Innovation in Academic-Industry Partnerships: Measuring the Challenges to Effective Performance

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ABSTRACT

The goal of this paper is to propose a method to measure the perception of discontinuities and development of continuities that will impact a distributed team's ability to achieve effective performance. The proposed method is grounded in organizational discontinuities theory within the context of innovation teams. Future research can use this method to understand differences in performance outcomes for academic-industry partnerships, and improve the capability, effectiveness, and output of innovative teams.

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INTRODUCTION

Distributed teams are groups of geographically- and often organizationally-dispersed individuals working together over time towards a common goal. They may be particularly useful for innovation, as teams benefit from diverse ideas, capabilities, expertise and experiences (Edmondson, 2002). At the firm level, Ahuja (2000) found that the number of direct and indirect ties a firm had positively impacted innovation output. At the team level, Taylor & Greve (2006) suggested that teams with "multiple knowledge domains produce novel combinations that increase the variance" of innovation. These findings fit with the conclusions of a review paper that concluded that team performance benefits from access to a diversity of opinions (Horwitz & Horwitz, 2007). However, while distributed teams have many potential benefits, distributed workers face many real challenges. Watson-Manheim, Chudoba, & Crowston (2002) argued that distributed work is characterized by numerous discontinuities: a lack of coherence in some aspects of the work setting (e.g., organizational membership, business function, task, language or culture) that hinders members in making sense of the task and communications from others (van Fenema, 2002; Wilson, Crisp, & Mortensen, 2009), or produce unintended information filtering or misunderstandings (Armstrong & Cole, 2002; Cramton, 2001; Dougherty, 1992). These interpretative difficulties in turn make it hard for team members to develop shared mental models of the developing project (Espinosa et al., 2001). A lack of common knowledge about the status, authority and competencies of team participants can be an obstacle to the development of team norms (Bandow, 1997, p. 88; Mortensen & Hinds, 2001) and conventions (Mark, 2002).

The presence of discontinuities has been shown to be particularly problematic for teams seeking to innovate. Gibson & Gibbs (2006) noted four specific features of distributed work

(geographic dispersion, electronic dependence, structural dynamism and national diversity) that hindered innovation. More effort is required for interaction when participants are distant and unfamiliar with each other's work (Hinds & Mortensen, 2005; Ocker & Fjermestad, 2000; Seaman & Basili, 1997). The additional effort required for distributed work often translates into delays compared to traditional face-to-face teams. For example, academic-industry partnerships funded by the National Science Foundation's (NSF) Partnership for Innovation (PFI) program, which typically have distributed team members, often require extensions to complete their planned work (Informal communication with NSF program officers, 2011). In response to the problems created by discontinuities, studies of distributed teams stress the need for a significant amount of time spent learning how to communicate, interact and socialize using information and communication technology (ICT) (Butler, Sproull, Kiesler, & Kraut, 2002). Communication can help clarify potential uncertainties and ambiguities and socialize members with different cultures and approaches into a cohesive team (Grabowski & Roberts, 1999; Jarvenpaa & Leidner, 1999; Kiesler & Cummings, 2002; Kraut, Steinfield, Chan, Butler, & Hoag, 1999). Formal and informal coordination mechanisms are also important for a project's performance (Hinds & Mortensen, 2005; Walz, Elam, & Curtis, 1993). Cohen & Levinthal (1990) noted that the "ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends is critical to its innovative capabilities," an ability they called absorptive capacity. In summary, successful distributed teams share knowledge and information and create new practices to meet the task and social needs of the members (Levina & Vaast, 2006; Orlikowski, 2002; Robey, Khoo, & Powers, 2000). However, the nature of these practices and their relation to performance and innovative outcomes are still important topics for research. The goal of this paper is to propose a method to measure the perception of discontinuities and

development of continuities that will impact a distributed team's ability to achieve effective performance. The proposed method is grounded in organizational discontinuities theory within the context of innovation teams. Future research can use this method to understand differences in performance outcomes for academic-industry partnerships, and improve the capability, effectiveness, and output of innovative teams.

The remainder of the paper is organized as follows. In the following section, we first present the theoretical basis for our study, a theory of organizational discontinuities that conceptualizes the problem of distributed work and how workers in this setting adapt their practices to work together effectively. Then we propose a method for evaluating the propositions developed in the theory section. We conclude with a brief discussion of possible outcomes from use of our method and appropriate responses to enhance the performance of academic-industry partnership teams.

