan to form a governance committee with broad representation to oversee the evolution of the open source product, and we have partnered with a third-party company, Recombinant Data Corp (recombdata.com), which has significant experience working in academic healthcare settings, to provide as-needed support to institutions.

06

Impact of DTMI Regulatory Affairs and DTRI on Translational Science at Duke

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The Duke Translational Medicine Institute (DTMI) Regulatory Affairs (RA) team serves as an internal expert resource to the investigator community regarding regulatory requirements, interactions with regulatory authorities, and regulatory strategies across the spectrum of preclinical to late phase clinical research. The RA team also works very closely with the Duke Translational Research Institute (DTRI), whose mission is to rapidly and effectively invent, develop, and test new drugs, diagnostics, and devices for human use. The DTRI also utilizes funding from Duke's Clinical & Translational Science Award (CTSA) to fund innovative translational projects, focusing on the invention, preclinical development, and/or first in man studies of novel therapeutics. The DTRI pilot project grants facilitate the formation of teams of basic scientists and clinical researchers, thus enhancing drug/biologic/device development and their translation into the clinical trials.

The RA team has four main approaches in facilitating translational science: a) regulatory strategy development; b) guidance and assistance with preclinical testing and Good Manufacturing Practice (GMP) requirements, c) guidance and assistance with Investigational New Drug (IND) and Investigational Device Exemption (IDE) preparation and maintenance; and d) training and education.

The RA group works closely with DTRI-funded teams, which are often at the very early stages of drug/biologic/device development and thus are in need of regulatory strategies for complex issues with potential for significant compliance impact. The DTRI pilot program utilizes a team approach to discovery and development where the faculty-led team is augmented with team leaders and operational experts. Should the project require it, the RA group provides guidance and assistance on required preclinical studies and in understanding and complying with GMP requirements for the manufacture of investigational drug product. In addition, the RA group facilitates meetings with the Food and Drug Administration (FDA) and assists in scheduling, preparing and guiding the investigator in pre-IND/pre-IDE meetings. The translational progress on the 22 projects funded to date includes one new IND, 14 publications, 9 projects with follow-on funding (>$13M combined), creation of two new companies, licensing of one new drug, and generation of many new partnerships. Projects are making progress on a second IND application and one IDE.

A major focus of the RA group to date has been to assist Duke investigators and their teams in the preparation and submission of the initial IND/IDE applications as well as annual report, amendments and other required submissions. The RA group has compiled a database of all sponsor-investigator initiated IND/IDE studies at Duke and thus is able to assist investigators in meeting the regulatory requirements that might apply to their clinical research. In addition, the RA group has prepared a program to assist investigators holding INDs to meet their clinical study monitoring responsibility as sponsor.

Finally, the RA group provides training and education on regulatory issues and requirements (e.g. IND/IDE preparation, submission and maintenance, development of internal regulatory programs, etc.). This training is provided individually with investigators or through seminars and workshops. Much of the training program has been recorded and is now available online. Templates for IND/IDE submissions, annual reports and other regulatory submissions, which represent a "best practice" approach, are available to all research teams. Those templates are used not only at Duke University but also at other CTSA institutions.

As a result of our integrative work with various teams during the past two years, the RA group has filed over 30 initial IND applications for investigators at Duke University, scheduled, prepared and attended over 10 pre-IND/pre-IDE meetings, and submitted over 20 other regulatory submissions (annual reports, amendments, etc.). Future plans include continuing to provide comprehensive regulatory and quality assurance services to research teams at Duke, in order to facilitate the bench to bedside translational research.

Title: Towards an Applied Communicative Theory of Proposal Development in Interdisciplinary Research

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Objective:

Proposal development in Interdisciplinary Research (IDR) is a collaborative process that is communicative and organizational. This project seeks to develop a theoretical understanding of IDR proposal development through a convergence of Communication is Constitutive of Organization (CCO) theory and theories grounded in language and social interaction analysis. Additionally, by combining theory and practice in applied research, this project seeks to systematically develop successful strategies for IDR proposal development teams.

The capacity for IDR to extend knowledge and foster discovery is well documented. These collaborations, from aerospace to weather radar, have resulted in innovations vital to the nation's civilian and commercial infrastructure. Public, private, and academic collaborations bring together a diversity of knowledge and experiences. This diversity also brings differences in both epistemology and disciplinary structures that often create tensions within discourse. These discursive tensions can lead to misunderstandings which may result in design conflicts, over-budgeting, and fragmented personal and institutional relationships. These tensions often manifest in the earliest stages of the project, in the context of research proposal development. An IDR project is a continuous stream of conversational events, and discursive tensions may continue throughout the life of the project, impeding success.

IDR research teams can be described as emerging organizations grounded in communication. According to CCO theory, these teams organize systematically through four communicative flows: membership negotiation, activity coordination, self-structuring, and institutional positioning. These four flows provide a theoretical focus for understanding teamwork within a framework of organizational communication. Discourse and interaction analysis can show how meaning is shared within language use, social interaction, power relationships, and inferential speech, in the context of self-organizing. Unshared meaning can disrupt communicative flow and hinder organizational development.

This organizational communication project proposes to capture the face-to-face and digital interactions of IDR teams engaged in the process of proposal development. Using conversation and content analysis, interactions will be analyzed for discursive tensions that hinder the communicative flows described by CCO theory. Results will inform theoretical development, applied research, and best practices.

The four organizational flows in CCO theory provide a multi-faceted approach to developing intervention strategies. For example, IDR personnel choice is critical to the success of a research project; CCO theory's membership negotiation flow provides a systematic approach for creating strategies that can facilitate this process. This project's specific focus on IDR proposal development teams will enhance collaboration and organizing at critical early stages of project development. Knowledge gained could enhance digital resource development, institutional proposal development structures, and create innovative strategies for cross-disciplinary scientific collaboration.

08

Effects of Scale, Scope, and Team Structure on the Productivity of Academic Labs

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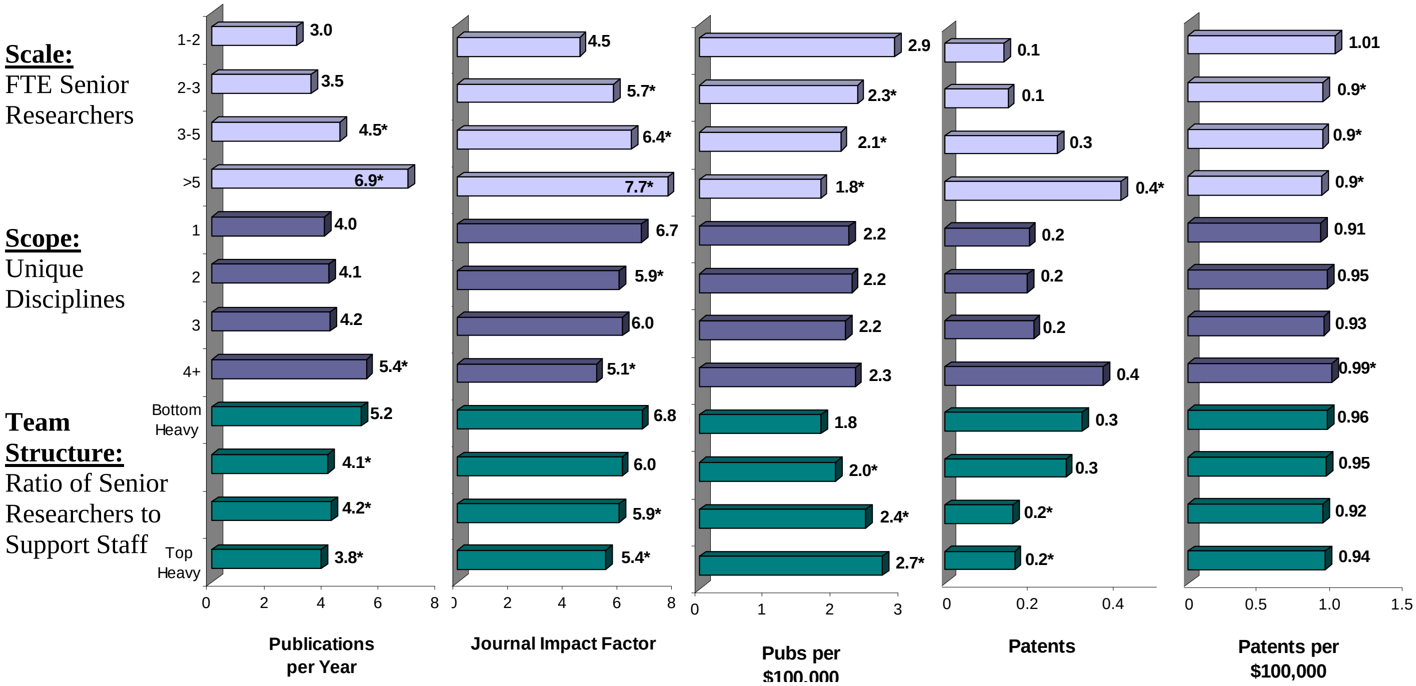
Objective: This research focuses on the choices of the principal-investigator in assembling the academic laboratory team and examines how those structural choices affects both their productive output and productivity in the creation of new knowledge

Methods: Mailed survey conducted in 2007 of 3080 life sciences faculty at the 50 universities with medical schools that received the most NIH funding in 2004 (74% response rate). The analytical sample was limited to principal investigators who maintained a research lab that actively conducted basic research as part of the research portfolio, representing 55% of respondents (n=1,197). Multivariate regression analyses model the impact of scale (as measured by the number of senior researchers), scope (the number of unique scientific disciplines represented in the lab), and team structure (the proportion of project leaders to all staff) on five measures of academic lab output: publications, journal impact factor, patents, publications per $100,000 of research funding, and patents per $100,000 of research funding. Control variable include characteristics of the principal investigator (gender, professional age, research hours per week) and characteristics of the research (funding per FTE lab member, dummy variables for whether the lab also conducts translational, clinical trials, or health services research).

