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Knowledge boundary spanning process: synthesizing four spanning mechanisms

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Abstract

Purpose – This paper seeks to advance the study of knowledge boundary spanning by approaching spanning as a process that involves four spanning mechanisms.

Design/methodology/approach – Building on the insights from practice-based view of knowledge and knowledge management literature more generally, the authors formalize and articulate two spanning mechanisms (boundary practice and boundary discourse), in addition to two other previously established spanning mechanisms (boundary object and boundary spanner).

Findings – The paper formalizes two further spanning mechanisms and suggests an integrative framework for examining the mutual and compounding effect between the four spanning mechanisms. Building on the suggested framework, the process of spanning is analysed as a time-based combination of various mechanisms which evolve over time. The framework opens new windows to look at the projective and emergent mode of spanning mechanisms as a duality, rather than a dualism.

Research limitations/implications – Researchers are freed to explore the deployment order of the spanning mechanisms and the conflicting or synergistic effects. Practitioners would benefit from tracing successful spanning processes for replicating in similar contexts to advance collaboration efforts.

Originality/value – Boundary practice and boundary discourse are introduced as well as synthesizing the mechanisms into a coherent framework. Viewing boundary spanning as a process that includes dynamic combination of four spanning mechanisms is a particularly novel insight that can stimulate future research avenues.

Keywords Boundary spanning, Knowledge boundary, Boundary object, Boundary spanner, Boundary practice, Boundary discourse, Knowledge management, Innovation

Paper type Conceptual paper

1. Introduction

Arguments for specialization and efforts to establish a community of practice's legitimacy have accelerated the construction of knowledge boundaries (Carlile, 2002, 2004; Zeiss and Groenewegen, 2009). When individuals from different communities of

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practice come together, forming a community of interest (Koskinen and Mäkinen, 2009), the presence of knowledge boundaries hinders coordination and problem solving. Thus, managing knowledge across boundaries is a constant activity due to communities of practice (Carlile, 2002) and the increased reliance on assembling diverse teams to solve problems effectively (Prahalad and Krishnan, 2008). The global pressure placed on managers to respond and act quickly intensifies the need to develop strategies that rapidly overcome knowledge boundaries. Additionally, technological advances and innovations often reside outside the boundaries of a community or firm and resolving boundary conflicts can be a source of innovation (Wenger, 2000; Rosenkopf and Nerkar, 2001; von Hippel, 2005). Therefore, advancing managers' understanding of knowledge management across boundaries is key to firm growth.

The need for spanning knowledge boundaries is evident, for example, when experts from different domains collaborate in designing a new product. Not only does each community expert need to understand the ideas of other communities, but also all involved experts need to collaborate in the co-creation of new collective knowledge and transforming it into workable designs and products. Thus, the spanning process is often characterized by being multi-actor, emergent and iterative requiring the adoption of a wide range of mechanism to overcome the challenges posed by cognitive gaps.

The purpose of this paper is to advance the study of knowledge boundary spanning, and innovation literature generally, by approaching spanning as a *process* that involves time and a compounding effect of multiple spanning mechanisms. Extant research has clearly identified two boundary spanning mechanisms that facilitate coordination across knowledge boundaries: boundary spanners (e.g. Brown and Duguid, 1998) and boundary objects (e.g. Star and Griesemer, 1989). However, research has been schizophrenic towards a third mechanism: boundary practice. Knowledge management literature includes practice or work routines as boundary objects (Wenger, 2000; Hayes and Fitzgerald, 2009) but also includes practice as a method to develop knowledge, especially tacit knowledge (e.g. Polanyi, 1966). However, other studies have shown the importance of distinguishing between boundary practice and the other two spanning mechanisms (Levina and Vaast, 2006). Therefore, to respect the ability of engaging in practice to co-create knowledge across communities, we formalize practice as a boundary spanning mechanism. This formalization clarifies the role of practice in overcoming knowledge boundaries through the use of tacit knowledge and helps in analytically distinguishing between its role and the roles of boundary objects and boundary spanners. Additionally, we propose a fourth boundary spanning mechanism: boundary discourse. In essence, boundary discourse is the content stemming from the dynamic process of engaging in identifying and articulating ideas, building up a party's knowledge to overcome the knowledge boundary. Boundary practice and discourse share a conceptual foundation but the former deals with collectively engaging in activity while the latter deals with the content and dialogue explicitly expressed when overcoming knowledge boundaries.