THEORY DEVELOPMENT

In this section we develop the theoretical model that we will use as the basis for the proposed research method and project. As noted above, a significant advantage of distributed teams is the way they facilitate access to diverse knowledge. There is considerable agreement in both theory and practice that cross-functional teams are crucial for successful new product development (Brown & Eisenhardt, 1995; Hauser, Tellis, & Griffin, 2006; Nakata & Im, 2010). Much of the research on innovation has been carried out in a single firm in the context of new product development (Boland, Lyytinen, & Yoo, 2007; Hauser et al., 2006). However, innovation is often a distributed phenomenon taking place across networks in an industry, e.g., in building design and construction (Boland et al., 2007), within consortia of multiple organizations (e.g., Kodama, 2002) and academic-industry partnerships (e.g., Dixon & Panteli, 2010).

While distributed teams seem to offer some advantages for innovation, achieving integration across the various boundaries is problematic. Conflicts often increase (Griffin & Hauser, 1996; Hinds & Mortensen, 2005) and communications problems arise when transmitting information across the boundaries between different domains (Beverland, 2005; Carlile, 2002; Hauser et al., 2006). Perhaps as a result, findings from research on the link between integration in cross-functional teams and new product performance have been equivocal, with the link found to be positive, negative and non-existent (Nakata & Im, 2010). We interpret this evidence as suggesting that some innovation teams have problems capitalizing on the diverse knowledge and background of their members, but that others do not.

Similar inconsistent findings have been found in other research on distributed teams, e.g., conflicting findings from prior research on the implications of cultural diversity in virtual teams for conflict (e.g., Dube & Pare, 2001; Kankanhalli, Tan, & Wei, 2006/2007; Mortensen & Hinds, 2001). To address these apparent inconsistencies, we draw on a new theory of the effects of boundaries on distributed work, organizational discontinuity theory (Watson-Manheim, Chudoba, & Crowston, 2011). In this model, boundaries between team members are problematic only to the extent that they create problems. Furthermore, if members of the teams recognize a communication or work process problem, they may adapt their actions to create shared routines and mental models and thus mitigate the problems. In the context of innovation teams in particular, adapting processes and practices across boundaries to integrate the varied knowledge and experience of team members has been found to maximize the speed and productivity of the development process (Beverland, 2005; Brown & Eisenhardt, 1995; Carlile, 2002; Eisenhardt & Tabrizi, 1995; Majchrzak, Rice, Malhotra, King, & Ba, 2000; Malhotra, Majchrzak, Carman, & Lott, 2001; Nakata & Im, 2010). As a result, a crucial source of competitive advantage and

successful performance can be gained through a better understanding of this adaptation in innovation teams and how it takes place.

The context for the research is comprised of academic-industry partnership teams focused on innovation, e.g., developing innovative commercial applications for new technologies. Such teams can draw on more diverse bodies of expertise and knowledge, but to be successful, team members must collaborate across boundaries of organization, profession, distance and even time. A further complication in such teams is that the members are often multi-teaming, meaning that participation in this partnership team is not the only responsibility members have: they are concurrently members of the consortium team and members of teams in their home organization (Mortensen, Woolley, & O'Leary, 2007).

To develop the specific propositions, we first develop a conceptualization of boundaries and their effect on work, introducing the concept of discontinuities as a way to describe the problems created. We then discuss how discontinuities may be recognized and then managed, introducing the concept of continuities to describe how these problems can be mitigated. We present a synopsis of the theory, however the full description can be found in (Watson-Manheim et al., 2011).

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Boundaries and Discontinuities

We start with the concept of boundaries in distributed work. Boundaries are important because they distinguish one domain or situation from another, ordering and simplifying the environment (Ashforth, Kreiner, & Fugate, 2000; Schneider, 1987; Schreyögg & Sydow, 2010). Recognizing what is inside and outside of boundaries helps individuals decide where to focus their attention and how to access needed resources. Common understanding of behavioral rules and expectations within the boundary increases efficiency of operations (Ashforth et al., 2000;

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Comment [2]: Could add reference to focus theory here (or not if it muddles things). Focus theory (Feld 1981) tries to explain patterns in social networks. The "focus" could be the workplace or an organization where people are engaged in joint activities. Joint involvement in the activities is the basis for the social ties and development of a network that connects the interacting people.