Results: Figure 1 presents the results of the regression analyses, documenting the effect on academic lab output by approximate quartiles of scale, scope, and team structure. Scale and a wide multidisciplinary scope were both associated with a significant increase in the quantity of publications and patents. More hierarchical labs (i.e., those with a larger ratio of junior to senior staff) have both higher quantity and quality of publications compared to top-heavy groups. Multidisciplinary lab output is associated with less prestigious journals. In contrast to these effects on the pure number of papers and patents, larger labs and hierarchical labs were linked to lower productivity in terms of papers and patents per research dollar.

Figure 1: Effect of Lab Team Characteristics on Scientific Lab Output by Quartiles



*Average effect size when all other variables are set at their mean value; *p<0.05 compared to first quartile*

Implications: Overall, the findings lend support to the well-documented benefits of collaboration and cognitive diversity in solving complex problems. The productivity metrics suggest that even within a well-defined and co-located laboratory team, coordination and communication issues across large teams have the potential to substantial impact on the efficiency of scientific discovery. The results also show that characteristics that are associated with higher quantities of output are also linked to lower productivity, indicating a potential conflict of incentives between the academic scientist and scientific sponsor in how best to structure the laboratory team.

Abstract for a poster on **Bringing the Social to Team Science**

By Stephanie Jo Kent, University of Massachusetts Amherst and James Cumming, Chaos Management, Ltd

Proposal

Despite decades of leadership from the health sciences, progress in resolving barriers to interdisciplinary research appears static. One reason stems from the failure to engage knowledge developed from a social perspective (Fiore, 2008). We aim to bring the social to team science by imagining all of the participants, presenters, organizers, and sponsors of this conference as "a team" – as a group of scientists engaged in a common task: to understand and improve the practice of team science. By imposing the model of team science on the group, we create boundary conditions for analysis of the conference discourse and dynamics about team science. This maneuver invites all those in the conference who wish to do so to engage with us in an active and collaborative process of learning. We will challenge these self-selected conference participants to identify the substance of social intelligence required in the applied practice of team science through voluntary monitoring, self-evaluation and self-reflection, Paying dual attention to the processes of 1) talking about team science and 2) doing team science will generate a snapshot of the current state of the field, provide insight into the norm-governed behaviors, attitudes, and cognitions that promote or inhibit productive team science, and highlight the specific skills, strategies, and synergies of effective leaders and team players.

Method

We propose to conduct a running ("live") discourse analysis of participants' interactions during the Science of Team Science Conference, in order to explore relationships between a) the structures and processes of generating knowledge about working in teams with b) the content of knowledge shared during the conference. An "ad" in the conference program would alert participants to the study and initiate a consent/dissent procedure for human subjects research. Steph and James will observe the discourse and dynamics beginning at the Wednesday evening reception through the Saturday workshop, collect additional discursive and dynamic data from volunteers, and reflect impressions back to participants via a weblog dedicated to the conference and/or at www.reflexivity.us. Our poster will contain information about the theories we use and our data collection tools. In addition, we will pose a hypothesis derived from our observations of the conference about the relationship of the social to science in order to help us engage in dialogue with participants.

Product

Summaries, discussions and questions raised by observations and feedback will be posted daily through a weblog (possibly stimulating on-going conversation and remaining as a permanent resource). We hope to identify potential partners for future research in Team Science and to contribute conceptual material of substantive value to the field. An article will be written for publication in the conference proceedings (or some other outlet if no proceedings are planned). This article may include suggestions regarding how the conference structure facilitates or counteracts the interdisciplinary development of team science.

Process

We will need to have some coordination with the Program Committee regarding informed consent procedures and possibilities for survey-type data collection. It will be ideal if conference organizers are open to announcing and promoting participation in the study.

REFERENCE: Fiore, Stephen M. 2008. Interdisciplinarity as Teamwork: How the Science of Teams can Inform Team Science. *Small Group Research.* Vol. 39. pp. 251-277. Sage.

Advancing the Science of Evaluating Team Science Outcomes: The Research on Academic Research (RoAR) Initiative: Part 1 Sociometrics

Cameron Norman[1], Tim Huerta[2], Sharon Mortimer[3] & Alison Buchan[4]

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Background: In 2006 the University of British Columbia opened the Life Sciences Institute (LSI), the first building of its size at UBC to be developed to support cross-disciplinary bio-sciences team research. The Research on Academic Research (RoAR) initiative was initiated in 2007 to serve as a platform for conducting exploratory research and evaluation of the effect that co-location of previously disparate researchers and institutional policies have on the organization and output of scientists.

Objectives: To employ differing evaluation methodologies to determine the outcomes associated with the re-organization of the scientists from academic department buildings into integrated problem-based research groups.

Methods: An evolving, longitudinal multi-method study design has been employed to support the development of a core set of indicators used to assess impact of collaboration. These include:

- **Part 1: Survey of LSI investigators and trainees that included two core components: Social-behavioural measures of attitudes, knowledge, collaborative skills, and perceived benefits and risks associated with various models of research;**
- Part 2 : Measures of social network size, shape, density and composition;
- Part 3:Use of bibliometric data examining publication patterns (# citations, # publications, journal impact factors, H-index) collected from Web of Science;
- Part 4: Grant application review to explore the submissions and outcomes associated with research since joining the LSI
- Qualitative interviews with team leaders and key members of the LSI networks (planned)

Primary data was collected from principal investigators each year. The survey was administered using a Web-form followed by pencil and paper version using a modified Dillman approach. In the 2009 wave of surveys, 153 participants completed the survey. All other data was collected using administrative files and databases at the University of British Columbia.

Results: Data was analyzed using SPSS 18.0 (current year data). Data was structured to elicit responses regarding team science activities across four major domains: Interdisciplinarity, collaborations, the nature of interactions with others, and professional identity. In the first waves of data collected in the first two years of the study, participants initially expressed low interest, confidence and perceived support for transdisciplinary research in their discipline or the university. Analysis of data in years 3 and 4 of the study self-reported expression of confidence (self-efficacy), perceived value, and reported normative expectations of transdisciplinary collaboration within their primary discipline and in health sciences overall. Using 2009 data, participants reported high levels of confidence in their ability to do team science, experienced benefits from it, and perceived it to have high value to their work, representing a significant shift from previous years' responses.

Conclusions: The overall attitudes, skills and knowledge about how to do transdisciplinary research and the perceived value of team science to academic work changed considerably over four years suggesting that models of research need to consider appropriate time horizons for capturing both cultural and psychosocial shifts in research activity. The addition of qualitative interviews from team leaders and key stakeholders provides the opportunity to explore the nature of this shift in greater detail.

A Bibliometric Comparison of the Characteristics and Productivity of the Transdisciplinary Tobacco Use Research Centers (TTURCs) and Tobacco R01 Grants

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The Transdisciplinary Tobacco Use Research Centers (TTURCs) were funded through a grant program of the National Cancer Institute (NCI) to promote transdisciplinary collaboration in tobacco research. A series of studies are being undertaken to broadly evaluate the scientific merit of this initiative, including a bibliometric study to examine the productivity and impact of the TTURC centers. Initial findings will be presented in this poster.

This study utilizes a quasi-experimental design to compare the outcomes of the TTURCs, which were supported by a P50 grant mechanism, to the outcomes of two different comparison groups, each composed of grants funded under the traditional R01 mechanism. The comparison group grants were selected for comparability to TTURCs on tobacco research relevance, funding duration, and funding dates.

With respect to overall productivity, the TTURCs had an initial lag in publications compared to the R01 groups. However, by the fourth year of funding this difference was eliminated, and by the end of the comparison period (10 years), the TTURCs published more than either comparison groups (351 vs. 270 and 189 cumulative publications, respectively). With respect to impact, differences in journal impact factor and citation rates were not detected. However, we found that TTURC publications consistently included more co-authors than the comparison groups' publications. .

Examining within-group variability, we found dramatic variation in publication rates within each comparison group. We have hypothesized this variability is less likely to occur among the TTURC group and are currently conducting analyses to test this hypothesis. Preliminary results on this topic will be shared at the conference. We will also share results from moderator analyses conducted to explore potential causes of within-group variability in publication patterns. We identified five main types of studies, ranging from basic science to epidemiologic studies. Preliminary analyses have revealed that the type of study is associated with substantial differences in publication patterns, with animal studies producing a greater number of publications compared to epidemiologic studies and clinical research. Additional moderator effects related to authors' seniority and number of concurrently funded R01 grants were also observed. Implications and future directions of this research will be discussed.

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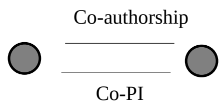
The Impacts of Co-authorship Networks and Citation Networks in "Team Science"

Meikuan Huang
Jordan Liu
Annie Wang
Noshir Contractor

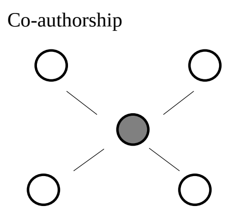
Northwestern University

Abstract

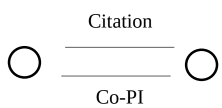
Prior collaboration is a key team assembly factor which has been found to have mixed effects on group performance. Based on theories of transactive memory and shared mental models, this study examines how prior co-authorship and citation network configurations influence team success and leadership formation in scientific research groups. Here is a summary of hypotheses and research questions:



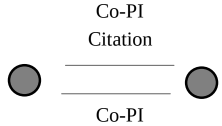
Research Question 1: How can co-authorship network among members of the proposal team influence the success of project proposals?



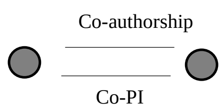
Hypothesis 1a: Members of the proposal team with higher betweenness centrality in co-authorship networks are more likely to be PIs.
Hypothesis 1b: Proposal teams with members having a higher betweenness centrality in co-authorship networks are more likely to succeed.



Hypothesis 2: On proposal teams members tend to collaborate with those whom they have a citation relationship with.



Hypothesis 3: Proposal teams with members having a citation relationship with each other are more likely to succeed.