Viewing boundary spanning as a process contributes to the existing literature in three main ways. One, as the boundary object concept has become overextended (Wilson and Herndl, 2007) the distinction between the four spanning mechanisms helps to purify and specify each concept in order to consider the different roles that each mechanism plays in spanning knowledge boundaries. Two, shifting the focus to the process of boundary spanning reveals that multiple boundary spanning mechanisms

are often deployed to overcome a knowledge boundary. This finding has particular importance in advancing future research and knowledge management strategies; and, is especially relevant for managers interested in preventing future boundary confrontations. Three, we introduce the concept of time into the analysis by shifting focus to viewing boundary spanning as a process. Understanding that spanning a boundary takes time frees researchers to explore the deployment order of the spanning mechanisms and to begin tracing successful spanning scenarios for replicating in similar situations or contexts. The distinction between four spanning mechanisms provides us with sufficient basis to bring to the fore the role of time, by analyzing how different sequential combinations of mechanisms (called spanning scenarios) can be leveraged in real-time applications.

To fulfill our purpose, we first present an overview of knowledge boundaries and boundary spanning as a general concern. Then, boundary objects and boundary spanner literatures are reviewed, since these are more established concepts. Next, practice as a boundary spanning mechanism is clarified, followed by the introduction of boundary discourse. We then provide an analytical framework of the four boundary spanning mechanisms and spanning scenarios examples. The paper concludes by reviewing the key implications stemming from our analysis, interlaced with future research ideas.

2. Knowledge boundaries

A knowledge boundary represents the limit, or border, of an agent's knowledge base in relation to a different domain of knowledge. Knowledge boundaries are not static. They adjust through structured learning environments, such as training programs; and, they fluctuate throughout a person's continuous social and material interactions. This paper adopts Boisot and MacMillan's (2004, p. 506) definition of knowledge:

> [. . .] as comprising a set of beliefs which informs decisions by agents to take actions that consume the agent's (scarce) resources.

Accordingly, a person's knowledge base heavily influences the structure of their interpretive framework (Polanyi, 1962), sometimes called personal narratives (Hawkins and Saleem, 2012). This interpretive framework then determines how people interpret information by influencing what they view as important or unimportant (Brown and Duguid, 1998; Boisot and MacMillan, 2004) along with what new information they can integrate into their existing knowledge base.

In work contexts, formal and informal interactions heavily influence a person's knowledge base. A community of practice can develop when multiple individuals develop a collective knowledge base, including personal narratives, centered on a particular practice (Orr, 1996; Brown and Duguid, 1998; Wenger, 2000). Professional training programs and associations can influence larger communities of practice while smaller communities can exist within a firm related to a practice, such as invoicing. Therefore, knowledge boundaries can hinder transferring knowledge across communities of practice: the inability of the other party to see information as important or to understand how to integrate the new knowledge into their interpretive framework thereby hindering coordination (Nicolini *et al.*, 2011). In order to overcome coordination barriers stemming from knowledge boundaries, spanning mechanisms are deployed.

3. Four knowledge boundary spanning mechanisms

In this section, we first comment on the two established spanning mechanisms (boundary spanner and boundary object), and then we formally articulate two other mechanisms (boundary practices and boundary discourse), which are less developed. The introduction of these four mechanisms help us to specify each mechanisms by comparing the four, commenting on the differences between them in terms of their units of analysis, key theoretical foundations, the role that each mechanism serves for the sake of boundary spanning, and visual depictions of the knowledge flow are presented (see Table I).

3.1 Boundary spanner

Boundary spanners are human agents who translate and frame information from one community to another in an effort to promote coordination (Aldrich and Herker, 1977; Brown and Duguid, 1998). Boundary spanner studies focus on the human agent as the main unit of analysis, their social interactions and their ability to translate knowledge across boundaries. Due to the fact that spanners use language and their cognitive power to mediate the movement of information they are most effective in moving explicit knowledge, particularly fluid knowledge (Boisot, 1998). Researchers typically classify boundary spanners based on their standing within the communities involved in the problem solving team. For example, Brown and Duguid (1998, p. 103) label spanners with membership in only one community as boundary translators, while boundary brokers are individuals who have membership in both communities. Hayes and Fitzgerald (2009) label individuals with membership in both communities as boundary crossers while Star and Griesemer (1989, p. 411) label these multi-community members as marginal people. Accordingly, boundary spanner research often addresses socio-relational perspectives in the spanning process.

