

INFORMAL NETWORKS OF INNOVATION: STABILITY IN 'SMALLISH' WORLDS, THE PRESENCE OF ACTANTS, AND INSTITUTIONS IN THE BACKGROUND

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"What I am pointing out, however, is that "new" technologies - like multi-touch - do not grow out of a vacuum. While marketing tends to like the "great invention" story, real innovation rarely works that way." Interviewee...

We report here on a detailed 'micro study' of informal networks of innovation. The goal of this study is greater empirical and conceptual understanding of the social structures that underlie technological innovation. For the empirical basis of this study, we focus attention to the small community of scholars, research labs, product companies, funding sources, and graduate students who are involved in table-top computing (with Microsoft's 'surface computing' product the most well known). Through a combination of interviews, bibliometric analysis and other secondary sources, we developed a detailed network depiction of the informal connections among key scholars, institutions (that provide resources), core technologies, and specific organizing concepts that draw these together. Our data illuminate the relative stability of informal social connections over time, the secondary importance of institutions, and the centrality of particular technologies/artifacts and concepts (in the Latourian sense of being actants). To explain this empirical insight we draw on and synthesize from work from the literatures of invisible colleges, communities of practice, social network theory, innovation and science and technology studies.

The Issues:

This work represents an explicit initial, or pilot, exploration into the social structures of innovation. Innovation is lauded as critical to economic success and draws considerable scholarly attention from economists, political scientists, organizational scholars, and scholars in science and technology studies (STS). Each group of scholars, however, has developed insights that are embedded in their disciplinary structures (Powell et al. 2005). Engineers, and more recently computer scientists, have also been interested in the practice of innovation, primarily to argue for the importance of substantial funding for research.

There are at least five common themes from across these literatures. First, findings from each body of literature highlight the importance of people. Some consider human actors as critical factors and above all social processes (Brown et al. 2001; Davenport et al. 1998). Others argue that people's education and

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experience are key proxy measures to innovation (Polanyi 1967). Findings from several areas argue for the importance of formal and informal professional social connections (Powell et al. 1996; Von Hippel 1986). Second, most literatures highlight the significance of institutions, though there is significant variations in the roles that institutions can play (Hargadon et al. 1997). In the literatures of invisible colleges (Crane 1972), communities of practice (Wenger 1999) and STS (Williams et al. 1996), there is explicit attention to the centrality of concepts and the sharing of particular forms of information. These often serve to pull together and shape the social structures/networks of the community. Fourth, in the writings on science and engineering, they note the importance of key artifacts or technologies. Fifth, implicitly or explicitly these literatures rely on or assume the presence of some sort of social network. These common themes in the literature align with arguments put forth by Hargadon and Sutton (1997) that networks of innovation are organized around different sets of physical artifacts, human actors, and concepts. To these elements, and building from the literature, we also add the social structures of networks (See Figure 1).

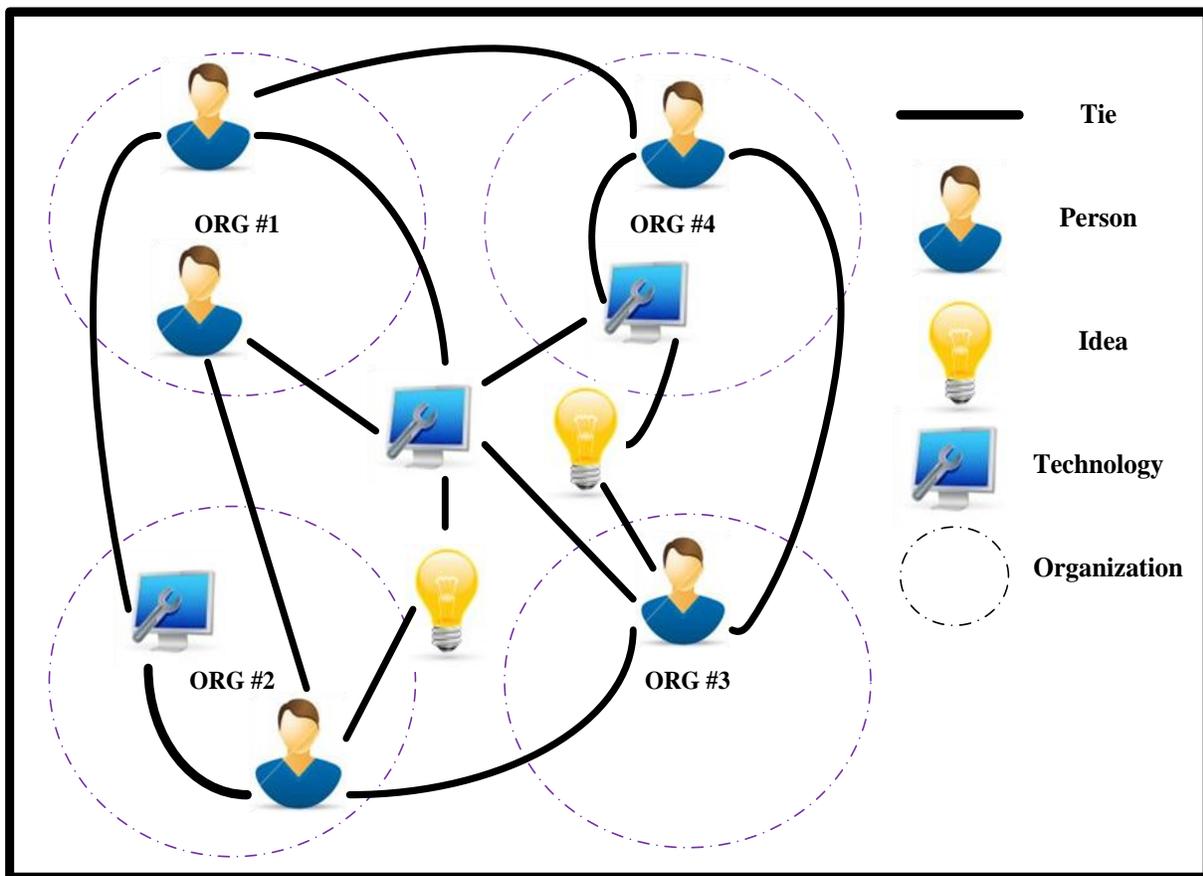


Figure 1: The informal network of innovation

The Community:

