Sharing Knowledge in Heterogeneous Environments

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On October 8 and 9, 1999, the first Research Greenhouse brought together about 60 members of the Society for Organizational Learning (SoL) to share ideas on leadership, organizational learning, and change. The exchange of ideas took several forms including informal and formal conversations ("germination sessions"), poster and paper sessions, and panel debates.

As the conference organizers Karen Ayas (SoL) and John Carroll (MIT Sloan School) emphasized the importance of reflecting on the Greenhouse, this paper is a summary of my reflections based on my experience, memories, available research papers, and session tapes and notes. I center on the topic of knowledge sharing across boundaries—a focus of the Greenhouse's discourse and a subject of my own research.

The Community of Communities

In setting the stage for the Greenhouse, John Carroll stated that one goal of the event was to build relationships and nurture research in and around the SoL community. But the notion of "community" calls for a closer examination. Is SoL a single community? Karen Ayas noted that SoL unites researchers, consultants, and practitioners. These are three very different communities. Moreover, members of SoL belong to different national cultures, organizations, professions, and even research fields—all constituting communities in their own right. The realization that we live in a world of multiple communities is not new. However, in the past decade, research on learning has focused

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on homogeneous communities using a “communities of practice” lens (Brown and Duguid, 1991). The Greenhouse underscored a need to consider the heterogeneity within a community and its larger social context.

Dvora Yanow (California State University at Hayward) led one a germination session in which 15 researchers discussed situated learning, knowledge, and knowledge transfer. The most prominent questions raised were:

- How does local knowledge connect to the collective knowledge in a productive way?
- What skills are necessary to achieve such connections?
- What are the limits to what we, as outside researchers, can learn about local practices?

With these questions as a base, presenters at the Greenhouse discussed how to share knowledge across boundaries and be successful at that. They also talked about the leader’s role and qualities in facilitating learning activities in heterogeneous environments as well as methodologies of studying learning.

In this paper, I pull together common themes from some of the case studies discussed and identify prominent success factors as a way to share academic knowledge with consultants and practitioners.

Reflecting on Case Studies

Most of the case studies focused on sharing knowledge across different boundaries inside heterogeneous groups and across different groups. I have found it useful in my own research to identify specific boundaries posing barriers to knowledge sharing. In the next section, I classify types of boundaries relevant to the case studies, give an overview, and discuss their success factors.

Table 1. Classifying Boundaries

Type of Boundary	**Boundary between:**	**Major Barriers to Knowledge Sharing**
Relationship	People who had no history or poor history of prior interaction.	Low level of trust
Spatial/Temporal	People distributed in time and space.	Lack of contextual clues or details Memory loss Discontinuity in progress toward goal
Inter-organizational	People who belong to different organizations.	Differences in organizational cultures and goals
Intra-organizational	People who belong to different organizational units or groups.	Differences in: Unit sub-cultures Unit goals Local problem constraints
Professional	People with different professional backgrounds and training.	Differences in: Professional cultures Professional goals Specialized languages and methodologies
National	People belonging to different national cultures or ethnic subcultures.	Different national cultures and natural languages
Status	People who occupy different levels in the organizational hierarchy	Inability to voice relevant knowledge Unwillingness to listen

Different types of boundaries pose distinct barriers to knowledge sharing (table 1). Some boundaries overlap (for example, status and relationship boundaries, and organizational and spatial/temporal boundaries), but each poses different challenges. For example, it is possible to have a relationship boundary characterized by a low level of trust between people who are in the same organizational unit, practice the same profession, have the same organizational status, and are collocated in time and space.

Selected Case Studies

Next I briefly summarize the case studies in the order of presentation. I indicate the groups in the collaboration, their goals, and the boundaries to knowledge sharing that they encountered.

Silicon Alley

Theresa Lant (New York University) studied the formation of Silicon Alley, a new community delivering Internet content, located in New York City. This new economic agglomeration spanning many organizations came together through converging boundaries of previously separate communities—traditional publishers, film-makers, broadcasters, journalists, graphic artists, entrepreneurs, and technologists. Different communities gathered to create a new single community with a unique identity. The boundaries to knowledge sharing, according to my classifications, were relationship, spatial/temporal, inter-organizational, and professional.

Xerox PARC

Sim Sitkin (Duke University) reported on his study of Xerox PARC projects conducted with John Seely Brown (Xerox PARC). They examined collaborations among artists, scientists, engineers, and designers or marketers. These cross-disciplinary collaborations were created in order to enhance innovation opportunities among individual specialists, while maintaining the separate goals and identities of the communities involved. The boundaries I identified were relationship, inter-organizational, intra-organizational, and professional.