Regardless of the spanners membership status, their core function is to promote coordination and facilitate problem solving through translating and actively framing knowledge to bridge cognitive gaps between parties. Membership status becomes particularly important in this process due to legitimacy and honesty issues. Boundary spanners can be tempted to bias knowledge translation in order to favor one community over the other, especially if they reside in the community (Nonaka *et al.*, 2000). Further, Hayes and Fitzgerald's (2009, p. 424) study on dual status boundary spanners found that "working across organizational and occupational boundaries as difficult, demanding and from a career perspective, potentially dangerous". As the term "marginal people" alludes to, boundary spanners, while understanding the communities' knowledge bases, can still feel unaccepted in both communities. Thus, besides cognitive capabilities, boundary spanners possess personality and political skills that enable them to succeed despite legitimacy, trust and membership issues.

Spanners often rely on persuasion to develop legitimacy when translating and framing knowledge. The use of persuasion is generally more pronounced when the spanner resides outside a party's community (Wenger, 2000). The need for rhetorical persuasiveness decreases as one obtains community membership, but the need for rhetoric never completely disappears because translating and framing knowledge can be used to benefit or hurt individuals, projects and departments (Brown and Duguid, 1998). Since knowledge is embedded in a community's practices (Carlile, 2002) engaging in practice serves as a key process for developing and understanding the collective

	Boundary spanner	Boundary object	Boundary practice	Boundary discourse
Unit of analysis	Cognitive capabilities and social relations of human agents	Material or abstract presence of object	Engagement in collective activities	The content of knowledge and ideas
Key ideas	Skills and personalities Membership status Legitimacy and trust Emotions and motivations Politics and power relations	Shared meanings Materiality/physicality De-contextualization De-personalization	Knowing in practice Collective knowing Situated knowing Contextualization Tacit knowledge	Domains of knowledge Scaffolding content Cognitive proximity Explicit knowledge
Spanning functions	Translating knowledge Framing knowledge Legitimization	Transforming knowledge Reminding Objectifying Transferring embedded knowledge	Learning knowledge Co-creation Understanding and internalizing	Building knowledge Sensitizing Situating/selecting on specific ideas Articulation and clarification

Table I.
Spanning mechanisms framework

knowledge base of a community (Brown and Duguid, 1998). Thus, spanners can demonstrate their knowing by engaging in practice to demonstrate competency (Wenger, 2000; Brown and Duguid, 2001; Orlikowski, 2002) thereby developing legitimacy (Orr, 1996).

Spanners play an important role in translating knowledge over cognitive gaps but what occurs when their cognitive capabilities or social relations hinder coordination? Perhaps, the spanner can initiate dialogue among the parties, or engage in collective practice to build up knowledge. Mechanisms, such as engaging in practice or using community artifacts in an appropriate manner can develop legitimacy, promote the learning of tacit knowledge and facilitate coordination. Thus, approaching spanning as a process indicates avenues for additional mechanism to complement boundary spanners.

3.2 Boundary object

A boundary object refers to a physical, abstract, or mental object that serves as a focal point in collaboration enabling parties to represent, transform and share knowledge (Carlile, 2002; 2004; Koskinen, 2005; Hayes and Fitzgerald, 2009). The main unit of analysis for boundary object studies is the material or symbolic presence of an object that de-contextualizes and de-personalizes knowledge so that it can be transformed. Prior research has focused on objects ranging from standardized forms (Star and Griesemer, 1989) to narratives (Bartel and Garud, 2009) and even some authors have conjectured that routines (Wenger, 2000; Kuhn, 2002; Hayes and Fitzgerald, 2009) and knowledge (Carlile, 2004) can serve as boundary objects. While the boundary object concept can be subject to overextension (Wilson and Herndl, 2007), it is important to remember that labelling objects as boundary objects is traditionally an academic activity and not commonly done within organizations. Labelling boundary objects is often an *ex post* facto activity applied by scholars to objects that facilitated the overcoming of a knowledge boundary by providing a stable, and sometimes purely mental, artifact to promote coordination.

