Better Science through Philosophy: The Story of the Toolbox Project

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I. *Introduction*

Philosophers like to think of their subject as the mother of all disciplines. Typically, this is served up as a historical claim concerning disciplinary origins; however, one might also interpret it as a claim about philosophy's deep concern with the character of the various intellectual disciplines. Taken in the latter way, it should come as no surprise that philosophy has something to offer the growing number of cross-disciplinary projects that dot the research landscape. These projects confront many challenges, including linguistic differences and epistemic incommensurabilities. Underlying these challenges are fundamental differences in the worldviews that frame disciplinary research. Because of its connection with a wide range of disciplines, we believe philosophy can be systematically employed to abstract away from specific disciplinary differences toward epistemic common ground on which to build mutual understanding.

Among the most central challenges to cross-disciplinary scientific research are those that involve communication. Effective communication is essential for the success of cross-disciplinary collaboration. The Toolbox Project (http://www.cals.uidaho.edu/toolbox) is built upon the premise that philosophy can be deployed to generate mutual understanding and thereby enhance cross-disciplinary communication (Eigenbrode et al. 2007). With support from NSF IGERT and NSF SES, we have developed an approach that uses structured dialogue in a workshop setting to encourage collaborative teams to examine the philosophical dimensions of their scientific projects, dimensions that are otherwise rarely examined explicitly as part of

collaborative efforts. After conducting more than 50 such workshops, we have gained insight into the collaborative process and the unique epistemological perspectives that collaborations involve.

In this essay we describe in detail the nature of our engaged philosophical work, focusing on the role that philosophy can play in improving the effectiveness and efficiency of cross-disciplinary communication. We begin by sketching the scientific context within which the Toolbox Project operates, a context that features a growing interest and commitment to cross-disciplinary research (CDR). After introducing our focus, we describe the Toolbox approach in some detail before closing with a brief discussion of outputs generated by its application.

II. *The Scientific Context*

CDR is often required to address urgent, persistent, and complex problems confronting contemporary societies, such as climate change (Eaglesham and Hardy 2009) and the human and ecological costs of war (Machlis et al. 2011). Because of their complex, contextual, and dynamic nature, these problems require CDR responses that integrate knowledge from the different intellectual disciplines that are relevant to the problems at hand. For example, work on climate change requires input from geographers, meteorologists, hydrologists, sociologists, ecologists, ethicists, among others (Hanson et al. 2006).

The need for CDR motivates collaborative action at a number of levels. Many institutions of higher learning are reconceiving their research and teaching missions in terms of interdisciplinarity (Crow 2010). U.S. Federal funding agencies, such as NSF, NIH, and NIFA, are giving it greater emphasis. For example, in 2007, then-NSF Director Arden Bement proclaimed: “Developing effective ways to transcend traditional boundaries, and bring very

different scientific cultures together for the benefit of science and society, without compromising excellence, is a critically important challenge for the Foundation" (NSF 2007).

As a result of the increase in attention and funding, there is a rapidly growing community of scientists deeply committed to doing CDR and doing it well (NAS 2005). Yet CDR is challenging and difficult, and the growth in interest has outpaced attention to the *process* of work across disciplines. Yet the past few decades have seen a growing number of books (e.g., Frodeman et al. 2010), professional societies (e.g., the Association of Integrative Studies), and centers (e.g., the UNT Center for the Study of Interdisciplinarity) arise to address this need.

The challenges that confront CDR are manifold; they include the academic reward system (NAS 2005), lack of conducive institutional cultures (Klein 2010a), and turfism (Campbell 2005), to name three. Focusing more squarely on the practice of cross-disciplinary *scientific* research, challenges include developing a truly integrative research question (Baron 2010), finding common ground between CDR team members, problems with scale and scope working across disciplines, developing a mixed methods approach, creating an analytical framework for combining and analyzing data sets, and developing a meaningful final product (Lélé and Norgaard 2005).

III. *Our Focus*

Each of these more specific, research-focused challenges is fundamentally related to *team communication*. Essentially, progress on these complex research challenges requires collective, coordinated effort. In a scientific context, effort of this type increases the demand on groups to communicate in ways that lie outside the bounds of conventional, disciplinary scientific inquiry. Thus, we agree with the observation made in NAS (2005) that communication is the "heart" of

cross-disciplinary activity, understood as comprising "the conversations, connections, and combinations that bring new insights to virtually every kind of scientist and engineer" (p. 19).