Surgical Teams

Amy Edmondson (Harvard Business School) studied the introduction of new technology into surgical teams, highlighting the importance of knowledge sharing between physicians and nurses and across various medical care settings (for example, intensive care unit and primary care physicians). The goal was to adopt new medical technology as efficiently as possible into an already diverse community. The boundaries were relationship, spatial/temporal, inter-organizational, intra-organizational, professional, and status.

MIT-Visteon

Janice Klein (MIT Sloan School) studied the effectiveness of virtual teams by reflecting on lessons learned in the research collaboration between MIT and Visteon Automotive Systems, a parts supplier for Ford. The distributed team was located in several countries in Europe and the United States. The goal of the collaboration was to create a jointly

defined research agenda and process. The boundaries were relationship, spatial/temporal, inter-organizational, professional, and national.

World Bank and Detroit Edison

Joyce Fletcher (Simmons College) and Katrin Kaeufer (MIT Sloan School) studied characteristics of distributed leadership in large organizations. At the World Bank, they looked at the effort to move the organization closer to clients in the field. At Detroit Edison, they examined the effort to address work/family issues. The boundaries to knowledge sharing here were spatial/temporal, inter-organizational, intra-organizational, and national.

The Natural Step

Hilary Bradbury (Case Western Reserve University) studied how change was achieved in The Natural Step trans-sectorial initiative on sustainable development. The initiative included both scientific and business communities. The goal of the collaboration was to create and implement sustainable development initiatives. The boundaries were relationship, spatial/temporal, inter-organizational, professional, and national.

TQM Studies

Nelson Repenning (MIT Sloan School) studied TQM and other process improvement techniques in various manufacturing organizations. These techniques were used to aggregate the knowledge of local unit operations into a model of a collective production

system. The goal was to improve operational efficiency, for example, to reduce the number of production defects. The major boundary was intra-organizational.

Shell

Bill Brenneman (Shell, Texaco, Aramco's Equiva Services, LLC) and his colleagues used deep root cause analysis of major failures to move managers from a local focus to macro systems thinking. (Root cause analysis is a technique designed to use systems thinking for analyzing problems.) The goal for senior managers was to recognize which existing global structures were unsuitable for achieving performance, learning, and change in local organizational units. The boundaries were intra-organizational and status.

Nuclear Power Plants

John Carroll (MIT Sloan School) studied the implementation of root cause analysis techniques for major accidents in nuclear power plants. His goal was to share knowledge across organizational unit boundaries to understand what caused an industrial accident and make improvements. Instead, the approach was used for minute criticism on the local level, rather than for achieving understanding on a larger scale. The boundaries were spatial/temporal, intra-organizational, and status.

Ford

Nancy Dixon (George Washington University) studied how 37 Ford plants shared explicit knowledge on frequent, routine tasks among groups with prior related

professional knowledge.[1] Each plant's goal was to increase productivity by 5% a year. The boundaries were spatial/temporal and intra-organizational.

British Petroleum (BP)

Nancy Dixon studied the Peer Assist program at BP, which shared site exploration expertise across different sites. At BP, unlike Ford, there was a need for sharing tacit knowledge of non-routine tasks among teams from somewhat different backgrounds. The goal was a successful site exploration. The boundaries were spatial/temporal and intra-organizational.

Teachers' Empowerment Group

John Meyer and Jean Bartunek (both from Boston College) studied the processes for developing and maintaining memory in a teachers' group with frequent turnover of members. The goal was to create programs to empower teachers. The boundary was spatial/temporal.

Network Technicians

Alessandro Narduzzo (University of Trento) conducted an ethnographic study of how network technicians installed wireless networks for customers across wide geographical areas. The goal was to improve the quality and efficiency of the installations. The boundaries were spatial/temporal, inter-organizational, and intra-organizational.

Community Organizers

Dvora Yanow discussed her field study of Israeli community organizers who were sent by a government agency to remote locations.[2] The goal was to organize local communities and to learn about their needs. The boundaries were spatial/temporal, intra-organizational, and status.

Success Factors

Although the case studies occurred in different settings and crossed various boundaries, many had common success factors in facilitating knowledge sharing. When researchers analyzed the data, they found the following 12 factors critical to successful knowledge sharing. I pull these factors together across case studies, provide my commentary on the effectiveness of a given factor in overcoming certain boundaries to knowledge sharing and illustrate each factor with a few prominent examples.