Numerous studies (e.g. Carlile, 2002, 2004; Koskinen and Mäkinen, 2009) have demonstrated the ability of objects to facilitate coordination across knowledge communities. This is because boundary objects are flexible, or plastic, enough to allow individuals from different communities to attach localized meanings to the object. However, there is enough common, shared meaning across communities enabling the object to bridge the cognitive gap (Star and Griesemer, 1989; Brown and Duguid, 1998; Kuhn, 2002; Carlile, 2002; 2004; Koskinen, 2005; Wilson and Herndl, 2007; Koskinen and Mäkinen, 2009). For instance, Carlile (2002) demonstrates that assembly drawings used by both assemblers and engineers almost immediately facilitated coordination. In other cases, the shared meaning of the boundary object needs to be developed or strengthened before the object can facilitate coordination (Koskinen, 2005). As Bechky (2003) argues, the de-contextualization provided by the object allows parties to transform knowledge across boundaries. In this manner, the object is removed from its in-use context allowing it to serve as a coordination platform.

Additionally, when overcoming pragmatic knowledge boundaries individuals need to adjust their current knowledge set. However, members of communities can take knowledge adjustments personally if they view their professional or self-identity is being challenged (Carlile, 2002). Boundary objects can facilitate coordination by de-personalizing the discussion. By focusing on an object, which is used by both

communities, the perceived threat to identities can be reduced. Further, objects have meanings. When presented with an object an individual can recall additional knowledge they have attached to this object. Thus, the associations attached to the boundary object can spark insightful knowledge connections that would have otherwise been missed.

Compared to boundary spanners, who mediate the transferring of knowledge, boundary objects objectify or remind parties of knowledge that ultimately facilitates coordination. In some situations a pre-existing object de-personalizes or de-contextualizes knowledge (Bechky, 2003) or the boundary object emerges during the spanning process. The necessity for dialogue, negotiation, and discourse (e.g. Koskinen, 2005) and, on occasions, engaging in activity with the boundary object (e.g.: Boland *et al.*, 2007) demonstrate that the boundary spanning process often relies on the presence of multiple spanning mechanisms. For example, Boland *et al.* (2007) show that the introduction of an innovative technology required extensive hands-on training and integration into current practice before the technology could serve as a boundary object. Additionally, boundary spanners and boundary objects suffer from a similar shortcoming, in that they heavily rely on existing knowledge to be recalled and transformed. Further, since boundary objects are incorporated into differing communities' practices this leaves knowledge objects or practices that emerged during the team's interactions unable to be classified as boundary objects, since they are not localized to the community. Thus, additional mechanisms are needed to fully analyze the spanning process.

3.3 Boundary practice

Boundary practice is defined as a boundary spanning mechanism that overcomes a knowledge boundary by engaging agents from different knowledge communities in collective activities. The focal unit of analysis for boundary practice is the practice which allows the co-engagement in activity, resulting in the generation of new knowledge which, in turn, facilitates coordination. Boundary practice is most effective in addressing knowledge boundaries involving tacit knowledge that is not easily codified into explicit knowledge. Engaging in practice not only helps in sharing tacit knowledge that cannot be expressed or one party does not fully understand (Polanyi, 1962; Boisot, 1998) but can also facilitate the understanding of another's interpretive framework. Ironically, boundary practices use the metaphor of "let's do it together" in order to cross knowledge boundaries. Thus, it bridges cognitive gaps by engaging experts from distinct communities in a process of co-generating knowledge.

Knowledge management literature, especially practice-based literature, has firmly established that engaging in practice develops knowledge. Further, Brown and Duguid (2001, p. 41) argue that "learning-in-working" is the only way to transfer tacit knowledge, because a portion of knowledge is contained in practice (Inkpen and Dinur, 1998; Carlile, 2002). Additionally, despite efforts to codifying knowledge, in most cases engaging in practice, in context, is what gives codified knowledge value (Brown and Duguid, 1991; Brown *et al.*, 2005). This is because in some cases the "know how" is more important than the "know what" (Polanyi, 1962). In prototyping, for instance, differing communities interact around the construction of an ideal elevating the importance of knowing how the system will work and be constructed over the ability to explicitly state how the system will work.

What makes a practice serve as a boundary practice? Boundary practices, compared with specialized practices within each knowledge domain, have the capability of

engaging knowers from different domains in a shared site of knowing (Nicolini, 2011). In fact, engaging in collective practices at the boundary of different knowledge areas creates a situation that facilitates the development of new knowing. The notion of context as an important driver in knowledge creation and innovation has been recognized by Nonaka and colleagues' (2000) *ba* space, for example. What seems less developed in previous studies is that in order to be a boundary practice, the practices should:

- be un-assignable or un-separable into sub-tasks that can be delegated to experts in each specialized domains; and
- be performed within a flexible space between the domains of expertise.