Hypothesis 4: Proposal teams with members having a co-authorship relationship with each other are more likely to succeed.

We collected scientometric data of 51 research proposal teams with a total of 104 applicants (51 PIs and 53 Co-PIs) who submitted proposals to a grant competition in 2009 hosted by a National Institute of Health funded research institute on Clinical and Translational Sciences located in a Midwestern university. We tested multivariate and multi-attribute ERGM models in XPNet, a computer program designed specifically for analysing social networks with multiple relationships and attributes. Preliminary results lent support to the premises of prior or repeat collaboration that people are likely to have better familiarity of and higher chance of collaborate again with those they share a collaboration history.

Key words: repeat collaboration; co-authorship networks; citation networks; team assembly.

Dynamic Support for Dynamic Challenges: Using Collexis to Support Researchers at the University of Michigan Medical School

Authors: Michael Warden, Collexis, Inc; Marisa Conte, University of Michigan Health Sciences Libraries

Objective: To demonstrate how implementation of Collexis' Research Profiles has helped to facilitate dynamic research support and simplify research administration at the University of Michigan Medical School (UMMS).

Building on a variety of information resources, including publication and grant data, Collexis' Research Profiles provides innovative solutions to the pressing needs of the academic research environment. From identifying collaborators, to matching researchers with new funding opportunities, to streamlining strategic research planning, UMMS is using Collexis to identify and address the needs of both researchers and administrators.

The Collexis Research Profiles tool provides a dynamic dashboard to help users identify proven experience and expertise across the diverse organization. This is especially important given the recent emphasis on interdisciplinary, collaborative and translational research initiatives. Researchers can use the Research Profiles tool to find potential interdisciplinary collaborators quickly and efficiently. At Michigan, Research Profiles has been used to match clinical faculty with basic sciences researchers, to identify current experts in emerging areas of research interest, and to track research trends across UMMS departments. Additionally, the UMMS Office of Research can quickly match funding opportunities with researchers through customized, targeted communication.

The UMMS has utilized available web services to connect publication data to other local data sources. With this data integration, it is now possible to connect a variety of information across disparate datasets, and to port this information into faculty management systems. This data enables administrators to execute complex queries related to collaboration patterns, including social network analysis. As key strategic questions are identified by leadership, UMMS now has the ability to provide data and information to support complex ad hoc analyses, or to address questions such as 'what are we good at?', 'who are the key individuals in our organization?' and 'who should we invite to participate in this strategic initiative?'.

This poster will illustrate how the partnership between UMMS and Collexis has driven product development, enhanced the structure and portability of the data to maximize its use, and facilitated research expertise identification and research administration at the University of Michigan Medical School, setting a new standard for supporting researchers using technology.

Leadership and Communication Behavior That Is Conducive to Effective Teamwork

Skillful leaders demonstrate the behaviors identified below. Leadership development and team building are conducted to develop these skills and enable leaders and teams to be productive in their work.

Listening and Having Dialogue

- Listen with empathy as team members describe their problems, goals, ideas, and beliefs.
- Focus completely on what others are saying.
- Suspend judgment and decision making until you understand others' points of view.
- Paraphrase others' key points to demonstrate understanding.
- Invite opposing points of view.
- Follow through on agreements.

Reaching Meaningful Consensus

- Identify the future state you are trying to achieve.
- Involve others in identifying priorities that the team will pursue.
- Identify the barriers that impede achievement of the priorities.
- Involve others in developing and carrying out action plans to remove the barriers.
- Achieve strong commitment to, even if not complete agreement with, the plans that are made.

Meeting To Solve Problems

- Circulate an agenda before the session so that others can prepare.
- Encourage differing points of view.
- Develop a balanced perspective and make use of participants' varying strengths and traits by:
    - Identifying the facts.
    - Brainstorming possibilities.
    - Identifying logical solutions.
    - Considering the impact of possible decisions on others.
- Identify next steps.
- Press for timely results.

Managing Stress and Conflict

- Make use of others' strengths in doing the work.
- Maintain an environment that energizes others with autonomy, structure, flexibility, involvement, respect, appreciation, and open communication.
- Identify the stress and conflict "triggers" such as deadlines, resource allocation, change, vagueness, detail, and excessive introverting or extroverting.
- Empower team members to reduce stress in order to be productive.
- Train team members to step back from the brink of conflict to regain perspective.
- Provide the support that is needed.

Delegation

- Differentiate between delegating and assigning.
- View delegation as an investment in others.
- Feel secure about delegating.
- Tell the team member what is to be accomplished.
- Agree on standards and feedback.
- Give enough authority.
- Explain resources.
- Be certain that the other wants to do the task.
- Monitor and coach according to others' skills.
- Appreciate the work that is performed.
- Accept the outcome even if it is different from what you would have done.

Developing Synergy

- Distinguish between leading and managing.
- Encourage everyone to participate in setting the direction of the team.
- Accommodate varying work styles as long as the work gets done.
- Encourage constructive feedback to and from everyone.
- Admit when you don't know the answers or make mistakes.
- Facilitate a sense of ownership by others of the decisions that are made.
- Encourage collaboration.
- Have professional development plans.

Interdisciplinarity Research Assessment Tools

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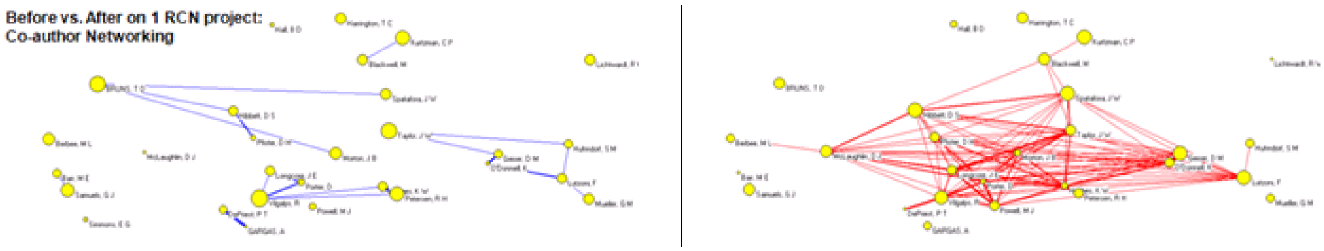
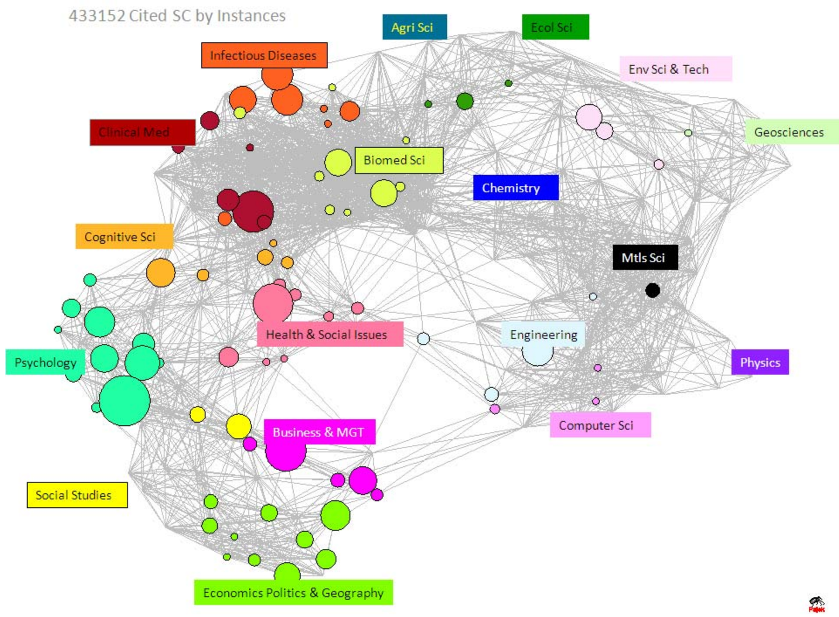
Team science and interdisciplinarity are multifaceted, presenting challenging measurement and representation issues. We are developing a suite of analytical and visual tools to begin to address these issues and to apply them to help assess research projects and programs.

By “mining” select research texts (e.g., papers, proposals, reports), we can readily compile a variety of statistics. For instance, we have recently been exploring several NSF programs to determine “how interdisciplinary” the research really is. One such analysis examines article abstracts to tabulate # of authors/paper, # of collaborating institutions, journal impact factor, and so forth. Another perspective is provided by visualizing research networks before and after research funding is injected into the network. This can be illustrated several ways, including drawing networks based on co-authoring (see the“Before vs. After” Figure) or other various forms of bibliographic coupling.



We can also map research based on Web of Science Subject Categories. These results contribute to benchmarking the funded research with other comparison research outputs. The figure below shows the diversity of cited Subject Categories for papers deriving from one NSF project overlaid on a base map of Science.



On behalf of the National Academies Keck Futures Initiative to enhance interdisciplinarity in the US, we devised a set of metrics to gauge the interdisciplinarity of select research elements. In collaboration with Ismael Rafols, we have identified a compelling conceptual framework to consider “diversity” in terms of variety, balance, and disparity. We are also particularly enthused about the potential of using analytical techniques to track research knowledge diffusion – e.g., from cited references, to publications, and on to the articles that cite those publications.

Given the growth of available, mineable scientific and technical information, and increasing sophistication of analytical and visualization tools, we foresee tremendous opportunity to increase our understanding of how Science works.

Advancing the Science of Evaluating Team Science Outcomes: The Research on Academic Research (RoAR) Initiative: Part 3: Bibliometrics

Sharon Mortimer[1], Tim Huerta[2], Cameron D. Norman[3], & Alison Buchan[4]

1 – Michael Smith Foundation for Health Research; 2 – Rawls College of Business, Texas Tech University; 3 – Dalla Lana School of Public Health, University of Toronto; 4 – Faculty of Medicine, University of British Columbia

Background: In 2006 the University of British Columbia opened the Life Sciences Institute (LSI), the first building of its size at UBC to be developed to support cross-disciplinary bio-sciences team research. The Research on Academic Research (RoAR) initiative was initiated in 2007 to serve as a platform for conducting exploratory research and evaluation of the effect that co-location of previously disparate researchers and institutional policies have on the organization and output of scientists.