1. Networks

Networking is important for overcoming relationship boundaries because it builds a history of positive interactions. In the Silicon Alley case, the ability to network and form relationships with actors from different backgrounds was critical in establishing a new community and pursuing entrepreneurial opportunities. In the surgical teams case, boundary spanning, which included networking with referring physicians and intensive care unit physicians, was the strongest predictor that the organization would adopt the new technology.

2. Tolerance for Mistakes

Having tolerance for mistakes gives groups time to build a relationship for long-term benefits despite a history of poor results, helping them overcome relationship boundaries. In the Silicon Alley case, a high risk tolerance among community participants meant that entrepreneurs and even established firms would rather make errors of commission than errors of omission. At Xerox PARC, managers believed in the value of learning from mistakes. They perceived that a lack of failures by collaboration teams indicated missed innovation opportunities. In the surgical teams case, psychological safety, described as "openness about mistakes," predicted successful technology implementation.

3. Group Stability

Group stability helps overcome relationship boundaries by giving people time to establish trust through multiple interactions. It also helps people cross spatial/temporal boundaries by developing the group's memory and facilitating continuous progress toward goals. In the formation of Silicon Alley, the repeated interaction between community members was a crucial element in legitimizing the community. In the surgical teams case, team stability was the strongest predictor of a team's efficiency in adopting the new technology. On the other hand, the lack of stability in the teachers' empowerment group, which had regular membership turnover, meant that lessons learned in earlier interactions were forgotten.

4. Structures for Interaction

Many Greenhouse presenters emphasized the value of structures in facilitating heterogeneous interaction. Structures help overcome relationship boundaries: some, such as formal selection processes, elevate levels of initial trust, while others create formal agreements for dealing with problematic relationships. Structures also help overcome spatial/temporal boundaries by building group memory and establishing processes for reaching goals.

In the Silicon Alley case and in the MIT-Visteon collaboration, physical infrastructures (for example, computer networks, meeting spaces, video-conferencing equipment) as well as scheduled repeated interactions among group members were important structures for organizing. Xerox PARC institutionalized the process of selecting candidates for the collaboration and created otherstructures for sustaining the effort and dealing with problems. Ford used several structures to institutionalize the transfer process: a computer information system, organizational routines for knowledge contributions and responses to the system, and measures of outcomes.

5. Shared Narratives

Narratives are a critical mechanism for overcoming spatial/temporal boundaries because they express a group's memories and describe contextual details. Members of the teachers' empowerment group relayed stories to share knowledge not readily available in a tangible form. The network technicians also shared narratives face-to-face and over the phone to convey procedural and historical knowledge.

6. Shared Artifacts

Shared artifacts are practical for overcoming many boundaries and were present in most of the case studies. As part of social structures, they inherit various roles that structures play in overcoming barriers to knowledge sharing. In addition, shared artifacts help cross relationship boundaries by providing tangible results of work, capturing agreements between parties, and representing common investments. They help overcome spatial/temporal boundaries by allowing group members to see tangible steps in their progress toward a goal, building memories, and forcing members to be more explicit about contextual details. Shared artifacts are helpful in overcoming inter- and intra-organizational, professional, and national boundaries as they can represent various diverse or facilitate the creation of common cultures, goals, languages, methodologies, and problem descriptions.

At Xerox PARC, images as diverse as network graphs, art collages, photographs, and Escher drawings conveyed ideas. In the surgical team case, new, minimally invasive surgery created a challenge to provide effective illustrations and communicate ideas through images. The human body could not be used, which necessitated using less vivid, technology-based representations. This created significant communication problems: poor representations meant that team members had to learn to communicate verbally about things that were best described visually or through other senses. In The Natural Step and BP cases, experts involved in knowledge sharing relied heavily on charts and drawings on blackboards and walls. Finally, the network technicians used “official” artifacts (for example, an installation manual) and “unofficial” tools (for example, a temperature simulation tool) to aid their work.

7. Boundary Spanners

Boundary spanners often play the role of trusted agents for multiple parties. They know the details of different contexts and have memories of dispersed interactions, which helps them cross spatial/temporal boundaries. They aid in overcoming inter- and intra-organizational, professional, and national boundaries by belonging to multiple cultures, speaking many languages, sharing different goals or acting impartially, and understanding different methodologies and problem constraints.

In The Natural Step initiative, the leader of the effort was a boundary spanner between scientists and businesspeople. Shell senior managers integrated knowledge from many local business units. Network technicians working for the supplier company bridged the gap between the supplier and customers' organizations. Yanow's community organizers helped managers learn about local needs.