It is entirely possible that the boundary practice results in an outcome that can then serve as a boundary object, allowing for task delegation, however the development of the object was through boundary practice. For instance, prototyping is a situation where parties collectively engage in the development of a finished prototype that could serve as a boundary object in later episodes. Unlike the dominant focus of practice-based studies on established and routine practices, boundary spanning practices have significant novelties for experts from different knowledge domains. Boundary practice provides a zone of possibilities for co-creating new knowledge through engagement in a situated series of practices by different knowers.

The use of practice as a boundary spanning mechanism is mentioned but little explored in prior work. For instance, past research points to practice being used in conjunction with other boundary mechanisms (Levina and Vaast, 2006), such as when practical training is used with boundary objects (Carlile, 2004; Boland *et al.*, 2007). In fact, Star and Griesemer (1989), the originators of the boundary object concept, recognized that individuals using boundary objects sometimes need to learn how to *use* them correctly (p. 406). This learning process often involves training or demonstrating how to use the boundary object. However, the potential of using practice as a boundary spanning mechanism has been less formalized in spanning literature, partially due to the strong influence of the structural hole bridging metaphor promoted by network theory (Burt, 1997, 2004), over gap closing.

Boundary practice should not be confused with boundary work. Boundary work refers to routines or practices that bring community members into contact with non-members. Lawyers and front-line employees engage in boundary work when talking with clients and customers, respectively. These are normalized routines that involve cross-boundary interactions. Boundary practices are activities that are novel and occur in a space between normalized community routines. When various sub-trades assemble to install an innovative ventilation system in an existing building, they apply their practices iteratively and continuously in a contextualized, situated site of knowing and collaboration. Thus, boundary practice involves an overlap of practices but the practice itself is not specialized to a particular community, since the particular boundary practice emerges out of context and agents' collective actions.

3.4 Boundary discourse

Boundary discourse referrers to the content of knowledge that shapes the dialogue among the experts from distinct domains. More specifically, boundary discourse pays attention to what is communicated between knowledge communities. The main unit of

analysis for boundary discourse is the content of discourse that builds knowledge, ultimately allowing the parties to close the cognitive gap through newly acquired knowledge, primarily explicit knowledge. The ideas and issues which constitute such a dialogue need to have a minimum level of conceptual overlap with the cognitive schemas of involved experts, while properly distinct from dominant discourse within each community. In other words, boundary discourse should have a state of cognitive in-between-ness to be able to engage experts from different communities in the dialogue.

The deployment of boundary discourse is not necessarily regulated by boundary spanners, who have community knowledge, but can be used by experts who are engaged in cross-domain collaborations. Boundary discourse, as a boundary spanning mechanism, addresses the use of language and lexicon, building on syntactic and semantic knowledge similarities allowing the parties to overcome the knowledge boundary. This process of learning is similar to Bruner's (1977) scaffolding process. In scaffolding, a person identifies the current knowledge base of an individual and incrementally builds on knowledge until the knowledge objective is met. In project coordination, for instance, the knowledge objective is often emergent (Engeström, 2001) and based on the specific context and problem being addressed. Thus, it is often domain experts who can lead the discourse process through identifying, articulating and clarifying concepts.

It is important to clearly note how boundary discourse is related to boundary spanners and boundary objects, since both can involve verbal language. Spanners are concerned with translating and reformulating knowledge so another party can understand the meaning. Spanners are not focused on adjusting an individual's knowledge base rather they are interested in adjusting information to fit into an individual's existing knowledge base. Similarly, boundary objects serve as a focal point to attach and transform knowledge so that the parties can understand each other. This distinction enables verbal narratives to serve as boundary objects because they objectify knowledge, enabling people to represent or translate their ideas against the narrative (Bartel and Garud, 2009). Thus, despite being verbal in nature, a narrative or slogan are objects or vessels filled with meaning while boundary discourse is focused on identifying and adjusting an agent's knowledge base not objectifying the knowledge. Further, boundary objects are used by each party in their practice, while boundary discourse derives from community knowledge.

The introduction of boundary discourse provides another mechanism, besides translation, that boundary spanners can deploy in the boundary spanning process. Further, the identification of a learning based spanning mechanism allows for a deeper analysis into what accounts for the effectiveness of boundary spanners. For instance, is it the spanner's ability to translate knowledge or their ability to promote learning in the parties through building on prior knowledge that makes them effective? By viewing boundary spanning as process one begins to recognize that multiple spanning mechanisms are often utilized to overcome knowledge boundaries.