The study is focused on scholars, research scientists and others involved in the basic research, applied research, and product development in the area of ‘tabletop’ or ‘surface’ computing. This space brings together computer scientists involved in multi-touch displays, gesture recognition, multi-image processing; scholars of human-computer-interaction; and scholars of computer-supported collaborative work. This community can be found centered on a few institutions, though the institutional homes change over time. The community was selected for conceptual and pragmatic reasons. Conceptually, it was a clear example of a research community that is connected to product development, allowing insight into innovation. Pragmatically, new products were just entering the market, making a study of the form we pursued opportunistically timely. Further, the community is relatively well bounded and we had the possibility of relatively easy entry to participants in the community.

The Method:

The research design is based on five distinct elements. The first element is using our deductive model as guide. The model directs attention to constituents of the heterogeneous network: concepts, people, institutions and artifacts/ technologies.

The second element was an initial exploratory examination of the intellectual space. The preliminary investigation of relevant websites, academic scholars provided clues about the key concepts, technologies and people. Due to the emergent and ephemeral nature of the network, no firm boundaries were drawn. The main objective was to obtain an overall gestalt of the intellectual space which was created by the interaction of core actants (Latour 2005). As such, our empirical data were not aimed at “the one true network.”

The third and fourth elements of the research design are the explicit uses of a combination of primary and secondary data. The principal secondary sources include researcher’s websites. The principal primary sources are a number of interviews with key informants. The selection of informants, and the identification of key resources, was -- of course -- iterative, deeply engrossing and time-consuming.

The fifth element of the research design is a multi-level analysis. One level of analysis was the development of a simple network of relations among key players that was expanded through data collection via interviews. The network was then enriched through an exhaustive and iterative bibliometric analysis through which we studied the ways in which actors are connected by drawing on one another’s technological or conceptual contributions. In this way, concepts and technologies were assigned to paper(s) and then they were linked when a citation was seen. The co-authorship relationships among individuals from different organizations were also used to connect the actors. The resulting network of relations was then subjected to member-checking and additional development to depict the ‘as is’ or a contemporary network structure. We will include depictions of this network in the final version should our work be accepted to the workshop. It remains a work in progress as we begin to deconstruct it for temporal changes and to focus on various patterns.

Initial Observations:

From this data collection, network depiction and analysis of relations, concepts, people, institutional participation and relevant technologies, we proffer four observations. These observations are tentative in that our analysis continues. We proffer these for discussion at the workshop because they have arisen from the analysis and withstood the careful attention of rival explanations.

1. **Invisible colleges.** The intellectual space is easily and well characterized as a social network. It resembles, however, an *invisible college* in that the nodes are between individuals and not institutions. While the institutional homes of key actants change, their relationships with others do not. In some sense this is a smallish world: a core set of actors, slowly growing in number (Uzzi et al. 2005). But, they have large out-network contacts that they use to draw in concepts, resources and technologies. In this sense the actors in this smallish world consume resources from the larger network.
2. **Knowledge moves through people moving.** Interns (graduate students) play a substantial role in the movement of information/knowledge and the cementing of social connections. Many of these people leave the smallish world upon graduation, but some do not and their presence adds both to the depth of connections within and the range of connections without the smallish world that is surface computing. Still kinship relations (of advisor to advisee, and employer to intern) create dense ties and elevate the importance of certain people (hubs). Innovative knowledge is most easily transferred between institutions by the mobility of individuals (Roger et al. 1984). This movement can be temporary -- like the intern's role -- or more permanent -- such as key nodes moving from one institution to another (often leaving little trace of their presence upon their departure!).
3. **Institutions have distinct, important, but secondary roles.** Institutions are critical, but they are not, however, part of the smallish world. Most institutions provide resources, with the most useful being funds (for research, travel, hiring interns or paying for students). It does not appear that the basic concepts and core technologies remain connected to any one institution. This noted, product development is disconnected from the smallish world of research (to the chagrin of some players and glee of others). Product development happens within institutions, but happens through the participation of core actants who are deeply enmeshed in the smallish world. We note in passing that basic research funding (from the NSF or other sources) is prized for its support of graduate students. But, this funding is not a significant percentage of the total resources consumed to move this research forward!
4. **The informal networks of innovation involve both concepts and specific artifacts or technologies.** Core concepts often have been around for a long time, but technologies that instantiate or reflect these come later. These technologies evolve, and each provides inspiration for the next generation or series of artifacts. In many case, the technologies/artifacts and concepts serve as bridges or hubs that link or unite people. The ongoing negotiation on the implications insights and meanings of these evolving concepts and technology artifacts are network defining activities (Garud et al. 2003).

Drawing from these observations, we expect the ensuing discussion will engage: The nature and roles of institutions; the importance and roles of concepts and specific artifacts/technologies; and the form, stability and uses of the informal social network of innovation – what we are calling smallish worlds.

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