Schreyögg & Sydow, 2010). The actions of individuals who work within a boundary are integrated (Ashforth et al., 2000; Schneider, 1987) and form a coherent set of structures reflected in social practices (Levina & Vaast, 2006; Orlikowski, 2002). Thus, boundaries are reified and solidified through the actions, behaviors and beliefs of those within the common domain. Routines, or patterns of behavior, common language and background differentiate boundaries and often constitute the boundary (Feldman & Pentland, 2003; Schreyögg & Sydow, 2010).

Boundaries have been a useful conceptual tool for studying distributed teams in particular. In this context, boundaries have generally been understood as static demarcations that separate the individual team members, such as geography, time zones or organizational and national boundaries (Espinosa, Cummings, Wilson, & Pearce, 2003). Similarly, boundaries have been useful in conceptualizing teams involved in innovation (e.g., Carlile, 2004; Hauser et al., 2006). In these research streams, boundaries have been considered as points (or areas) where differences between team members become salient and potentially problematic. Coherence within a boundary, however beneficial, may lead to difficulties when individuals must work across boundaries. The problems faced when working across boundaries are not due simply to the demarcations separating them but may be due to the differences in actions, attitudes and experiences (Levina & Vaast, 2006; Maznevski & Chudoba, 2000; Mortensen, Caya, & Pinsonneault, 2009).

However, boundaries are not uniformly or even necessarily problematic. In many cases, dispersed teams, including those involved in innovation, are able to adapt their processes over time to span these differences (Bjørn & Ngwenyama, 2009; Gibson & Gibbs, 2006; Orlikowski, 2002). To understand how people adapt to working across a boundary, it is important to distinguish the static boundary from the relational effects of the boundary. We suggest that a

boundary becomes problematic when an individual perceives a change in information and communication flows that requires conscious effort and attention to handle (Watson-Manheim et al., 2011). We define this disruption as a *discontinuity*. For example, Dixon & Panteli (2010) presented a case study of a UK-based academic-industry partnership established to create exploitable knowledge and technologies by developing a portfolio of research projects and create linkages across projects. In this setting, they found discontinuities stemming from the different work practices, priorities and culture that members brought from their 'home' organizations (Dixon & Panteli, 2010). Their findings are consistent with other research that has found communication and setting priorities are often problematic in academic-industry collaborations (Pertuzé, Calder, Greitzer, & Lucas, 2010; Walsh & Maloney, 2007).

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Comment [3]: Change reference to the online version on ISJ's website

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Comment [4]: Leonardi 2011 (Org Science) talks about challenges in innovation projects because of differences in org culture

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Detecting discontinuities

We next discuss how individuals might detect discontinuities. We have argued that for a discontinuity to exist, a disruption must be perceived and recognized as attributable to the boundary. Recognition is important to "trigger" an individual to move from a relatively automatic behavior mode to a more attentive and reflective mode of thinking (Watson-Manheim et al., 2011). Detecting discontinuities is then dependent on individuals paying sufficient attention to work practices and interactions with co-workers to recognize and attend to potential problems.

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However, we note though that working across a boundary need not lead to a discontinuity. Similar to dormant faultlines, or demographic differences among group members, which have the potential to create conflict but are not always activated (Lau & Murnighan, 1998), boundaries may exist but may not lead to discontinuities between group members. Specifically, if flows of communication and action are as expected or require minimal attention

and effort to manage, then the situation is perceived as normal, i.e., a discontinuity is not present (Watson-Manheim et al., 2011). This perception of normality can happen for three reasons. First, individuals may have negotiated common understanding of concepts, work practices and behavioral rules at the boundary such that disruptions do not occur. This negotiation may take place explicitly (Dixon & Panteli, 2010; Watson-Manheim et al., 2011) or tacitly, e.g., through use of boundary objects (Carlile, 2002; Kellogg, Orlikowski, & Yates, 2006) or previous experience (Gabarro, 1990; Wilson et al., 2009). Alternatively, people may view the disruption as an exception or anomaly that does not require adaptation or effort to handle, i.e., not as a discontinuity. For example, individuals may attribute perceived problems to shortcomings of or mistakes made by other team members (Cramton, 2001) and not as a situation requiring any adaptation. Finally, team members may not be actively engaged in communication, with little consideration of others viewpoints and perspectives and limited deliberation and reflection among members. In this situation, communication is superficial and may not be productive for the team but individual members are likely not to perceive a discontinuity.

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Kathy: ?? Anticipate formation of subgroups would be evident from network analysis.