At this juncture it is helpful to summarize the spanning mechanism based on the spanning functions they serve (see Table I). Boundary spanners translate knowledge from one domain to another domain however the individual remains contextualized thus their status and social legitimacy (if exist) can facilitate or hinder the spanning process. In comparison, boundary objects transforms knowledge that can remind

parties about common themes by objectify, de-personalize the knowledge or de-contextualizing (Bechky, 2003) concepts that might have otherwise been difficult to notice in the absence of those objects. Differently, boundary practices fill the knowledge gaps by the co-creation of knowledge between distinct domains of knowing. Unlike boundary objects, boundary practices contextualize the problem and knowledge in the very specific context of knowing. Hence, boundary practices allow parties to learn knowledge. Finally, boundary discourses play their spanning role by sensitizing involved knowledge communities about ideas and themes which can fill the knowledge gap. Boundary discourses fill knowledge gaps by selecting and situating the dialogue on specific themes which can enhance the opportunities for knowledge building. Furthermore, boundary discourses, if properly selected, can articulate or clarify the knowledge of one side to be transferred to the other side.

4. Mechanism synthesis: towards a process model of boundary spanning

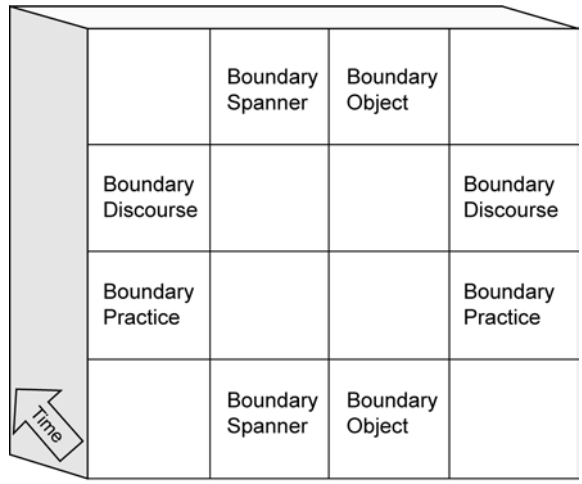
The four spanning mechanisms though intertwined in reality, are analytically distinct. Accordingly, these four spanning mechanisms bring to the fore different issues when studying the spanning mechanisms individually, as current literature typically does, or when studying how they are collectively and sequentially utilized during the spanning process. When studying boundary objects individually, the focus is on the shared meaning of the object (e.g. Carlile, 2002), the possibility of making sense of the object by different communities, and the impact of the physical characteristics of the object on the cognitive processes (e.g. Bechky, 2003). Research focusing on spanners typically addresses issues such as the required skills and characteristics, membership status in different knowledge communities, legitimacy and credibility, and the role of human issues, such as emotions and motivations that can effect knowledge translation. On the other hand, boundary practice brings to the fore the importance of tacit knowledge; the role of practice in knowing and creating new knowledge; and, the collective and socially situated nature of learning. Finally, studies interested in boundary discourse will pay more attention to the knowledge bases which are going to be closed and their cognitive distance along with the possible contents or concepts that can build the parties' knowledge to fill this gap.

The following section integrates these mechanisms addressing the deployment of the boundary spanning mechanism collectively during the spanning process over time. Incorporating time into the spanning process provides three main benefits to future research. First, the sequence of mechanism deployment is presented for analysis. This shifts focus to evaluating the process to develop an understanding of effective sequencing scenarios to facilitate future collaborations. Second, the interactions between mechanisms can be explored along with identifying when the mechanisms provide conflicting or synergistic effects. For example, is it beneficial to have boundary objects involved in boundary discourse or does the presence of an object artificially constrain the knowledge exploration characteristic of boundary discourse? Third, by recording the spanning process researchers can identify the key episodes that significantly shaped the outcome. In this sense, the legacy costs of employing a specific boundary mechanism could be detected and analyzed to guide future decision making.

It can be difficult to transform and translate knowledge across cognitive gaps because the other parties do not understand the social context in which the knowledge

was developed (Sapsed and Salter, 2004). Further, Dewey (1991) argues that when individuals are exposed to new knowledge they often hold this view in suspense while looking for additional support, especially if the knowledge does not easily conform to their interpretive framework. This period of suspense can stem from the epistemic differences due to residing outside a community or the de-contextualization of the knowledge could make it more difficult to understand another view, without applying the knowledge in context. Therefore, utilizing multiple spanning mechanisms can overcome states of knowledge suspension by providing context and a level of redundancy which facilitates learning (Nonaka *et al.*, 2000).