Objectives: To employ differing evaluation methodologies to determine the outcomes associated with the re-organization of the scientists from academic department buildings into integrated problem-based research groups.

Methods: An evolving, longitudinal multi-method study design has been employed to support the development of a core set of indicators used to assess impact of collaboration. These include:

- Part 1: Survey of LSI investigators and trainees that included two core components: Social-behavioural measures of attitudes, knowledge, collaborative skills, and perceived benefits and risks associated with various models of research;
- Part 2 : Measures of social network size, shape, density and composition;
- **Part 3:Use of bibliometric data examining publication patterns (# citations, # publications, journal impact factors, H-index) collected from Web of Science;**
- Part 4: Grant application review to explore the submissions and outcomes associated with research since joining the LSI
- Qualitative interviews with team leaders and key members of the LSI networks (planned)

Primary data was collected from principal investigators each year. The survey was administered using a Web-form followed by pencil and paper version using a modified Dillman approach. In the 2009 wave of surveys, 153 participants completed the survey. All other data was collected using administrative files and databases at the University of British Columbia.

Results:

Comparison of publication metrics demonstrated that the citation patterns for investigators showed years 3 – 5 were the highest citation years for all but one group. This is contrary to the accepted use of years 2 – 3 years commonly used to determine impact factors. The move into the LSI did not affect publication patterns or number of publication submitted by research group. This finding contrasts with the common expectation that moving productive researchers and realigning their space results in significant down time reducing productivity.

Comparing researchers at the UBC LSI with three major Canadian Universities demonstrated that in the field of Cell Biology the move into the LSI correlated with a significant increase in impact of publications, which was not seen in Biochemistry & Molecular Biology or Microbiology the other two Departments that moved their entire research operations into the LSI

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Conclusions:

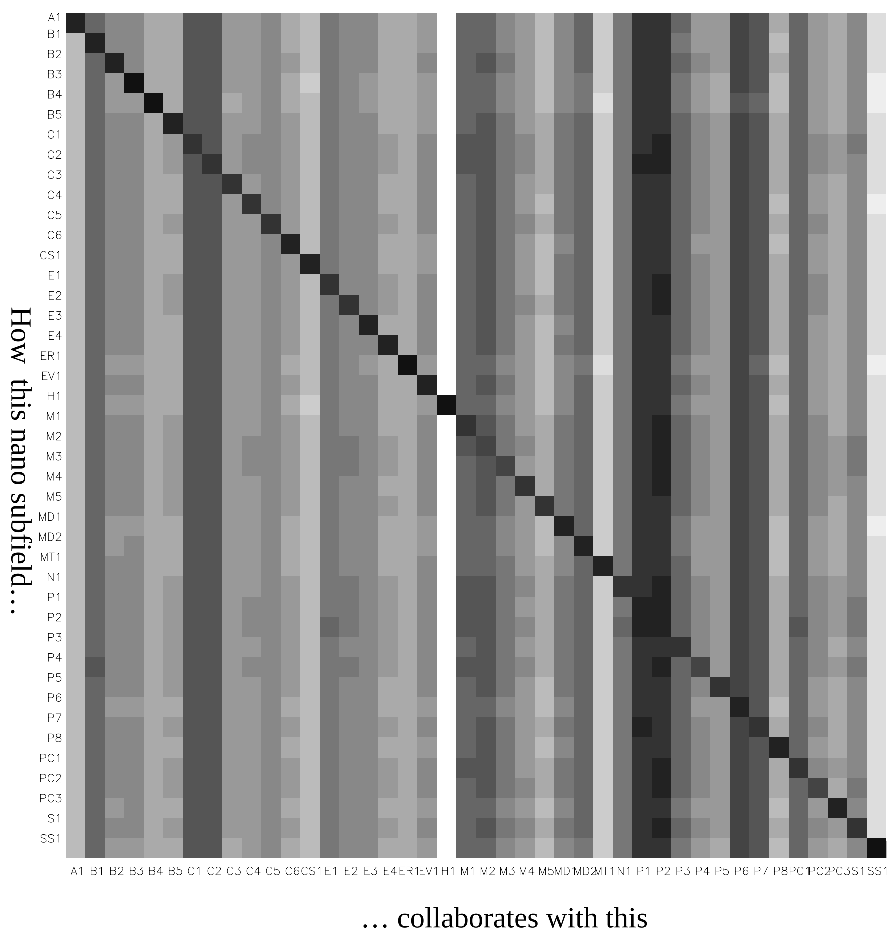
Given the citation pattern of papers published by researchers in the LSI it is too early to make definitive statements about the effect of the move with the exception of the rapid rise in impact of papers in Cell Biology. The first year at which the effect of the LSI on publication impact can be assess will be 2010.

Studying Interdisciplinarity and Transdisciplinarity at the Subfield Level: The Case of Nanotechnology

Staša Milojević

Indiana University Bloomington, School of Library and Information Science

In this study I examine the social structure of nanoscience/nanotechnology at the level of individual subfields, focusing on collaboration patterns both within and among different subfields. Coauthorship networks for 2000-04 period are constructed from NanoBank database. Collaboration is measured from coauthorship networks, by analyzing the subfield distribution of collaborators of nanoscience researchers (who themselves belong to various subfields). The results of this study show that different subfields of nanoscience exhibit different collaboration patterns, indicating that different scientific practices and cultures originating from different parent disciplines are driving the collaborative behavior of researchers within different nanoscience subfields. The results of the analysis of the collaboration among different subfields indicate that scientists within particular subfields strongly collaborate with others from the same subfield (dark diagonal in Figure 1), although not at the same level. The results also show that two nano subfields that come from physics (dark vertical band in Figure 1) ensure cohesion among the authors working in almost all other nano fields. These results suggest that nanoscience exhibits properties of transdisciplinarity.



A1 Agriculture
B1-B6 Biosciences
C1-C6 Chemistry
CS Computer Science
E1-E4 Engineering
ER Earth Sciences
EV Ecology & Environment
H1 Humanities
M1-M5 Materials Science
MD1-MD2 Medicine
MT1 Mathematics
N1 Nanotechnology
P1-P8 Physics
PC1-PC3 Physics & Chemistry
S1 Science Multidisciplinary
SS Social Sciences

Figure 1. Collaboration of a given nano subfield (y-axis) with subfields on the x-axis. Shades of grey indicate different levels of collaboration, with black being the strongest. For example, for nanoscientists working in agriculture (A1) we observe the first row. It most strongly collaborates with itself, none at all with H1 (humanities), strongly with P1 and P2 (physics), and so on. Plot is not symmetric because while most of the collaborators of field A may belong to field B, for field B collaborators from field A may represent only a small fraction of all collaborators.

Using ScienceWire® to Support Research and Policy Development for the Science of Team Science

Beth Masimore, Joshua D. Schnell, Laurel L. Haak, Matt Probus, Mike Pollard
Discovery Logic/Thomson Reuters, Rockville, MD 20850

Science is increasingly being performed by interdisciplinary and geographically diverse teams funded by large-scale initiatives. The Science of Team Science is an emerging research field that seeks to identify drivers in the conduct of team science and levers for process improvements and policy interventions. Critical to such research is the quality and comprehensiveness of data available that capture the varied interactions among team members as well as their research products. Discovery Logic built ScienceWire® as a data and software platform that integrates and interlinks public and proprietary data on research and its outcomes, including: publications indexed by MEDLINE; publications, conference proceedings, and citations indexed by Thomson Reuters' Web of Knowledge; Federal Research Grants from the National Institutes of Health, the National Science Foundation, the Department of Energy, the Department of Defense, and the US Department of Agriculture; patent applications and issued patents from the US Patent and Trademark Office; and approved drug products from the FDA Orange Book. ScienceWire's integrated architecture makes possible the abstraction of people, organizations and ideas from all these data sources. We demonstrate how ScienceWire can be used to study teams. Team membership can be represented by *direct interactions*, such as joint publication or presentation of research findings, joint leadership on funded research projects, or by joint development of intellectual property such as patents. Membership may also be inferred by *indirect interactions*, such as co-acknowledgement of research funding support when publishing or patenting, or co-citation of research publications or patents. We can create these multiple views of team membership to quantitatively study the dynamics of teams through up-to-date social network analyses of the scientific enterprise or the development of novel metrics to describe collaboration and multi-disciplinarity. When evaluating team science initiatives using ScienceWire, evaluators can easily test different comparison groups to measure distinct aspects of the scientific model, for example, comparing scientific outcomes among single-investigator based research grants and center based research grants. In addition, this system enables the use of metadata from different data sources to paint a more comprehensive picture of entities like people or organizations within the scientific enterprise. ScienceWire can be applied to the study of research team dynamics and to develop methodology and data to inform decision-making and policy development for the Science of Team Science.

Production of Scientific Knowledge in Virtual Organizations

Maria Christina Binz-Scharf* and Leslie Paik**

Research scientists have become increasingly dependent on collaborations across laboratories and organizations to maintain their productivity. Much of the dramatic progress in the basic sciences has been driven by investigator initiated proposals and an entrepreneurial spirit. However, increasing specialization of individual laboratories works against a current drive towards understanding systems, especially for the biological sciences. Consequently, there is a tension between the growing importance of collaborative efforts and the practical and structural challenges in establishing and managing such collaborations in the quest to understand our world.