8. Common Language

Like shared artifacts, a common language is a joint investment that helps cross relationship boundaries. It overcomes differences in culture and languages in order to cross inter- and intra-organizational, professional, and national boundaries.

Silicon Alley needed a shared language that would also help establish a new, unique identity. The result was a language full of jargon. Xerox PARC's common language was a major accomplishment in aiding cross-disciplinary collaborations. Unlike Silicon Alley's specialized language, Xerox's was widely accessible to a large community of diverse individuals. In the MIT-Visteon collaboration, establishing English

as the common language helped communication in a globally dispersed team. In The Natural Step initiative, not only was there a necessity for a common language, but participants had to perceive the language as neutral. The language of science served this purpose.

9. Using Process Improvement Techniques

Process improvement techniques both create structures for interaction and encompass shared artifacts. In addition, they are powerful tools for integrating constraints encountered in different local contexts, facilitating knowledge sharing across intra-organizational boundaries. They also help overcome status boundaries by allowing low-status organizational members (for example, line managers) to share their knowledge.

In the TQM studies, process improvement methods were used to aggregate knowledge from various local contexts into a comprehensive systems model. Similarly, at Shell, root cause analysis techniques helped managers understand how global structures constrain local action. However, in the nuclear power plants case, root cause analysis methods were not used to share knowledge, but rather to punish individuals.

10. Goal Alignment

Goal alignment, marked by shared and individual, non-conflicting goals, is a direct mechanism for dealing with differences in goals created by inter- and intra-organizational and professional boundaries.

For the MIT-Visteon collaboration, a key lesson related to the misalignment of goals between academics and practitioners: a long-term academic focus versus a short-

term industry focus. In The Natural Step initiative, self-interests needed to connect to common interests to effect change. For example, IKEA, a participating organization, wanted to appeal to a well-educated European market by implementing good environmental policies. Participating scientists wanted to both publicize their ideas about environmental issues and collaborate with other scientists.

11. Norms of Reciprocity

Reciprocity is a mechanism for dealing with differences in goals without achieving alignment. It helps share knowledge across inter- and intra-organizational and professional boundaries by facilitating collaboration based on mutual help.

Each Ford plant had to increase productivity by 5% a year. This incentive made all plant managers look for ways to improve processes. Reciprocal behavior occurred because each manager had to contribute ideas to the system, while their implementation was voluntary. At BP, the success of site exploration was a performance criteria for the teams: getting valuable advice from others was key to enabling success. Knowledge exchange was based on the norms of reciprocity. Since there was a need for outside expertise at many sites, it was common for one site to support another without any monetary compensation.

12. Small Scale

Starting small is important for overcoming all types of boundaries because sharing knowledge on a large scale is difficult. Starting small mitigates the risks associated with

failure and allows participants to learn through experiments in overcoming various barriers.

Xerox PARC initiated the interdisciplinary collaboration projects on a small scale by carefully handpicking a group of scientists and local artists to work together. In the surgical teams case, the new technology was introduced in a few procedures, with adoption rates changing depending on the success of initial trials. Participants in the MIT-Visteon collaboration decided to start their virtual interaction in only three locations. In The Natural Step initiative, the project started from several conversations involving some scientists and later a few corporations. Ford began its effort in a face-to-face exchange of process improvement ideas between two plant managers and then moved to a formalized technology-supported exchange. At BP, the initial exchanges began with a few teams asking for help.

To summarize, networks, tolerance for mistakes, group stability, structures for interaction, shared artifacts, boundary spanners, and a common language (factors 1-4, 6-8) all played a role in dealing with relationship boundaries. Group stability, structures for interaction, shared narratives, shared artifacts, and boundary spanners (factors 3-7) were important for crossing spatial/temporal boundaries. Shared artifacts, boundary spanners, a common language, process improvement techniques, goal alignment, and norms of reciprocity (factors 6-11) were useful in overcoming inter- and intra-organizational, professional, and national boundaries. Process improvement techniques (factor 9) were also important for overcoming status boundaries. Finally, a small scale (factor 12) appears to play a role in overcoming all types of boundaries in knowledge sharing.

While I have given only a few illustrations, I suspect that these success factors were applicable across most of the Greenhouse case studies.

Leadership Role and Qualities

A few presenters reflected on the role and qualities of leaders in their case studies, some of which I list below. I then comment on how these qualities help overcome various barriers to knowledge sharing.