More specifically, the spanning process can be framed as an integration of several spanning mechanisms utilized by organizational experts over time. Figure 1 illustrates four boundary spanning mechanisms and shows different combinations of them[1]. Figure 2 illustrates two specific spanning scenarios where different temporal combinations of spanning mechanisms shape the spanning process.



Source: Authors

Figure 1.
Boundary spanning mechanisms matrix

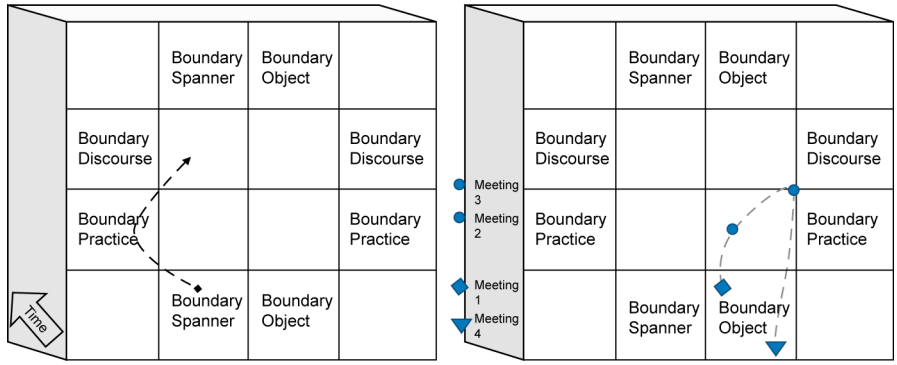


Figure 2.
Examples of boundary spanning traces

To better illustrate, Figure 3 shows how different spanning mechanisms have shaped a spanning process over time. We explain this process through four simplified episodes that present a general boundary spanning scenario exemplar.

Product development and other cross-disciplinary teams typically assign a project team leader, who occasionally functions as a boundary spanner throughout the spanning process. In our exemplar, for the first episode as a project facilitator the spanner translates the management's goals. As the interactions continue additional spanning mechanisms are introduced. Boundary objects could be used synergistically by the spanner. Perhaps, boundary discourse will emerge in an effort to develop a solution to the problem or outline a new product. Eventually, the boundary discourse requires action and boundary practice enters the spanning process.

For example, in software design under a Joint Application Development (JAD), knowledge boundaries between developers and users are first exposed and worked through using an initial boundary discourse which is often articulated as tentative system requirements. These requirements are neither far away from what developers know as technical solutions, nor are they too far from what users expect to have as the new system. Boundary practice arises during the prototyping process. Prototyping provides a shared site where opportunities to engage in cross-boundary practices arise. The eventual prototype changes both during the discourse and practice episodes, as agents interact together, collectively developing the prototype. While complete, the prototype, though not fully functional, has a minimum capacity to become a boundary object when it becomes integrated into the routines of various communities of practice. As a boundary object, the project facilitator, or spanner, can then assign separable tasks to communities (see Figure 3).

Identifying deployment sequences can be particularly challenging since the declaration that a boundary mechanism, for example a boundary object, is an *ex post* facto activity dependent on the success of the diagram overcoming the knowledge boundary (e.g. Carlile, 2002). As multiple mechanisms are utilized throughout the boundary spanning process, some being effective while others not, labelling them as a boundary object might not be realized until it is coupled with other boundary spanning mechanisms. Additionally, by viewing boundary spanning as a process researchers will be challenged to move from only classifying boundary mechanisms as actual boundary mechanisms if they are successful (Zeiss and Groenewegen, 2009); rather, researchers will need to view the deployment of each mechanism as having a compounding synergistic or conflicting effects. Specifically, even though a problem was not solved through discourse prior to the introduction of a boundary object, the prior discussions could have facilitated the success of the boundary object. This is similar to opening a jar after your friend could not and they promptly proclaim they loosened the lid allowing you to succeed! In the case of boundary spanning, perhaps engaging in boundary discourse adjusted their knowledge base facilitating the success of the final spanning mechanism.