While there is a growing body of research on the co-production of knowledge in collaborative settings, little is known about how that process happens in collaborations that are established and maintained through *virtual organizations*. Virtual organizations (VO) can facilitate scientific work across time and space but do not eradicate the social aspects (e.g. trust among scientists, institutional limitations, laboratory cultures) to scientific knowledge production. In this paper, we study new generations of scientific knowledge production in one scientific discipline – biology – that has not relied on VOs as much as other scientific fields like physics or engineering. We are especially interested in how the production of scientific knowledge in this field changes as scientists move from traditional face-to-face interactions to virtual collaborations. How does that affect the ways in which biologists craft interpretations of scientific findings? In particular, this paper investigates through ethnographic observations and in-depth interviews what aspects to the scientific work are still based on face-to-face interactions and pre-existing social relationships. It also addresses how the sharing of data, resources and workflow, as promoted by the VO, are shaped by those social factors. In this paper, we focus on the following fundamental questions:

(1) How is scientific knowledge produced in virtual organizations? How do VOs change the actual content and form of scientists' work and the resulting products?

(2) What social and technological factors affect the production of scientific knowledge in these settings and in what ways?

We have chosen a VO in the field of molecular and cellular biology because of its increasing reliance on and previous structural resistance to collaboration. An example of entrepreneurial science at its best, this field has flourished in an environment of investigator initiated grant applications. Indeed, it is the very idea of the independent scientist that has also driven professional development. Collaborations were viewed negatively for promotion unless the young professor could demonstrate scientific independence. However, two factors have fostered greater dependence on collaborations. The first is increasing need for technical innovation for which individual investigators have too narrow fields of specialization. The second is that the field has evolved to a point where a reductionist approach (as promoted by the independent scientist model) is insufficient for understanding the integrated nature of cell function. A new field of systems biology has emerged to explain this complex cell function, relying upon greater collaboration among scientists who have different skills.

Our study is especially insightful because, so far, most of the research on collaboration in virtual organizations has focused on their effectiveness (e.g. how to improve communication and trust among its members) rather than on the process of knowledge co-production. The study contributes to the sociology of scientific knowledge to consider the impact of VOs on the production of scientific knowledge. In addition to advancing theory, this research has important practical implications. By providing a general understanding of how scientists do their work in VOs, our study aims at identifying the conditions under which virtual organizations can enable and enhance scientific production and innovation. These findings will provide helpful guidelines for creating and maintaining productive scientific collaborations.

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Title: Supporting Coordination of Interdependent Work: A Network Representation of Dependencies in Innovative Engineering Research Teams

Authors: Laura Dabbish (Carnegie Mellon University), Jim Herbsleb (Carnegie Mellon University), Patrick Wagstrom (IBM Research), and Anita Sarma (University of Nebraska, Lincoln)

Objective: Develop network representation of interdependence in innovative engineering research teams to support project management and drive coordination technology.

Abstract:
Innovative engineering research involves experimentation, iteration, and rapid change. Task details are not necessarily known in advance and coordination requirements are highly volatile. Engineering research teams coordinate based on flows of information, experience rapid change, often cross organizational boundaries, and require adaptive capacity. Coordinating activities in these types of teams is a major challenge because their work can be highly interdependent, dynamic, and non-routine. To support collaboration in these teams, we need a detailed and flexible understanding of interdependent work and how dependencies can be successfully managed in innovative engineering research projects.

Current theoretical views of coordination have two shortcomings for describing dependencies in innovative engineering research work: First, they tend to focus on relatively stable, enduring patterns of dependencies in organizations. This is helpful for purposes such as organizational design in traditional, bureaucratic organizations, but is less helpful in understanding how to support non-routine intellectual work, in which coordination requirements are highly volatile. Second, current theories of coordination do not provide enough detail about the underlying connections between work tasks, and how these dependencies influence collaboration. Neither do they give sufficient insight into how to coordinate work in highly volatile environments typical of engineering research projects.

In this work, we propose a theory of coordination that represents work in an engineering research project as a network of linked design components that are mutually constraining. In engineering research, work progresses by making decisions about the contents of a design. In this representation, the components of an engineered design are interdependent, i.e. linked in a decision network, when they are involved in the same decision. The properties of this *decision network* determine the impact that the actions of one worker completing a task can have on the tasks of other workers. These impacts must be accommodated appropriately so that all tasks can be completed successfully. The need for this specific accommodation, as described by the network, is what we call the “coordination requirements” for the work. Coordination activities, in our theory, are actions that workers perform specifically to manage, address, and satisfy the coordination requirements. This networked approach provides benefits over traditional theories of interdependence because it is flexible, describing dependencies that do not fit into existing typologies and describing change over time, and it is fine-grained, and so can support coordination activities at the design element level.

We use observational data from a robotics engineering research project to illustrate several properties of decision networks that we have observed to impact the effectiveness of coordination activities. These include modularity, characteristic path length, and degree distribution which predict propagation of design changes across the network and describe design complexity. We discuss how the concept of decision networks is general enough to represent many kinds of work, extending our understanding of coordination and advancing computer-supported collaboration technologies. Technology that supports coordination of non-routine work should be able to 1) predict and measure coordination requirements and 2) understand what coordination activities and tool support are needed for any given set of coordination requirements or dependency patterns. Our work begins to address these issues.

Title: A Comprehensive, Mixed-Methods Evaluation of the Interdisciplinary Research Consortium on Stress, Self-Control, and Addiction

Author: Jacob Kraemer Tebes, Ph.D., Nghi D. Thai, Ph.D., Samantha G. Matlin, Ph.D., Emily C. Cook, Ph.D., Roy S. Money, M.S., Carolyn Mazure, Ph.D., & Rajita Sinha, Ph.D., Yale University School of Medicine

Purpose: This poster summarizes early findings from an evaluation of an interdisciplinary research consortium that illustrate emerging trends in interdisciplinary team science, and the implication of team science for policy.

Over the past 50 years, a growing body of research has shown that contributions and innovations in science are now more commonly produced by research teams, and that team-authored publications have a greater impact on science than those produced by individuals (Wuchty, Jones, & Uzzi, 2007). In addition, research conducted in teams increasingly consists of researchers from different disciplines, thus promoting a trend toward interdisciplinary team science (Kessel, Rosenfield, & Anderson, 2009). Interdisciplinary team science enables researchers to address complex biomedical and public health challenges more rapidly and effectively (Abrams, 2006; Kessel et al., 2009).

Currently, the National Institutes of Health, through the Roadmap Initiative, funds nine Interdisciplinary Research consortia (IDR) that utilize interdisciplinary team science to address a variety of health and biomedical challenges. The largest funded NIH consortium, the Interdisciplinary Research Consortium (IRC) on Stress, Self-Control, and Addiction (Sinha, 2007) involves more than 60 scientists at Yale University, the University of California-Irvine, and Florida State University. The consortium includes ten interdisciplinary scientific project teams, two P30s, and a Research Education program (R25) explicitly designed to facilitate interdisciplinary team science and to translate findings from research into practice and policy. The consortium is comprised of researchers from such diverse disciplines as psychology, neurobiology, psychiatry, genetics, health policy, chemistry, pediatrics, economics, and cardiology, and examines three major types of addiction: smoking, drinking, and overeating using both human and animal models. Currently, the IRC is the only consortium among the nine to fund a rigorous, longitudinal, and comprehensive evaluation of the processes and outcomes of interdisciplinary team science as part of its initiative.

This poster session summarizes some of the early empirical findings from this evaluation (Tebes, 2009). It includes: depiction of an a interpersonal process model of scientific innovation in team science and empirical data to support the model; longitudinal social network analyses of participating scientists; and empirical data on team and affective climate, satisfaction with the consortium, collaborative activity, scientific innovation processes, and scientific productivity. Also included are examples of recent Science-to-Policy Briefs produced through the consortium for scientific and professional audiences.

Laboratree – A Web-based Platform for Team Research Collaboration

Jack H. Pincus, Jamison R. Hemmert, Joy A. Nellis, Brandon, J. Peters, and Sean D. Mooney
Selican Technologies, Inc., Indianapolis, Indiana and Buck Institute for Age Research, Novato, CA

It is challenging to enable life sciences team research. With the recent rise of Science 2.0 web-based tools, many Internet technology-based solutions have been proposed including wiki's, document management systems, and custom websites. We are developing Laboratree as new web-based team research collaboration platform. Laboratree is not a Facebook for scientists or other social networking site. It is a secure platform that enables collaborative document and data management, centralized authentication using OpenID, and application exchange using Google's OpenSocial. It supports open source and open data standards. We are working with the Indiana CTSI, an NIH funded Clinical and Translational Science awardee to evaluate the needs of collaborating teams for enhancing Laboratree. We believe our approach to a web-based collaboration platform designed for the needs of life science research teams will enhance collaboration by providing a common platform for projects, improving communication, and increasing the efficiency of data and information exchange.

Interrelationship of cognitive and social conflicts in team-based design classes

Xaver Neumeyer[1], Ann F. McKenna[1]

[1]Department of Mechanical Engineering, Northwestern University

NORTHWESTERN UNIVERSITY

Motivation

Our research seeks to investigate team conflict and its impact on team performance metrics such as final design, quality of ideas as well as how it interrelates with learning goals. In particular, we were interested in determining the most common types of team conflicts among students as well as the conflict management strategies they implemented.

Results

We found that different levels of commitment, different ideas about the project direction as well as different working styles are among the most common team conflicts (see **Fig. 1**). Furthermore, did we find that students intuitively utilize design process tasks such as Prototyping to convert their social conflicts into more productive intellectual conflicts. Therefore, could we extract a variety of regressive and progressive conflict management strategies used by student team members (see **Fig. 2**) .