Fundamental to these communicative challenges are the philosophical assumptions that underlie team members' scientific worldviews. 'Communication' in the context of CDR concerns the transfer of information and insight across disciplinary boundaries in order to make possible the epistemic combination and integration constitutive of CDR. Among the communication challenges that threaten successful CDR are the existence of different disciplinary languages and the false appearance of agreement that can arise when the same word is unknowingly used with different meanings (Schoenberger 2001), managing disagreement and conflict (Bennett et al. 2010), and building and maintaining a productive mutual identity (Littlejohn and Foss 2008). As Frank (1961) noted 50 years ago, unspoken disciplinary assumptions are "rarely formulated" and "are taken for granted by the members of each group who imply but do not explicitly disclose them in their attempts at communication" (p. 1801)

IV. *The Toolbox Approach*

The Toolbox approach aims to address philosophically based communication issues by engaging participants in a structured dialogue that enables participants to abstract away from specific disciplinary differences toward conceptual common ground they share as research scientists (or as in Galison 1997, "trading zones"). This dialogue is intended to reveal their research worldviews, integration of which will be crucial to CDR success. The approach consists of two main parts, the Toolbox instrument and the Toolbox workshop, with the instrument deployed in the workshop to structure the dialogue. We consider each of these in turn.

IV.1 The Toolbox Instrument

Using the tools of analytic philosophy, we have designed an instrument that reveals scientific commitments through responses to pointed statements about scientific knowledge and practice. There are 34 philosophical statements in all that illuminate fundamental research assumptions. These statements are divided into two broad categories: what the world is like that we may know it (i.e., *metaphysical*) and what we are like that we may know the world (i.e., *epistemological*) (Kornblith 1993).

The Epistemology category is subdivided into sections of Motivation, Methodology, and Confirmation. These correspond to what motivates researchers to initiate a research project, how as researchers they collect and evaluate relevant data, and how they identify knowledge when they have it. The Metaphysics category is subdivided into sections of Reality, Values, and Reductionism. These categories capture three aspects of the world under investigation that can divide researchers, namely, whether the world is independent of the investigators, whether values are an essential part of the world, and whether the world must be reduced for explanatory purposes to more basic elements.

To illustrate, consider the Confirmation section of the Epistemology category, supplied in the Appendix. The core question expresses the main theme of this section: what does knowledge in a given discipline require? The remaining statements are designed to reveal aspects of the process of confirmation that can divide representatives of different disciplines, such as the nature of measurement and the role of replication. As a whole, the instrument can be understood as piece of "philosophical technology" that abstracts away from the specific problems that research teams face and guides those who use it to conceptual common ground on which they can stand with fellow scientists and discuss their research perspectives.

IV.2 The Toolbox Workshop

The Toolbox instrument is deployed in a workshop environment. The workshop begins with each collaborator scoring the statements on their copy of the Toolbox instrument, adopting the perspective of their own discipline. Once the statements have been scored, the collaborators are invited to discuss them, beginning anywhere they choose. The participants then work their way around the instrument in dialogue for 90 minutes.

We have conducted in excess of 50 Toolbox workshops over the past five years with many different types of participating groups: research teams, administrative teams, networked researchers who aren't working on a particular team, and *ad hoc* groups. The primary type of group for which the Toolbox approach was designed is the team of scientists collaborating on a particular research project. Functioning as a team with a mutual purpose, groups of this type have a collective stake in their project and form a team identity that influences how they collect and interpret data and make scientific judgments (Campion et al. 1996). These characteristics also incline the groups to be more serious and focused about the dialogue in the workshop, since they recognize it as an opportunity to learn more about their collaborators.

Therefore, participants have an opportunity to articulate their own scientific conceptual schemes and acquire an understanding of the schemes of their collaborators. Among other epistemic achievements, they can come to recognize through the dialogue that their assumptions are not shared. This can engender a greater degree of mutual understanding, thereby making it possible for the team to avoid miscommunication rooted in confusion about collaborator attitudes concerning the collective project (Klein 1990).

V. *Outputs from the Toolbox Approach*

The Toolbox Project is both an *outreach* project intended to improve the conduct of CDR and a *research* project designed to increase our understanding of the communicative aspects of CDR. In the former role, it has generated data that support the broad, anecdotal endorsement of the approach by those who have experienced it. For example, of those who have completed followup surveys, 85% indicated that they found the Toolbox workshop useful and 92% indicated that the experience was a contribution to their professional development. In the latter role, it provides data for philosophy, and in particular, social epistemology (Goldman 1999). Toolbox workshops generate data that (a) enable us to determine whether the philosophical categories emphasized in the instrument get at matters of central concern for CDR teams (e.g., whether issues related to confirmation divide teams), and (b) put us in a position to study conceptual aspects of knowledge construction that interest philosophical epistemologists (e.g., issues related to reasonable disagreement as exemplified in cross-disciplinary dialogue).

These workshops are an intervention into the life of a group that probes its functionality and has a range of outputs. We focus on two: effects on the attitudes of collaborators, and on the communicative processes at work within the group.

V.1 Attitudinal Effects.