Discontinuities are perceived at the individual level but the experience may be cumulated across members of a team creating difficulties for communication and information sharing. For example, the combined perception of discontinuities by multiple individuals may lead to the emergence of subgroups (O'Leary & Cummings, 2007). In the setting we want to study, multiple academic members may perceive discontinuities in working with industry partners, leading to difficulties in communication and information flows that have an effect on team performance. We suggest if a discontinuity is perceived by a critical mass of team members, the discontinuity is aggregated across the team and will become a shared team property affecting the performance of the entire team (Klein & Kozlowski, 2000; Markus, 1987) (see Figure 1).

P1: If a discontinuity perceived at the individual level is experienced by a critical mass of team members, the discontinuity will a) become a shared team property and b) will have a negative affect on team performance.

--- Insert Figure 1 about here ---

Constructing continuities

We turn next to individual and group response to discontinuities. In the previous section, we argued that a boundary leads to a discontinuity when extra effort is involved to navigate a boundary and actions taken to work across the boundary do not produce expected results. Individuals must then make sense of the disruption to be able to make changes to address the problem. This extra effort may prompt them to vary their actions to reduce discomfort surrounding the situation (George & Jones, 2001). They may be motivated to pay more attention to the situation and consider alternative routines of behavior to deal with the discontinuity, leading to the emergence of new behaviors. Thus, a corollary to discontinuities is the emergence of continuities. A *continuity* reduces or eliminates the problems associated with the boundary (i.e., the discontinuity). The additional attention and effort required to understand and manage the situation when it was initially perceived is reduced (Dixon & Panteli, 2010; Watson-Manheim et al., 2011). For example, Dixon & Panteli (2010) found that some pre-existing boundaries provided means for continuity to emerge, such as members with previous marketing experience banding together to form an ad hoc team to address new issues that required marketing expertise. Thus, continuities are defined as equivalent expectations across members of a group leading to group understanding and accommodation, and are a construct distinct from discontinuities. Continuities can be created through deliberate management or group member

intervention or emerge as members work through problems arising from the presence of discontinuities.

However, a change in behavior only leads to a continuity when it is repeated over time, typically because it resolves problems triggered by perceptions of the discontinuity. The repetition leads to expected patterns of behavior and a new normal in work practices is created (Feldman & Pentland, 2003). If, however, the change in behavior does not lead to the expected results or a positive outcome, then individuals may try something else or alternatively, revert back to their prior work practices. Trial and error is often necessary in novel situations as members of teams try to resolve problems. Individuals may be willing to repeat the new behavior for some time even if it does not immediately achieve the desired results, perhaps making minor modifications over time in search of a solution. We suggest that behaviors that are perceived to reduce the problems associated with a discontinuity and are repeated over time become expected and ordinary, i.e., a continuity is developed at the team level, resulting in the boundary becoming unproblematic for members. Thus, we propose:

P2: Adjusted behaviors that are perceived to reduce the problems associated with a discontinuity and are repeated over time by a critical mass of group members become expected and ordinary, i.e., a continuity is developed, resulting in the boundary being unproblematic to the group.

Effects on Academic-Industry Team Performance

We next examine the effects of discontinuities and continuities on team performance. We focus our discussion on the particular setting we plan to study, that of academic-industry partnership teams focused on innovation. Collaboration between these groups can provide significant potential benefits for both parties. Companies can access advanced technologies with

less risk than internal development and lower cost than working with industry partners. Universities can increase income from external funding as well as royalties and licensing and patenting income (Barnes, Pashby, & Gibbons, 2002). NSF has funded a number of such initiatives through its PFI program. For example, the Wireless Grid Consortium team's objective is to develop and commercialize technology that allows wireless devices to recognize each other and after appropriate authentication, self-assemble into a communications grid (http://wglab.net/wigit). The Oregon Commercialization Initiative (OCI) is a partnership between Oregon State and Portland State Universities. Its objectives include providing an incubator for prospective commercialization opportunities and enhancing knowledge transfer by providing the knowledge and tools needed to identify and prepare research projects for commercialization (http://www.virginia.edu/vpr/pfi/aboutpfi_awards.html) . However, the potential benefits of partnerships between very diverse organizations are often not realized in practice (Barnes et al., 2002). We believe that examining performance of these teams from a discontinuity/continuity perspective can help identify teams that are most likely to have successful outcomes, as well as identify and diagnose those teams that are likely to be less successful. We first present a series of propositions, followed by a suggested classification of different types of teams.

Role of continuities

Academic-industry partnership teams bring together members from very different organizations with distinctive work styles, cultures, and social objectives, among others. As well, the individuals involved have different backgrounds, professional training, education and experience. Thus, there is significant potential for conflict and misunderstanding between members on a wide range of issues, from conflicts over resources and personnel assignments (Olson, Walker, & Ruekert, 1995) to project goals, priorities and timelines (Barnes et al., 2002).