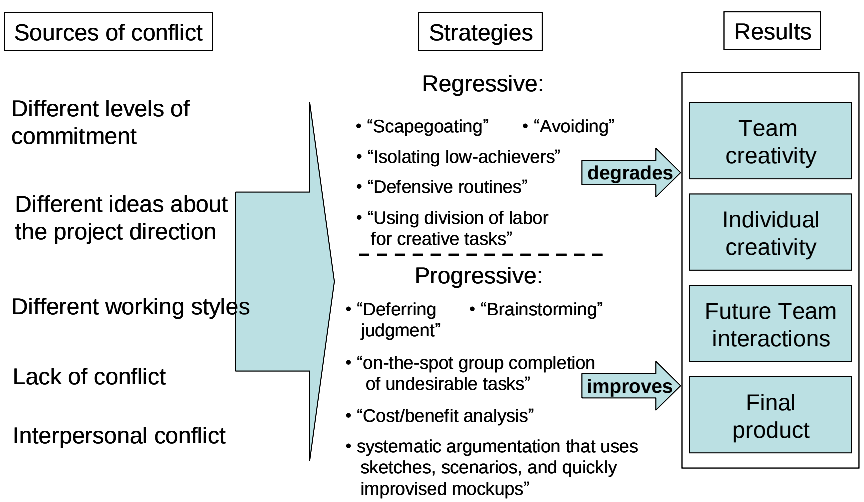
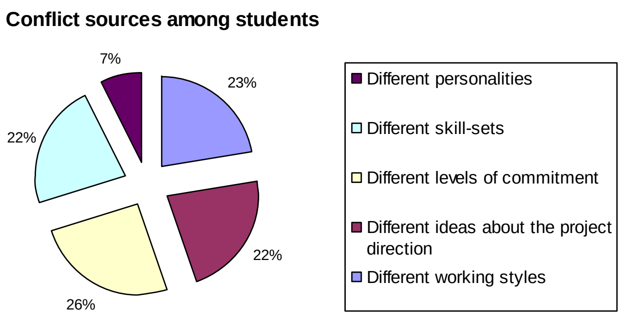


Fig. 2 Summary of conflict sources and student strategies

Data sets

Our study included in- as well as out-of-class team observations, student and faculty surveys as well as faculty interviews. Engineering design courses of all seniority levels were utilized (freshman to Ph.D.)



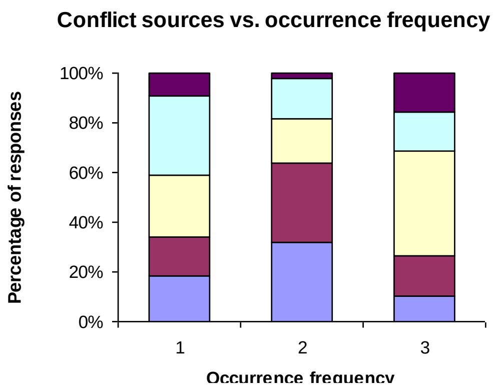


Fig. 1 Sources of conflict vs. occurrence frequency

Data Driven Analysis of Interdisciplinary Research Teams

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Background: The 21st century research workforce is expected to consist largely of collaborative teams with cross-disciplinary expertise. Understanding how social dynamics contribute to collaboration mechanisms will thus be important for initiating and maintaining effective interdisciplinary research (IDR) teams. Research on interdisciplinary teams in other settings suggests predictable strains may stifle creativity and productivity , and that these factors may include: disciplinary "silos" that control tenure and other rewards (Gross 2008); miscommunication due to differences in status and the jargon of disciplines (Farrell et. al. 2001); top-down recruitment of members by administrators, including risks of overbearing team members (Sutton 2007); work coordination problems due to disciplinary differences in the timing of cycles of work (Farrell 2007); inequitable distribution of thankless tasks and credit for work on publications, breakthroughs, etc. (Farrell 2003).

Objective: This project studied IDR teams in field settings from the perspective of researchers within such groups to determine how their social dynamics influence success. Questions posed were:

- Which types of teams are best positioned to generate "revolutionary" innovations in method or theory?
- What types of IDR collaborations are more likely to generate "normal science", efficiently generating routine output but not much that could be classified as breakthroughs or creativity?
- How are informal roles within teams and discipline networks implicated in successful IDR work?

Methods: An online survey (6 open-ended questions) of research faculty (N=201) was supplemented by intensive interviews with interdisciplinary researchers (N=42) at two research-intensive universities, to identify catalysts and barriers to effective interdisciplinary collaborations. Survey responses and interview transcripts were organized, categorized and coded in an iterative process using grounded theory techniques and *ATLAS.ti* qualitative data analysis software to identify main and subthemes, as well as to identify patterns that support theoretical contributions and conclusions drawn from this phase of the pilot study

Results and Conclusions: Our data suggest that the most effective IDR groups grow organically through series of informal relationships that select out most individuals who behave (as Sutton (2007) famously terms them) like "assholes" and thereby create safe havens for collegial individuals to pursue creative activity. The informal selection process increases opportunities for group members to develop trust and mutual respect, making the clashes of ideas that inevitably arrive from different cultural and disciplinary perspectives a process that can yield creativity rather than rancor or competition.

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Characterizing and Assessing Research Groups: A Self-organizing Approach

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Throughout the last decades, tightening budgets and an increasing competition between research projects, combined with a higher awareness on the outputs of science, have stimulated the development of new approaches towards the evaluation of science. Despite an important evolution, these assessments have a critical limitation: the boundaries of the unit of analysis are typically rigid (e.g by institutions or departments), overlooking the unique and self-organizing characteristics of the research endeavor This means, for example, that present techniques have difficulty noting differences between low and top performing groups within a focal unit, say a university or even a department within a university. This renders a comparison based on average levels of productivity or impact for an area of limited value and potentially misleading.

Simultaneously, the social network analysis (SNA) area has developed several community structure algorithms that identify groups within a network by dividing a network into communities of nodes with dense connections within these groups and looser connections to other groups (e.g. hierarchical clustering, edge removal or clique percolation algorithm). While useful, these methods are typically developed to be able to encompass and compare a variety of networks. Thus, they assume that all networks have similar structures and the communities that arise are formed through the same mechanisms.

To overcome these limitations, we developed and tested a method characterize and assess research groups (RG) that recognizes the endogenous, or self-organizing characteristics of the research endeavor. Instead of an ad-hoc definition of the unit of analysis and an unspecified networks structure, the proposed method uses co-authorship network groups centered around lead scientists and the specific body of knowledge that these collaborations entail to identify the frontiers of the focal units, as well as other units that qualify as relevant benchmarks;. First, the Principal or Lead Investigators and all their direct collaborators in a co-authorship network are identified using the notion of Cohesive Groups, a method used in Network Analysis for subgroup identification. Second, the boundaries of a RG are defined based on a two-stage rule of co-author and, if necessary, institution commonality. Third, we use backward citations found in the papers published by each group to establish its 'knowledge footprint' (KFP). These footprints are used to evaluate the degree of structural similarity between groups, i.e. the similarity between RGs is to be defined by how much their work cites common papers/journals. Once the RGs are characterized and their peers identified, we measure and compare the performance/productivity of each RG.

The method is demonstrated by characterizing and assessing groups in the areas of Physics, Applied Physics/Condensed Matter/Materials Science and Optics in Mexico for the period of 1990 to 1999. Results show that the proposed method accurately mimics how scientist self-organize into collaboration groups and produces more stable outcomes (i.e. groups), when compared to other (community structure) algorithms. In addition, the results suggest that the performance of universities within and across institutions is quite heterogeneous and the relative ranking of these organizations is highly dependant the unit of analysis. Thus, moving away from institutional boundaries and into RG in the assessment effort presents a much more accurate and complete perspective on the research impact. Furthermore, using the KFP we find that each group has one or two relevant peers, suggesting that system is really small.

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Title: nanoHUB: The Evolution of a Team Science HUB
Authors: Dr. Michael Beyerlein and Pamela Morris (Purdue University)
Purpose or Objective: Profiling nanoHUB as an evolving science gateway supporting knowledge generation

Today's science teams are composed of complex relationships that cross organizational and physical boundaries. Both for convenience and necessity, researchers are using electronic resources to connect with one another and perform work. State-of-the art cyberinfrastructures are being used as places for science teams to meet and share. For example, since 2002, the nanoHUB has been used by nanotechnology researchers to build and share simulation tools, develop and distribute nanotechnology curricula, and meet and work online.

As predicted by theories such as socio-technical systems and adaptive structuration, technologies and the people using them are not static. How and why cyberinfrastructures change over time reveal important lessons relevant to future development of team science online. Over its history, nanoHUB has evolved from a passive technology that enabled a deposit-and-retrieve paradigm to a one that more actively encourages interaction and collaboration. Our poster will present a timeline of the specific tools created during nanoHUB's evolution and juxtapose the processes and mechanisms that we propose are at work in this evolution. These processes include the development of trust, the building and shaping of culture, adaptations to changing audiences and goals, and the results other disciplines adopting the HUB cyberinfrastructure.

This research is part of an NSF-funded Virtual Organizations and Sociotechnical Systems (VOSS) project at Purdue University and the University of Michigan. The research team is studying electronic collaboration of researchers who are geographically distributed but focused on the same intellectual challenges. The goal of this project is to understand the degree to which websites used as science gateways, generate new intellectual capital; the technical and social features of the sites that support knowledge generation; and the conditions needed to improve design choices for the expansion and creation of science gateways. Findings from this study will contribute to a small but growing body of literature that will help to optimize science gateway design and use.

Title: COALESCE: **C**TSA **O**nline **A**ssistance for **LE**veraging the **S**cience of **C**ollaborative **E**ffort*

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Solutions to complex problems in the health sciences require teams of specialists from diverse backgrounds working across the boundaries of disciplinary silos. The COALESCE project aims to create, evaluate, and disseminate new, durable, readily accessible on-line learning resources to enhance skills needed to perform transdisciplinary, team-based translational research. Young trainees need help envisioning how transdisciplinary collaboration can work and overcoming the inevitable communication challenges that arise when working in multidisciplinary teams. To address this need, we have launched a two-year process (9/30/09 - 9/29/11) to develop four learning modules. Module 1, “The Science of Team Science” introduces key concepts, findings, and principles of team science by showcasing interviews with experts. Highly interactive Modules 2-4 will enable trainees vicariously to experience creative transdisciplinary opportunities and work through challenges unique to conducting team science in different research contexts. The modules provide case-based exposure to the team science research process in behavioral medicine (Dr. Spring: technology-supported intervention to reduce multiple risk behaviors); basic medical science (Dr. Woodruff: discovery of ways to preserve fertility in cancer); and clinical medical science (Dr. McDermott: intervention to prevent mobility loss among frail, elderly adults). Learners will explore disciplinary vocabularies and assumptions, establish communication and role relationships, and resolve conflicts in the e-learning environment created by award-winning Noggin Laboratories.