At any given time in the life of a research team, collaborators will have a range of attitudes about team-related matters. These attitudes are modifications of individual psychologies, although they can interweave in various ways to produce mutual, or "We", attitudes (Tuomela 2007). Two orthogonal distinctions stand out: the distinction between "epistemic" attitudes and "collective"

attitudes, and the distinction between attitudes toward self and attitudes toward others. We consider both, with the former supplying the frame for our discussion.

Epistemic attitudes include beliefs one has about one's own disciplinary perspective and knowledge base(s) and those of one's collaborators. The Toolbox workshop is intended to affect these attitudes in various ways. At a lower level, there is the impact the dialogue can have on the team's thinking (Bakhtin 1981); at a higher level, there is the effect on how one conceptualizes one's own discipline and the effect on mutual understanding within the team of the constituent disciplinary contributions (Thompson 2009). Failure to appreciate salient similarities and differences can give rise to unreasonable collective states, which could be either states of agreement or disagreement. A Toolbox workshop is intended to calibrate these collective states via dialogue and thereby enable scientists to see the research landscape through the eyes of their collaborators (Klein 1996).

Collective attitudes concern attitudes about team identity and function involving aspects such as the distribution of status across the membership, gender (Thomson et al. 2001), trust (Webber 2002), and team cohesion (Casey-Campbell and Martens 2009). Together, these aspects constrain how the team adjusts socially, functionally, and teleologically in response to new information and changing circumstance (McDonough 2000). A team's identity, or collective sense of self (Tuomela 2007), influences the research goals it sets for itself, the leadership structures it establishes, the roles that various participants take on within the group context (Goffman 1981), and the interactions that mark the day-to-day "work" of the team (Beebe and Masterson 2009). The focal dialogue within the Toolbox workshop can allow members to enhance their status within the group by virtue of their contributions, and it can also engender

trust by increasing the level of mutual understanding through collective self-disclosure (Powell 1990).

V.2 Communication Effects

Group communication can be resolved theoretically into the "*affective* or *expressive* dimension" and the "instrumental, or task-oriented dimension" (Keyton 1999). The former concerns "verbal and nonverbal messages that create the social fabric of a group by promoting relationships between and among group members", while the latter concerns information exchanged among group members that enables pursuit of team objectives (Keyton 1999). The social fabric of a CDR team is an important piece of the team's identity, and it is woven out of the threads of different disciplinary experiences. Disciplines can be understood as epistemic cultures, and so CDR creates a context in which communication is *intercultural*. In such a context, relationships among team members are forged in dialogue, an activity that enables achievement of a "unity within diversity" (Baxter and Montgomery 1998). The phenomenon of group communication is a multifarious one. Two specific aspects that we hypothesize exhibit effects in the wake of Toolbox workshops are the *cultural* aspect and the *discourse* aspect.

The cultural aspect can be conceived through the idea of *localization* (Crowley et al. 2010). The Toolbox approach is a localization effort that aims to make the research disciplines of cross-disciplinary collaborators seem "natural" by generating shared understanding of research assumptions through dialogue. By becoming familiar with their colleagues' epistemic cultures, participants can begin to see their project collectively and can thereby communicate more effectively with one another about project business. The discourse aspect is revealed by *discourse analysis*, a linguistic approach that looks for meaningful patterns of language use

across discourse-level language samples (Johnstone 2008). We see the workshop as an exercise in joint construal, a process by which interlocutors work cooperatively to construct meaning (Clark 1996). We hypothesize that it will be possible to identify linguistic markers that correlate with successful joint construal at several different levels of interaction.

VI. *Conclusion*

The Toolbox Project is an ongoing effort to apply philosophy, and particularly epistemology, to the practice of scientific research. The primary goal is to enhance the practice of collaborative CDR through communication improvements that derive from greater mutual understanding about scientific research worldviews. Thus, philosophical insight into structural aspects of science and scientific practice are valuable not only to philosophers, but also to practicing scientists.

VII. *References*

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VIII. *Appendix*

III. Confirmation

Core Question: *What types of evidentiary support are required for knowledge?*

12. There are strict requirements for the validity of measurements.

Disagree *Agree*
1 2 3 4 5 I don't know N/A

13. There are strict requirements for determining when empirical data confirm a tested hypothesis.

Disagree *Agree*
1 2 3 4 5 I don't know N/A

14. Validation of evidence requires replication.

Disagree *Agree*
1 2 3 4 5 I don't know N/A

15. Unreplicated results can be validated if confirmed by a combination of several different methods.

Disagree *Agree*
1 2 3 4 5 I don't know N/A

16. Research interpretations must address uncertainty.

Disagree *Agree*
1 2 3 4 5 I don't know N/A

17. The members of this team have similar views concerning the confirmation core question.

Disagree *Agree*
1 2 3 4 5 I don't know N/A