In the surgical teams case, the role of team leaders (surgeons) was critical for implementing procedures successfully. The surgeons' behavior included carefully selecting team members and coaching them on creating an open environment, leading discussions, nurturing trust, and focusing on teamwork.

At the World Bank and Detroit Edison, leaders were able to speak from experience, voice what was going on around them, and deal with conflicting situations. In these two organizations, leaders who wanted to share local learning with the larger collective often had to struggle with the fact that their roles were invisible and that their actions provided only an opportunity for change—the actual change had to happen through the collective actions of others.

In The Natural Step initiative, the leader had to play the role of a boundary spanner between scientists and business people. He had symbolic power (in this case, the power of science) and economic disinterestedness.

At Shell, a key role of senior managers was to understand the interrelationship between many local settings. Such understanding allowed for more effective strategy development and an ability to enrich local settings by introducing collective knowledge.

In reflecting on the distributed leadership qualities shown in the case studies, I think that the effective leaders were responding to various knowledge-sharing barriers (table 1). Clearly, many leaders were boundary spanners. In addition, most leadership qualities included fostering relationships, reconciling conflicting goals, and creating structures to enable collaboration. The leaders played crucial roles in overcoming status boundaries. They used their power to voice others' concerns and create open environments. The effective leaders in heterogeneous environments were instrumental in designing and implementing various success factors in practice.

Methodological Issues

Can researchers, as outsiders, study local knowledge? Most of the Greenhouse researchers collaborated with insiders, were insiders themselves, or became "partial insiders" through the use of ethnographic methods. For example, Sim Sitkin conducted his research with John Seely Brown, the head of Xerox PARC, while Amy Edmondson collaborated with a medical doctor and a technology and operations researcher. Bill Brenneman was an insider in the corporation that he studied. Alessandro Narduzzo spent seven months studying the work of network technicians using ethnographic methods. Many other researchers demonstrated that collaborating with insiders or becoming insiders is necessary to study local knowledge.

Greenhouse researchers often played the role of boundary spanners themselves. They had to cross all types of boundaries to share knowledge with their study participants. They had to establish trust, learn new languages, create shared artifacts,

provide structures for collaboration, define shared goals, and often start their research on a small scale.

Conclusion

Telling stories, discussing what worked, building theories, and reflecting on methods was how SoL researchers shared their heterogeneous experiences. While I have attempted to consolidate some common themes, it is clear that 12 success factors are hard to track and implement in practice. The multitude of factors indicates that knowledge sharing across boundaries is difficult, and one unlikely to be solved easily. Here I have analyzed what made these factors effective—that is, they helped people overcome specific barriers to knowledge sharing.

Identifying the barriers to knowledge sharing in a given context and then designing strategies for overcoming them is a practical way to address knowledge-sharing challenges. The Greenhouse provided a repertoire of useful strategies, some more useful than others in certain environments. For example, sharing artifacts is often more practical than engaging boundary spanners because of the psychological stresses that boundary spanners have to overcome and their limited availability (Star and Griesemer, 1989). Also, some success factors described here may have wider applicability than was apparent from the Greenhouse cases. For example, a study of an emergency room found that a white board—a shared artifact—helped deal with status boundaries by giving nurses a place to express their knowledge (Østerlund, 2000). Some success factors that are applicable in one situation may not work at all in another. For example, sharing

narratives is extremely effective for overcoming spatial/temporal boundaries (Brown and Duguid, 1991); however, if there is a difference in natural or professional languages due to the presence of other boundaries, sharing narratives may be impractical.

For the SoL community, the Greenhouse represented *ba*—a shared space that provided a platform for advancing individual and collective knowledge. I find this concept, borrowed by Nonaka and Konno (1998) from the Japanese philosophy of existentialism, useful in describing a meeting place for a community of communities. We all have *bas* inside our communities and organizations. SoL can be seen as a *basho*—a collection of researchers', consultants', and practitioners' *bas.* The discovery of similarities in analyzing the same phenomenon from different angles during the Greenhouse is an invitation to use this *basho* for further collaboration and cross-pollination of ideas.

Notes

1. Nancy Dixon reported on the work from *Common Knowledge* (Boston, MA: HBS Press, 2000). She used examples of Ford and BP to illustrate different knowledge-sharing needs and transfer mechanisms. Her book contains many studies of intra-organizational knowledge sharing.
2. Dvora Yanow gave several examples of various organizations using or failing to use bicultural translators—people capable of translating local knowledge into a larger context. I highlight only one example based on Yanow’s research.

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