Research in a variety of team settings where members have diverse backgrounds has found that common understanding across team members has a positive impact on performance. Espinosa and his colleagues (Espinosa, Slaughter, Kraut, & Herbsleb, 2007) found that increased task familiarity and team member familiarity had a positive impact on performance in distributed software development teams. Similarly, in new product development teams within organizations, ease of communication among team members from different functional areas has been found to have a positive relationship with innovative outcomes (Sethi, Smith, & Park, 2001). In addition, research on academic-industry partnerships has found that high levels of trust and commitment could counteract communication difficulties (Barnes et al., 2002) leading to a higher likelihood of success. We have defined continuities as equivalent expectations across team members that lead to common understanding, identity and shared practices. Thus, we propose:

P3: Academic industry partnership teams exhibiting high levels of continuities will perform better than teams with low levels of continuities.

Are discontinuities always a negative?

Even if communication is perceived to be difficult, that may not have negative repercussions for performance in academic industry partnership teams. Different backgrounds of members have been linked to innovativeness of team outcomes in a variety of product development settings (Sethi et al., 2001). The likelihood of innovative outcomes improves as the diversity of input increases. However, team members may perceive difficulty in communication and increased conflict due to their divergent views and varied backgrounds (Ancona & Caldwell, 1992a). For example, academic team members may tend toward novel technological applications while industry members may tend toward more standardized applications.

We propose that discontinuities are not always a negative phenomenon. High levels of

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Comment [9]: Could add Espinosa et al. 2007 (org sci) - >task familiarity and >team familiarity had positive impact on performance in distributed software dev teams.

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Comment [10]: Need to incorporate virtual organization citations if submit to VOSS: here are examples funded by NSF. http://en.wikipedia.org/wiki/VOICED http://socialnetworks.bowdoin.edu/2011/08/04/virtual-organization-breeding-environment-visualization-tool/

and here's a Canadian example http://www.nomj.ca/Articles/Technology/10-08-virtual.aspx

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discontinuities may be beneficial for innovation, with any negative effects counteracted by continuities. Research has found that cohesiveness and "social glue" in teams can counteract negative effects of functional diversity (Keller, 2001). On the other hand, if there are low levels continuities, the high level of discontinuity may lead to poor performance. Sethi and colleagues (Sethi et al., 2001) found that while "Functional diversity had no direct effect on cohesiveness, but functional diversity did lead to increased job stress, and the indirect path through job stress resulted in lower cohesiveness as team members became increasingly dissatisfied with work on the team."

Commitment and motivation of team members are important to the success of academic-industry teams (Barnes et al., 2002). Membership on this type of team is typically not a full-time job; members have other priorities that have to be managed. We suggest that if communication is difficult for members due to discontinuities and there are not continuities to counteract them, then performance of the team will suffer as members becomes less motivated and committed to the team.

P4: Academic industry partnership teams exhibiting high levels of discontinuities and high levels of continuities will perform better than teams with low levels of continuities.

Generally, creative project teams (Ford & Sullivan, 2004) and particularly new product development teams (Ancona & Caldwell, 1992b; March, 1991) are acknowledged to have distinct phases: a creation or exploration phase and an execution or exploitation phase. "Exploration enables the creation of new knowledge, whereas exploitation supports the refinement and use of existing knowledge" (Levinthal & March, 1993) as cited in (Lavie, Kang, & Rosenkopf, 2011). Lavie and his colleagues argue that there is a tension between exploration and exploitation, and organizations might want to alternate between the two over time because

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Comment [12]: if the discontinuities result in different perspectives being considered, ideas generated

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Comment [13]: Horwitz and Horwitz 2007 in JoM positive impact of task-related diversity on team performance although bio-demographic diversity was not significantly related to team performance.