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Understanding the Structure & Function of Multidisciplinary research Teams Using Complexity Science Theory

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Objective: Building multidisciplinary research teams (MDRT) to synthesize and translate knowledge from laboratory and/or clinical investigations into clinical applications has emerged as one of the major themes in the NIH Roadmap initiative. Our objective is to examine researchers' views and attitudes towards working in MDRT through the lens of complex adaptive system (CAS) theory. MDRTs are CAS, comprised of diverse individuals [agents] who can learn, interconnect, self-organize, and interact with their environment in a way that demonstrates non-linear dynamic behavior.

Method: Semi-structured interviews were conducted with 23 (64% females) researchers working in different departments at UTHSCSA and UTSA. About 34% were Mexican Americans or None Hispanic White and 30% identified themselves as Asian Americans. The average age of the enrolled participants was 39.5 (range: 35-50 year-old) and approximately 72% of those enrolled were junior faculty; 18% were senior faculty and 10% have recently transitioned to tenured faculty. Semi-structured interviews focused on three main topics: (1) collaborative readiness as expressed by the presence of interpersonal, environmental and organizational factors that led to team formation across various research domains, (2) team functioning as articulated by leadership styles, communication networks and conflict resolution strategies and (3) facilitators and barriers to MRTD work. Interview materials were tape-recorded, transcribed and content analyzed using qualitative methods.

Results: All participating researchers perceived working in MDRT as an important endeavor to advance science and improve human health [agents who learn]. Most of the ongoing collaborations (85%) reported in this study started with researchers who knew each other or who were introduced by close colleagues [agents who interact]. The majority of participants (80%) agreed that leadership inclusive styles play a major role in enhancing the work of MDRTs by putting together a group of researchers from different backgrounds [diverse agents], setting goals, delineate responsibilities, providing direction and creating good working environment [agents who interact with their environment]. The latter often included the leader's responsibility of managing and preventing conflict among the team members. All participating researchers indicated that leadership is not a "person" but it is an institution to ensure the success of MDRTs. In addition, participants pointed that being able to work in an environment that fosters the formation of long lasting professional relationships is highly valuable. Trust, open and frequent communication was perceived as crucial for the success of team research.

Most researchers (70%) identified several external and internal barriers to working in MDRTs. A common challenge faced junior faculty who came from other institutions is finding potential mentors and collaborators at UTHSCSA. Conversely, for those who obtained their highest degree at UTHSCSA, a challenge is to have the opportunity to network outside the institution. Additional barriers included: (1) finding potential collaborators in behaviors sciences [agents who learn]; (2) lack of opportunities for networking and effective communication [agents who interconnect], (3) lack of funds/protective time, (4) inadequate institutional support, and (5) modest valuation of MRTD collaboration. Although this type of collaboration can fulfill several institutional needs, the rewards of this type of collaboration are unclear. Because there is no immediate career benefit, teams formed for this purpose tend to be loose and unstable [self-organizing, non-linear properties].

Conclusion: Our findings highlighted several opportunities and challenges related to the formation of and collaboration among MDRTs. Viewing MDRTs as CASs will help in leveraging these opportunities and addressing the challenges. Our work contributes to the current efforts aimed at fostering translation research to improve human health.

A Study of Communication Technology Configurations in Virtual Research Environments

Iftekhar Ahmed[1]

Virtual Research Environments (VRE) are electronic meeting places for interaction among scientists created by combining software tools and computer networking. Currently, our knowledge about VRE-based scientific communication and what makes it effective is relatively immature in terms of understanding technology (interface, architecture, and software evaluation), system management (software systems, visualization, scalability), knowledge bases, expert systems, and coordination. Moreover, we do not have a comprehensive classification scheme for virtual research environments primarily from a technological viewpoint. This study provided an analysis of VRE from a technological standpoint and developed a conceptual model that identified factors facilitating collaboration effectiveness with a primary focus on technology. VRE portals were at the core of the investigation as they are the entry points for VRE related information and resource access. The study developed a methodological framework for characterizing VREs, applied that framework to examine and classify existing VRE systems, and developed a new classification. Thirty one VREs from physical, natural, and biological/biomedical sciences domains were examined. Study results show that the technological arrangements of the VRE neither depend upon scientific discipline nor the existing functional typology. Results identified a correlation between communication and collaboration technologies and VRE effectiveness. However, the study suggests that there is lack of sufficient communication and collaboration technologies within the VRE systems. In order to develop efficient systems, VREs should rearrange their technological configuration with more communicative/collaborative features.

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Formalized Co-Mentoring During Research Training: Impacts on Development of Professional Skills Essential to Research Teams

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Research Question: "How should classical training and development of young scientists be changed to prepare them for the larger and more complex research team?"

Biomedical research has evolved dramatically over the past decades from a predominance of individual Principle Investigator (PI)-led research groups, to collections of groups working more closely and collaboratively together in expanded teams. With the growth of collaborations there is a substantial increase in the need for PIs and team members to interact with a wider range of scientific expertise and knowledge. Many PIs are becoming less of a 'captain of a ship' and more of a 'mediator' among other captains and team members. For both PIs and other team members, different skills are needed to: negotiate priorities; understand and interpret data from more techniques and disciplines; see different ways of accomplishing a goal rather than defending their way; and managing a wider ranger of personalities and backgrounds. However, the traditional approaches to preparing young scientists for these new roles have been slow to change. Young scientists typically still learn how to do research by working with one research mentor at a time, learning from and adapting to that individual's way of doing science. It would seem logical that introducing young scientists to the way research is conducted in larger more complex teams should occur as early in training as possible.

The poster will describe a research study of PhD students conducting dissertation research in the NIH intramural facilities through the Graduate Partnerships Program (GPP). A high fraction of these students are required to, or spontaneously establish, structured co-mentored dissertations with two or more research mentors. In most cases, at least one co-mentor is an NIH scientist and one is a university faculty member. The co-mentored experience was effectively designed and managed to minimize potential complications and conflicts that can arise in any research collaboration. In many ways, the experiences of the co-mentored graduate students mimics their future lives in research teams more closely than the classical individual mentor model. The study used structured interviews with over 100 students and qualitative research methods to identify patterns of similarities and differences among students in single and co-mentored dissertations. It was a one-time snapshot of their experiences up to the time of the interviews, not a longitudinal or outcomes study. The magnitude and nature of the impacts of co-mentoring were quite dramatic, even at the early phases of the PhD training. The co-mentored training experiences appeared to: promote especially rapid professional growth and independence in scientific thinking and conduct of research; fostered development of skills related to collaboration and negotiation; helped students to learn more than one discipline, especially through participation in lab meetings of different research groups; provided students with multiple groups of professional colleagues/networks; and aided the development of communication skills. In summary, the study provides evidence for the positive value of expanding the direct involvement in research collaborations across research teams to students in early phases of training. It would seem logical the same would hold true for postdoctoral fellows as well. The study also showed that at least some PhD students are very ready to begin developing complex interpersonal and team management skills at a younger age than might be expected.

A full report of this study has appeared: http://www.lifescied.org/cgi/content/full/6/2/119

VIVO: Facilitating Collaboration by Developing a National Network of Scientists

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VIVO Collaboration: Consortium participants

Scientists work in increasingly interdisciplinary ways, but often face challenges in finding potential collaborators. Their institutions also struggle to effectively represent the nature of their research and teaching activities, both internally and to the outside world. VIVO (not an acronym) is an ontology-based system that applies Semantic Web technologies developed at Cornell University in 2003 to meet these individual and institutional research discovery needs. In 2009, Cornell and partner institutions the University of Florida (lead), Washington University in St. Louis, Indiana University, Ponce School of Medicine, Scripps Research Institute, and Weill Cornell Medical College were awarded $12.2 million by the National Institutes of Health to enhance and expand VIVO into a national network of researchers that facilitates inter-institutional connections and collaborations.

VIVO supports faceted searching for quick retrieval of people, organizations, activities, events, and more research-related information. Scientists use VIVO to find collaborators, and keep abreast of activity in their field of research; students use VIVO to find mentors or collaborators, and will soon be able use it to showcase their work and maintain professional profiles; administrators use it to find area or geographic expertise, encourage inter-disciplinary collaboration, and facilitate or create funding opportunities; funding agencies or donors use VIVO for targeting giving, or to locate individuals with specific areas of expertise (for review panels, for instance).

Institutions can participate in the national network either by implementing VIVO, or by providing semantic web-compliant data from the platform of choice. Institutional implementations will be controlled and—due to the ontology-based nature of VIVO—customized locally as needed. Multiple independent instances of VIVO will be interlinked to support cross-institutional discovery and networking. This active networking across diverse institutions will be facilitated via a cross-site search engine as well as through exploration tools employing network analysis and visualization.

Independent VIVO instances will be maintained largely through automated data ingests from a variety of sources including faculty reporting systems and human resources, course, grants, and publications databases. Although individuals will be able to log in and modify their VIVO profiles using local authentication procedures, VIVO's data ingesting capability provides rich profiles while minimizing the need for scientists to enter information manually. Apart from the automated ingest, networking, and visualization features already mentioned, VIVO will also offer a one-button biosketch generation capability, as well as the possibility to re-purpose or share data (via web services, for instance) with other web pages or consumers.

