Observations of the Lifecycles and Information Worlds of Collaborative Scientific Teams at a National Science Lab

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ABSTRACT

Team-based scientific collaborations play a key role in the discovery and distribution of scientific knowledge. In order to determine the social and organizational factors that help support a scientific team's successful transition from short-term experiments to long-term programs of ongoing scientific research, this study used observations of teams conducting experiments at the National High Magnetic Field Laboratory to determine what teams actually do during these experiments. As part of a larger, ongoing research project using mixed methods, our findings describe the scientific culture of hybrid teams at work, and demonstrate how multiple, overlapping, and nested lifecycles and information worlds play an important role in promoting successful and continuing scientific collaboration. The boundaries between worlds and efforts to span them are particularly important, requiring greater attention. Our future research will develop a model including these factors and add further practical and theoretical implications to those we have already identified.

Categories and Subject Descriptors

K.4.3 **[Computers and Society]**: Organizational Impacts – *computer-supported collaborative work, employment*.

General Terms

Human Factors, Theory.

Keywords

Scientific collaboration, observations, teams, lifecycles, information worlds, mixed methods, virtual organizations.

1. INTRODUCTION

Scientific work, once focused around the efforts of individuals, is now driven by team-based collaborations [14]. Given the importance of teams in the discovery and distribution of scientific knowledge of importance to society, many researchers are studying collaboration and the range of contextual factors—technical, organizational, and social—that play a role in the culture and practice of collaborative work [6, 10]. An important research question, of interest to funding agencies and science labs, centers on determining the social and organizational factors that best support the continuation of collaborative scientific projects, and in particular their successful transition from short-term experiments to long-term, collaborative research programs.

This study intends to answer this question by studying scientific teams conducting experiments at the National High Magnetic Field Laboratory (NHMFL) in Tallahassee, FL (http://voss.cci.fsu.edu/). Building on our prior research applying social network and citation analysis to study the relationships between publication productivity, team diversity, and citation counts of teams [7, 8, 15, 16], we conducted observations of scientific teams in action to gather a rich, descriptive picture of what actually happens while teams are conducting experiments at the NHMFL. This poster reports on the procedures we developed for conducting these observations, our quantitative and qualitative findings so far, and their implications for both scientists and scientific collaboration researchers.

2. BACKGROUND

The NHMFL is the largest and most powerful magnet laboratory in the world. Over 900 scientists a year use its magnets to run a variety of experiments, applying diverse knowledge in physics, chemistry, biology, engineering, and other related and cognate fields [1]. NHMFL scientists coordinate with visiting scientific teams and provide assistance before, during, and after experiments. Given the highly complex and interdisciplinary nature of the research taking place at the NHMFL, collaboration increases the chances of a successful experiment.

Collaboration is important to science and the scientific community, particularly within physics and its subfields [2]. Scientific projects are increasingly complex, large, and specialized [6], and scientific collaboration allows teams to pool their knowledge and expertise, increasing their chances for reliable findings and wider acceptance within the broader scientific community [14].

Collaboration generally increases scientific productivity, although other characteristics also play important roles [3, 6, 12, 16]. Many social, technical, and organizational factors can influence the lifecycles of scientific collaborations and their success or failure [4, 5, 11, 13, 14]. More research is needed on the lifecycles of transient, hybrid scientific teams and the factors that best predict

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their successful transition to long-term programs of collaborative scientific work.

3. METHOD

Research on scientific collaboration benefits from mixed methods, including social network analysis, citation analysis, content analysis, surveys, interviews, and observations [6, 14]. Our larger study of scientific collaboration, of which this study is a part, incorporates mixed methods to develop a more complete picture of the culture and nature of scientific collaborations. In the portion of the study reported here, we used observations to provide direct evidence for what teams actually do at the NHMFL, thereby complementing our previously published research [16].