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Comment [14]: I think concept originally associated with March (1991) but may not want to use his precise definitions. Found in org learning lit:

"Exploration includes things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation. Exploitation includes such things as refinement, choice, production, efficiency, selection, implementation, execution" (p. 71)

Levinthal and March (1993), "exploration enables the creation of new knowledge, whereas exploitation supports the refinement and use of existing knowledge" – quote is from Lavie et al., Org Sci, 2011. Lavie et al. say there's a tension between the two activities and orgs might want to alternate between the two over time because they require resource trade-offs, conflicting org routines

There's also an AMJ article by gupta et al. 2006 that specifically looks at interplay between explor. and exploit.

they require resource trade-off and conflicting organizational routines. Surfacing novel ideas and divergent opinions is especially important for success in the project formulation stage (Ford & Sullivan, 2004) or exploration. At the end of this phase, however, internal patterns of interaction should stabilize and become more predictable as the group transitions to the next phase (Ancona & Caldwell, 1992b). Moreover, surfacing novel ideas in the execution or exploitation phase can lead to poor performance and less creative outcomes (Ford & Sullivan, 2004). Thus, to the extent that discontinuities result in the generation of diverse ideas and perspectives, they may not be problematic during the idea generation or exploration phase of a team's life, and the shared work practices associated with continuities may not be necessary to see this benefit.

P4a: High levels of discontinuities and low levels of continuities in the exploration stage of the innovation process will be less likely to have a negative effect on overall team performance than high levels of discontinuities and low levels of continuities in the exploitation stage.

Interplay of discontinuity and continuity over time

Teams experience discontinuities as members expose their differences. Members may exert significant effort as they struggle to understand each other and evaluate differing perspectives on problems and issues. However, exposing differences can lead to more predictable relationships among team members (Gabarro, 1990). Through exposing differences, members of a team may begin to develop a shared identity and norms of practice that work best for group. In particular, norms that promote open task discussion have been found to have a beneficial effect on teams performing innovative tasks (Jehn, 1995). In Gabarro's model of the development of relationships, individuals move toward stabilization in their relationships, defining an interpersonal contract of behavior that is difficult to destabilize (Gabarro, 1990).

Thus, we suggest that exposing and navigating differences among team members is important not only for leveraging the diverse knowledge of team members but also for enhancing overall team effectiveness through the development of continuities. Alternatively, if teams do not go through this process, they are less likely to develop appropriate continuities. We propose the following:

P5: Academic-industry partnership teams with high levels of discontinuity and low levels of continuity are more likely to develop high levels of continuity than teams exhibiting low levels of discontinuity and low levels of continuity.

MEASURING DISCONTINUITIES AND CONTINUITIES

In the previous section, we developed a set of predictive propositions about discontinuities and continuities and their effects on work in distributed academic-industry teams. We suggest a mixed methods approach to ground and test this theory, at both individual and group levels of analysis. A series of case studies can help determine how the general constructs of the theory—boundaries, discontinuities and continuities—are expressed in academic-industry partnerships. Examining the teams at both individual- and team-levels of analysis by following guidelines from Klein and Kozlowski (2000) to ensure analyses are theoretically and methodologically sound can provide a more comprehensive understanding. As they recommend, one must explicitly address issues of construct measurement, model development, sampling, and analysis throughout the conduct of the research. We focus on step 1—construct measurement—in this paper and now explain how the research might be conducted, as well as the possible implications of findings from the case studies.

Construct and Measurement Choices

As Klein and Kozlowski (2000) argue, individual-level constructs are not likely to provide valid insights into team performance. They recommend examining three levels of team-level constructs: global properties, shared properties and configural properties. Global properties are "objective, descriptive, and easily observable" characteristics that are not related to individual team members (Klein & Kozlowski, p. 215). These properties can likely be gleaned by reviewing a team's website or from interviews with team leaders. Examples of global properties in the context of academic-industry partnerships might include team location (e.g., face-to-face or distributed) and its function or mandate (e.g., its objective as articulated to a funding agency).

Shared properties are those held by all members of a team and include "team cohesion, team norms, team climate, and team mental models" (Klein & Kozlowski, p. 215). While shared properties are assessed by querying individual members of a team, Klein and Kozlowski differentiate between individual- and team-level properties using the construct of efficacy. Asking team members how they perceive their own abilities is associated with self-efficacy, an individual-level construct. Asking team members how they perceive the team's ability to accomplish its objectives is a team-level construct, which is a shared property. Should individual-level responses indicate agreement across the team, then the data can be aggregated to represent a shared property. In terms of the propositions offered in the previous section, if members of a team agree on work practices, the work practices would constitute a continuity and be considered a shared property of the team.

A team's configural properties include "individual team members' experiences, attitudes, perceptions, values, cognitions, or behaviors (Klein & Kozlowski, p. 217). As with shared

properties, these can be gathered from individuals on a team but are meant to "capture the array, pattern, or variability of individual characteristics within a team." One does not assume that configural properties are shared across members of a team. Team performance is a configural property since it is usually conceptualized as an aggregation of the performance of individual members of the team (Klein & Kozlowski, 2000).