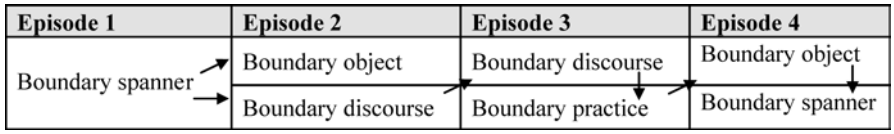


Figure 3.
Boundary spanning scenario

Knowledge boundaries arise during collaboration efforts to reach a solution or outcome. The final outcome, however, is not predetermined; rather, the final outcome is shaped by the interaction process that led to its development. Therefore, approaching boundary spanning as a process presents researchers and managers with the opportunity to trace backwards, to discover the specific episodes that became path dependant, leaving critical legacy costs on the final outcome. If the coordination process is perceived to be efficient, understanding the employment mechanisms and sequence would be beneficial if similar situations will arise in the future. However, if the final outcome is deemed ineffective, managers can trace backwards to identify the particular mechanism(s) that led to the negative legacy costs.

5. Discussion

Boundary discourse and boundary practice are different from the other mechanisms in that they focus on creating knowledge whereas spanners frame and translate knowledge and objects transform knowledge. The introduction of these new spanning mechanisms opens up future avenues of research. For instance, both spanners and objects involve existing knowledge while practice and discourse involve the co-construction of knowledge. Researchers exploring the synergistic or conflicting effects of each mechanism would be particularly fruitful for practitioners. During exploration episodes, is it reasonable to assume that the primacy provided by the use of existing knowledge could constrain the exploration, preventing boundary discourse from continuing to scaffold?

The incorporation of time into the spanning process supports rich explorations into the sequencing employment of spanning mechanisms. For time sensitive issues deploying a boundary spanner who focuses on translation over knowledge creation could be a prudent decision, however for less time sensitive issues utilizing boundary discourse or practice could prevent future boundary confrontations and thus be a more prudent decision. Practitioners would also benefit from studies that offered sequencing scenarios for complex decision making. Observation based studies can help determine if project teams are over-relying on spanners, in effect lengthening the spanning process, when the incorporation of boundary discourse would have developed a common ground in a more timely manner.

The time-based perspective of the spanning process helps us understand the fact that spanning roles (for each of the four mechanisms) can be both intentionally designed and emergent. A spanning process might start with intentionally introducing a series of boundary discourses, which they can in turn help the emergence of some objects to serve the spanning role. A similar scenario might take place when a spanner is not previously appointed, but during the spanning process the very deployment of a specific object or theme (discourse), foists a spanner status on them. Thus, as we tried to show, having a heterogamous and dynamic perspective of spanning helps us to consider these two modes of spanning mechanisms as duality, rather than dualism (Farjoun, 2010).

Innovation literature has found that resolving knowledge boundary conflict can often be a source of innovation (Wenger, 2000; Rosenkopf and Nerkar, 2001; von Hippel, 2005). The engagement in boundary practice and boundary discourse could offer additional insights into the innovation process. Perhaps, it is not the mere translating and transferring information from one community to another that leads to

innovation; rather it is the combining and synthesizing community knowledge in a shared site of engaging and knowing that creates innovative knowledge. von Hippel (2005) details a case of a kitesurfer who combined his kitesurfing skills and engineering skills to advance kitesurfing kits. It was in this shared space of practice, between kitesurfing and engineering that allowed him to develop innovative kites. Thus, future spanning research can also investigate the role of boundary practice and discourse in innovation development for it appears that these two mechanisms are utilized throughout the exploration process.

6. Conclusion

This paper introduces the roles of boundary practices and boundary discourse and shows how these two mechanisms are mutually interdependent, yet sufficiently distinct from the two traditional mechanisms. This analysis also relieves the pressure to overextend the boundary object concept (Wilson and Herndl, 2007). By shifting attention to spanning as a process it is revealed that multiple boundary spanning mechanisms are often deployed to overcome a boundary object. Additionally, this analysis suggests that each mechanism can benefit from the compounding effect of being linked together with other spanning mechanisms. Lastly, the provided spanning mechanism framework is offered as a conceptual foundation to begin explorations into knowledge boundary spanning as a process, involving combinations of various mechanism that have lasting effects on the outcome.

Surely, the conceptual framework suggested in this paper for spanning process requires future empirical studies to examine its relevance for analyzing spanning cases. As our framework shows, the spanning process often straddles various spanning mechanisms. Thus, researchers should be open to refining existing mechanisms as well as identifying spanning strategies. In addition, this general spanning process framework can be specialized by putting it into a contingent view. Various factors such as the task complexity and time pressure can shape the spanning process, giving more reverence to some spanning mechanisms over others.

Note

1. Please note that all permutations of the four mechanisms are not observable in this Figure, and this Figure only serves to aim illustrating the integrative framework.

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