After preliminary informal observations and discussions with senior NHMFL personnel, we developed two observation forms: *Observation cover sheets* recorded general data from the entire facility, including incidents of equipment use, computer use, and communication; numbers of people observed; general activity and engagement levels; and other general observations. *Observation data sheets* recorded specific data from individual experiments, including the number and roles of people observed; equipment use, computer use, and communication; types of interaction; other activities of interest; the team's overall activity and engagement levels; and an ethnographic timeline of activity and collaboration.

4. FINDINGS

Observations were conducted between June 2010 and August 2011. Forty-seven total observations, comprising 58 hours and 15 minutes, were made of 79 scientists from 28 separate teams (some teams and scientists were observed in multiple sessions). Fifteen of the observations also included cover sheets; in these, we observed per session averages of 32.7 people, 6.2 incidents of equipment use, 5.8 incidents of computer use, 4.8 incidents of face-to-face (F2F) communication, and 1.0 incidents of computer-mediated communication (CMC).

Within the equipment use category on the data sheets, probe use was most common (55% of teams), followed by cart equipment (48%), use of the magnet (45%), logbooks or notebooks (24%), and sample material (23%). Most teams used computers and other information and communication technology, with an average of 2.26 types of use per team; the most common uses were CMC (55%), monitoring data (55%), other work usage (48%), and analyzing data (39%). Unlike in the walkthroughs, F2F communication (79%) was slightly less used than CMC (82%) in the experiments; 36% of teams used e-mail and 30% used landline or mobile phones. Finally, we most frequently observed graduate students (30.1%), NHMFL scientists or technicians (25.2%), and postdoctoral researchers (10.5%) at work; interactions were commonly collegial.

Preliminary findings from the coding and analysis of the ethnographic timelines indicate NHMFL collaborations consist of multiple nested and overlapping lifecycles of activity, ranging from scientists making adjustments to equipment and watching the results over a few minutes to the same collaborators working on different experiments over many years. The daily and weekly lifecycles of operations at the NHMFL additionally impact teams and their collaborations. We also observed multiple overlapping and nested information worlds [9] at the NHMFL; individuals, groups, and teams may share similar norms, values, and information behaviors, but there are many subtle differences that indicate the boundaries and barriers between worlds and their lifecycles. While different visiting teams rarely interacted with each other, we observed that their boundary-crossing interactions with NHMFL scientists and technicians played an important role in the success and continuation of collaboration.

5. DISCUSSION AND CONCLUSIONS

Our focus on observations as one part of a broad mixed-methods study allowed us to see these lifecycles and information worlds in action, providing unique data that we could not have obtained from content, citation, or social network analysis and that would have been more difficult to determine solely from interviews. Observation data have also informed the development of appropriate and insightful questions for our ongoing interviews of research scientists.

Our findings indicate that the NHMFL can support successful continuing collaborations by taking into account multiple, overlapping, and nested lifecycles and information worlds, paying particular attention to their boundaries and encouraging attempts to span them. Boundaries between teams and their information worlds can serve as barriers to successful, ongoing collaboration, but we found collaboration efforts that span across them are more likely to be successful, continue, and grow throughout their lifecycle.

The ongoing collegial interactions and extensive use of communication, along with the presence of NHMFL scientists and technicians during experiments, provide an excellent opportunity for boundary crossing between information worlds. Information and knowledge obtained from NHMFL personnel is valued very highly by most teams; they know that collaborating with the staff—both those assigned to help them and others who frequent the area they are working in—will help them better complete their experiment and return to their home institution with accurate and useful data. Our social network analysis indicated that increased disciplinary diversity positively impacts productivity [16]. The more scientists can cross boundaries between disciplines—within or between teams—the greater their chances of productive, successful collaborations that advance science.

In our ongoing research, we are developing a lifecycle model that will inform theoretical research into the lifecycles and information worlds of hybrid teams and practices at the NHMFL and other science labs. Further research at such labs and into scientific collaborations in general, incorporating observations as part of a mixed method study, will improve our understanding of the culture and practice of scientific collaborations and the social and organizational factors that influence their continuation and success.

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