In order to assess shared and configural properties in academic-industry partnerships, we recommend asking members of the teams to evaluate relationships with other members of the team in terms of the presence of perceived discontinuities and continuities. The items shown in Table 1 reflect one way to do this. The items to assess objective boundaries perceived as discontinuities are drawn from prior research on distributed teams that identifies boundaries likely to be perceived as problematic (e.g., Chudoba, Wynn, Lu, & Watson-Manheim, 2005; Espinosa et al., 2003). Items to assess the development of continuities are drawn from research on distributed teams or virtual organizations that point to coordination practices such as shared norms that are strongly associated with effective performance. The first item looks at the role of shared communication practices and norms about the use of ICT (Watson-Manheim & Bélanger, 2007). The next set of items is drawn from a study of an interactive marketing organization that requires cross-boundary coordination within the context of uncertainty and rapid change (Kellogg et al., 2006). The items capture the role of display practices (item 2), representation practices (item 3), and assembly practices (item 4) to facilitate cross-boundary coordination. Items 5 and 6 are designed to assess the role of relational coordination, a communication-intensive form of coordination, and specifically shared goals and shared knowledge (Crowston & Kammerer, 1998).

--- Insert Table 1 about here ---

In sum, asking each individual on a team to assess his/her perception of discontinuities and continuities relative to every other member of the team will result in a matrix that can be evaluated to determine whether the data represent shared or configural properties of the team. The analysis is based on the pattern of responses, rather than the actual value/number provided by a team member in response to a question. For example, one might use software such as UCINet (http://www.analytictech.com/ucinet/) to create a pictorial representation of the data and determine whether the team is characterized by low or high discontinuities, and low or high continuities. Next, we suggest how such data could be interpreted and possible intervention strategies.

Characterizing Teams in Terms of Discontinuities and Continuities

Distinguishing academic industry partnership teams in terms of discontinuities and continuities can help identify those teams which are more likely to have successful performance outcomes. As well, such a framework can help recognize teams with potential performance problems and provide guidance for mitigating problems, therefore increasing the likelihood of successful performance. We briefly discuss the distinguishing features of teams in each quadrant of Table 2, identifying difficulties they may face as well as possible intervention strategies.

--- Insert Table 2 about here ---

Distracted team – Low Discontinuity/Low Continuity. These teams perceive little difficulty in communicating and low levels of shared practices. Individual team members may perceive few problems, but as a whole this team may have significant performance problems. As we have discussed, successful team level innovation requires the surfacing of divergent ideas and viewpoints of individual members. If team members are not actively expressing opinions and beliefs as well as reflecting on, and even challenging the opinions of others, innovative team

level outcomes may not surface. Moreover, the lack of open communication between members is also likely to inhibit the development of mutual expectations and routines of communication practice that have been found to also be important for team performance. Intervention for teams in this quadrant could focus on identifying the level of commitment members have to the team. Members of academic industry teams are often juggling many projects and responsibilities and may lack time or resources to effectively contribute. Alternatively, the goals of the team may not be clear to all members thus there is little foundation for engaged communication to occur.

Struggling Team – High Discontinuity/Low Continuity. Members of teams in this quadrant perceive communication difficulties but do not perceive significant levels of shared practices with colleagues. In this situation, members find communication so demanding that participation on the team becomes stressful and their commitment may subside (Keller, 2001). The team may move to the distracted quadrant with serious consequences for performance. Intervention could involve providing team etiquette (e.g., each person should provide input to discussions; the team must establish regular meeting schedules), or make provisions for frequent, ad hoc communication (Hinds & Mortensen, 2005) as that has been found to help overcome conflict.

Cohesive Team – Low Discontinuity/High Continuity. Members of teams in this quadrant do not perceive significant effort in communication with colleagues and perceive high levels of shared practices. In this case, individuals may have negotiated common understanding of concepts, work practices and behavioral rules that support ease of communication. These teams should be expected to perform well especially in the exploitation stage of innovation. However, members may need to be aware of groupthink and its associated problems. Low levels

of task- related conflict are associated with poor performance outcomes in cross-functional team as members became too complacent in their interactions (Jehn, 1995).