Title: Studying Teams from the Inside Out: A Computational Analysis of Meeting Transcripts

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Abstract: Teams, committees and other decision-making bodies composed of experts are critical for making scientific and technical decisions. The complexity of the context surrounding these decisions requires that knowledge is pooled from multiple specialists. The success of these pooling efforts is often impacted by social dynamics. For example, decision-makers are typically embedded within a web of existing social relations. Taken as a whole, these relations define an implicit social structure which can influence the decision outcome. One aspect of this structure is founded on interpersonal affinity between parties to the negotiation, and on the recognition of status characteristics, such as domain expertise. Other examples include group-think, strategic behavior, procedural bias, and institutional loyalty. These dynamics are not well-understood, particular among real-world expert bodies. This is largely due to a lack of methodology for directly studying such interactions in real-world situations. This poster presents a method for the analysis of transcripts of expert team and committee meetings using meeting transcripts as a data source. The goal is to uncover social dynamics of the sort described above. In particular, we focus on medical device advisory panels in the US Food and Drug Administration; nevertheless, the approach presented here is extensible to other domains and requires only a meeting transcript as input. The method is based upon natural language processing tools and is designed to extract directed social networks from these transcripts that are representative of the flow of information and communication on the panel.

Preliminary results demonstrate that the method presented here can identify groups of decision-makers with a contextual affinity (i.e., membership in a given medical specialty or voting clique), can extract meaningful status hierarchies, and can identify differing facilitation styles among committee chairs. In particular, application of this method to a set of 37 meetings from the FDA's Circulatory Systems Devices Panel shows the presence of numerous social dynamics. Prominent among these is the propensity for panel members from similar specialties to use similar language. Furthermore, panel members who use similar language vote similarly. We find that as panel members' language converges by medical specialty, panel members' votes also tend to converge. This suggests that voting behavior is mediated by membership in a medical specialty and supports the notion that voting outcome is, to some extent, dependent on an interpretation of the data associated with training. Furthermore, there is some preliminary evidence to suggest that, as data ambiguity increases, the strength of the mediating effect of medical specialty decreases. Finally, we find that voting outcome is associated with the order in which panel members are allowed to ask questions, such that members in the preference minority are more likely to ask questions later than are members in the preference majority. Preference minority members are also more likely to be graph sinks than are majority members suggesting an influence mechanism on these panels that might be associated with framing – i.e., minority members seem to be less able to convince other panel members to discuss their topics of interest. These results suggest the presence of non-negligible social dynamics that may have some relation to FDA panel procedures and structure. Finally, we present a preliminary computational model that embodies a theory of panel voting procedures. Model results are compared to empirical results and implications are drawn for design of teams and committees of experts.

Virtuality and Information Sharing in Teams

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With their broader pool of cognitive resources and task-relevant knowledge, teams are at an advantage compared to individuals in their potential to reach quality solutions to complex problems. However, when teams fail to effectively share information, their performance can be compromised (Mesmer-Magnus & DeChurch, 2009). One factor which may affect information sharing is team virtuality. We meta-analytically cumulate findings from 90 independent studies to explore the impact of three aspects of team virtuality: (1) extent of reliance on virtual tools as well as the (2) informational value and (3) synchronicity afforded by these tools (Kirkman & Mathieu, 2005) on information sharing. We determine the extent to which virtuality affects team information sharing, and then test virtuality dimensions as moderators of the information sharing - team performance relationship.

Our results suggest previous discrepant findings regarding the role of team virtuality may be a function of the differences in levels of virtuality in the focal teams. Specifically, virtual tools that result in interactions similar to those that would occur in face-to-face teams have fewer advantages and more disadvantages than highly virtual tools. We find more information sharing occurs in highly virtual and face-to-face teams than in low virtuality teams. Our findings also support previous research which has suggested that it is important for virtual teams to meet in person periodically; these hybrid teams tend to develop more efficiently and benefit from faster and more effective conflict resolution as well as greater team satisfaction and cohesion (Alge et al., 2003; Martins et al., 2004; Strauss, 1996). We also find that virtuality moderates the information sharing – team performance relationship. Specifically, this relationship is stronger in face-to-face and low virtuality teams than in highly virtual teams. Further, open information sharing is more crucial in highly virtual teams than in their less virtual counterparts. We elaborate on reasons for these differences as well as discuss profitable directions for future research in our presentation. In sum, our results support Kirkman and Mathieu’s (2005) assertion that team virtuality is a matter of degree and not a dichotomy.

Interactional Expertise: A Research Agenda

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A common obstacle to multi- and interdisciplinary Team Science is the inability of scientists to communicate across disciplines. This problem is even more acute when scientific teaming is being driven by outside forces (e.g., changes in funding priorities). One tool for addressing this problem may be Interactional Expertise. Interactional Expertise is a concept developed out of the work of Harry Collins and his research group in Studies of Expertise and Experience (SEE). Interactional experts have considerable discursive expertise in a specialized domain without having acquired the practical skills required to make contributions that advance that domain. Key to understanding Interactional Expertise is appreciating it in relation to Contributory Expertise: Contributory experts learn to make contributions to a given field by accruing hands-on experience through physical immersion in a form-of-life (and in the case of scientific disciplines, through formal training). Interactional experts, by contrast, learn about a field by talking with the people who have acquired contributory expertise. Nevertheless, interactional experts are people who are so skilled at "talking the talk" of a field outside of their specialization that their ability can be characterized as the capacity to "walk the talk!"

Research has isolated interactional expertise as the skill that permits someone to learn to speak a specialist language: to see the world from a specialist's perspective and even make jokes and raise devil's advocate questions that revolve around ideas typically known only to specialists in a field – without actually becoming a "contributory expert" oneself. The central element is the acquisition of tacit knowledge that operates in a domain and the ability to absorb that knowledge solely through dialogue. Interactional expertise has been identified in a wide range of individuals working effectively in multi- and interdisciplinary settings, including, for example, Gary Sanders, Director of the Thirty Meter Telescope Project. Individuals with interactional expertise enhance collaborative dialogue in multidisciplinary teams by fostering the development of *trading zones* and other techniques for effective cross-disciplinary conversation.

The specific area of interactional expertise that we are researching is the knowledge gap that exists regarding how Interactional Expertise develops. Our current plans include: Designing and conducting a series of studies that explore *how interactional expertise develops.* Our current agenda has two focal areas: 1) whether stages of development can be discerned; understanding what kinds of tacit knowledge are passed via dialogue, and how that knowledge is absorbed; identifying whether successful interactional experts share common background characteristics (intellectual, social, temperamental, linguistic, etc.). And 2) exploring whether the transfer of tacit knowledge can be accelerated. For example: if elements of tacit knowledge are made explicit and then transferred to students, do these elements of knowledge operate in the students in the same ways tacit knowledge absorbed through immersion and socialization does? Exploring whether there are differences in the ways in which interactional expertise operates or in the kinds of discussion and judgments that interactional experts can make across different disciplines or areas of expertise. We will be hosting an NSF Workshop in August in Berkeley to further develop this agenda.

Advancing the Science of Evaluating Team Science Outcomes: The Research on Academic Research (RoAR) Initiative: Part 2: Social Network Analyses

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Background: In 2006 the University of British Columbia opened the Life Sciences Institute (LSI), the first building of its size at UBC to be developed to support cross-disciplinary bio-sciences team research. The Research on Academic Research (RoAR) initiative was initiated in 2007 to serve as a platform for conducting exploratory research and evaluation of the effect that co-location of previously disparate researchers and institutional policies have on the organization and output of scientists.

Objectives: To employ differing evaluation methodologies to determine the outcomes associated with the re-organization of the scientists from academic department buildings into integrated problem-based research groups.

Methods: An evolving, longitudinal multi-method study design has been employed to support the development of a core set of indicators used to assess impact of collaboration. These include:

- Part 1: Survey of LSI investigators and trainees that included two core components: Social-behavioural measures of attitudes, knowledge, collaborative skills, and perceived benefits and risks associated with various models of research;
- **Part 2 : Measures of social network size, shape, density and composition;**
- Part 3:Use of bibliometric data examining publication patterns (# citations, journals, journal types, relative prestige of journal) using searches of major databases;
- Part 4: Grant application review to explore the submissions and outcomes associated with research since joining the LSI
- Qualitative interviews with team leaders and key members of the LSI networks (planned)

Primary data was collected from principal investigators each year,. The survey was administered using a Web-form followed by pencil and paper version using a modified Dillman approach. In the 2009 wave of surveys, 153 participants completed the survey. All other data was collected using administrative files and databases at the University of British Columbia.

Results:
Using a baseline results, we have seen an increase in the absolute numbers of collaborations happening within the LSI. While overall network density has increased and the frequency of inter-departmental and inter-research group has likewise grown, the number of such increases suggest a developmental and slow growing process rather than one that grows quickly, as seen in other social network applications. The first wave of collaborations tend to be focused on building interactions, with a slower growth in the sharing of resources second and the development of joint research seen as the slowest evolving process in the typology used. We also approached the question of perception using a network model approach and found that within the LSI. Biochemists were seen as integrators of science in the area of life science research.

Conclusions: Taking the Donabedian model of Structure-Process-Outcome after four years the researchers in the Life Sciences Institute show significant alterations in the Structure and Process areas with the outcome area, in this case, patents and commercialization, not being affected at this time. Consideration of specific interventions at the level of the LSI to support translational research could address this deficit.

Title: A toolbox-based approach to negotiating philosophical differences within cross-disciplinary research groups.

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Narrative Abstract:

Many current scientific problems require complex, cross-disciplinary approaches. However, successful projects can be hampered by several factors associated with discipline-specific traditions. While many of these factors are relatively apparent, e.g. disparate spatial and temporal scales of collaborating disciplines, differences arising from the philosophical underpinnings of science are largely unexplored in studies of cross-disciplinary research (CDR).

The practice of science depends on philosophical assumptions about the nature of the world and ways of knowing about it, impacting disciplinary views of issues such the validity of qualitative versus quantitative data, or reductionist versus holistic methods of study and inference. Such philosophical differences among disparate disciplines can be substantial and, if not recognized, can interfere with effective and creative science by collaborative teams.

We seek to enhance efficient and effective communication across disciplines through increased awareness of this philosophical dimension, gained through structured dialogue among collaborators. Our approach uses a set of guiding questions—the "Toolbox"—in workshops to encourage that dialogue within research teams. The Toolbox is organized into "core" questions within two main philosophical dimensions of scientific thought (Epistemology and Metaphysics), and "probing statements" that focus on more detailed ways of articulating these issues.