Engaged Team – High Discontinuity/High Continuity. Members of teams in this quadrant perceive significant effort in communication with colleagues but also perceive high levels of shared practices. These teams should be expected to perform well, especially in the exploration stage of innovation. Even though communication is perceived as requiring significant effort, the high continuities developed by the team should help counteract the possible stress and emotional discomfort arising from high levels of discontinuity. However, in the exploitation stage of product development, research has found that the introduction of novel ideas can disrupt performance by diverting attention from project execution activities (Ford & Sullivan, 2004). These teams may need to be aware of this potential problem in order to achieve high performance.

CONCLUSION

Academic-industry partnerships for innovation work together as a loosely structured distributed team. Our focus on academic-industry partnerships reflects initiatives common around the world. Governmental institutions recognize that innovation fuels economic development and even before the recent world-wide recession, have sought to support enterprises that have the explicit goal of creating innovation. The programs vary in terms of the research areas they support and the governance mechanisms used to ensure accountability, but the overall objective remains the same: support high value/moderate risk partnerships to conduct research that is likely to enhance economic development. These partnerships are an appropriate context to examine organizational discontinuities theory because teams include members representing multiple constituents who are geographically dispersed. As a result, the teams that comprise

these partnerships will have members who face boundaries of geography, organization and professional background among others. To be successful, team members will have to develop ways to work across boundaries, that is, to develop continuities.

We have offered a set of propositions to assess the effects of discontinuities and continuities on academic-industry performance. Next, we suggested a multi-level method to measure the perception of discontinuities and development of continuities, followed by examples of how the resulting data could be interpreted. Future research can test this method and evaluate its ability to illuminate differences in performance outcomes for academic-industry partnerships, and subsequently, improve the capability, effectiveness, and output of innovative teams.

Figure 1. Proposed Effects of Discontinuities and Continuities On Team Performance

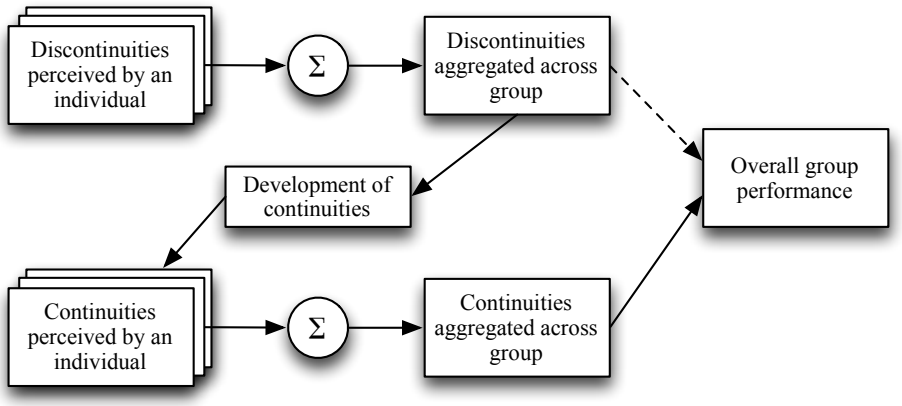

Table 1. Measuring Perceptions of Discontinuities and Continuities

Team members asked to assess each question relative to each of the other members of the team.	
Objective boundaries perceived as discontinuities On a scale of 1-7 with 1=not at all and 7=a great deal to what extent is interaction problematic and/or requires "extra effort" ….	1. Because we make heavy use of communication technologies like e-mail, telephone, chat, and/or Internet-based conferencing applications. 2. Because we work in different time zones. 3. Because our national or birth cultures are different. 4. Because our organizational cultures are different. 5. Because we speak different first languages. 6. Because our professional training is different.
Development of continuities On a scale of 1-7 with 1=not at all and 7=a great deal to what extent is interaction better ….	1. Because we agree how communication technologies like e-mail, telephone, chat, and/or Internet-based conferencing applications should be used. [MB and FB – technology portfolio] 2. Because we know about each other's work and commitments to the team. [Kellogg et al. display practices OS 2006] 3. Because we have established ways to share information and ideas [Kellogg et al. representation practices OS 2006] 4. Because we can reuse or revise work from prior projects to create new work products. Kellogg et al. assembly practices OS 2006] 5. Because we share the same goals about the team's task. [relational coordination – shared goals] 6. Because he/she knows the work that I do on the task. [relational coordination – shared knowledge]

Table 2. Teams Characterized by Extent of Continuity/Discontinuity

		Continuity Extent of shared practices, shared identity within team	
		Low Continuity	**High Continuity**
Discontinuity Extent of effort and attention required for communication and information flows within team	**Low Discontinuity**	Distracted	Cohesive
	High Discontinuity	Struggling	Engaged

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