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Greater Innovation by the Crowd in Crowdsourcing: The Sequencing of Knowledge Types That Balance Divergence and Convergence

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Abstract

This research focuses on an organizational form - collaborative crowdsourcing for innovation - in which the public is asked to collaboratively solve, online, an organizational problem in innovative ways over a reasonably short period of time (i.e., days or weeks). Using the lens of creative synthesis (Harvey 2014), the research seeks to address the question of how sequences of knowledge contributions independently offered by different participants affect the emergence of innovative solutions. Through an analysis of time-stamped contributions made in seven collaborative crowdsourcing events, the findings show that certain exemplar sequences have a positive impact on the emergence of innovative solutions in the crowd. On the other hand, some other sequences can negatively impact the emergence of innovative solutions. Specifically, the findings show that the emergence of innovative solutions are more likely after sequences from different contributors in which: 1) one contributor offers an early idea seed after others offer problem facts and analogies (rather than the inverse in which idea seeds followed by problem facts and analogies), and 2) one contributor describes a paradox which is followed by others adding more problem facts (rather than the inverse in which paradoxes are posted after facts). Additionally, innovative solutions are more likely to emerge subsequent to a single contribution of a paradox. However, multiple paradoxes raised sequentially dampen the likelihood of an innovative

solution emerging. We draw implications for future research on open innovation structures (like crowdsourcing) and also for the group creativity and innovation team literature.

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ABSTRACT

This research focuses on an organizational form - *collaborative crowdsourcing for innovation* - in which the public is asked to collaboratively solve, online, an organizational problem in innovative ways over a reasonably short period of time (i.e., days or weeks). Using the lens of creative synthesis (Harvey 2014), the research seeks to address the question of how sequences of knowledge contributions independently offered by different participants affect the emergence of innovative solutions. Through an analysis of time-stamped contributions made in seven collaborative crowdsourcing events, the findings show that certain exemplar sequences have a positive impact on the emergence of innovative solutions in the crowd. On the other hand, some other sequences can negatively impact the emergence of innovative solutions. Specifically, the findings show that the emergence of innovative solutions are more likely after sequences from different contributors in which: 1) one contributor offers an early idea seed after others offer problem facts and analogies (rather than the inverse in which idea seeds followed by problem facts and analogies), and 2) one contributor describes a paradox which is followed by others adding more problem facts (rather than the inverse in which paradoxes are posted after facts). Additionally, innovative solutions are more likely to emerge subsequent to a single contribution of a paradox. However, multiple paradoxes raised sequentially dampen the likelihood of an innovative solution emerging. We draw implications for future research on open innovation structures (like crowdsourcing) and also for the group creativity and innovation team literature.

INTRODUCTION

Pressed for continual innovation, organizations are required to solve wicked problems that are dynamically complex and ill structured (Rittel and Webber 1973). In order to solve such problems, organizations are increasingly leveraging new organizational forms to surface opportunities and innovative solutions (Afuah and Tucci 2012; Puranam, et al. 2013; West and Bogers 2014). These organizational forms include Wikipedia-style online knowledge production communities (Gulati et al. 2012), open source software development (Shah 2006), user innovation communities (Dahlander and Frederiksen 2012; von Hippel and von Krogh 2003), and community based design contests (Hutter et al. 2011) and innovation tournaments (Terwiesch and Xu 2008). By exposing their wicked problems to the public through these organizational forms, firms can leverage a wider diversity of perspectives than contained inside the firm (West and Bogers 2014).

This paper focuses on one such organizational form - *collaborative crowdsourcing for innovation* (Boudreau and Lakhani 2009) - in which the public is asked to collaboratively solve, online, an organizational problem in innovative ways over a reasonably short period of time

(i.e., days or weeks). Unlike innovation tournaments[1] (Terwiesch and Xu 2008), collaborative crowdsourcing contests and communities encourage open knowledge sharing with a highly collaborative innovation process (Bullinger et al. 2010; Dahlander and Frederiksen 2012; Füller et al. 2008; Hutter et al. 2011). *In the context of collaborative crowdsourcing, innovation outcomes are manifested in the solutions that emerge from the crowd during the period of the crowdsourcing event*. Chief innovation officers of the firms that leverage collaborative crowdsourcing typically judge the innovativeness based on novelty (not tried previously at the company) and potential to create competitive advantage for the firm if implemented[2] (Malhotra and Majchrzak 2014).

An element of the dynamics of crowd that has received limited research attention is the process of knowledge sharing during crowdsourcing. A few researchers have started to explore how large online groups share knowledge (Faraj et al. 2011; Franke and Shah 2003; Hutter et al. 2011). Extending this initial research, we specifically focus on the knowledge sharing process during collaborative crowdsourcing. *The knowledge sharing process is defined as the emergent patterns in the order and types of knowledge contributions made by a set of participants during the crowdsourcing event*. In collaborative crowdsourcing, the knowledge sharing process is both a collective as well as an individual process. Looking at the process from a group creativity perspective, an innovative outcome is not simply the average of individual creativity; it "… is the product of social influences" (Gong et al. 2013, p.828), understood as a collectively created knowledge object (Anderson et al. 2014; Ford 2000; George 2007; Harvey 2014). Collective creativity requires the exchange and combination of knowledge shared about data, ideas, and work-related information (Gong et al. 2013; Hargadon and Bechky 2006; Kurtzberg and Amabile 2001; van Knippenberg et al. 2004). Further, an innovative solution an emergent outcome of the collective[3]. Thus, in a creative group, there are two emergent phenomena: the knowledge-sharing process, and the resulting innovative outcome.

Building on the group creativity perspective, it is apparent that past studies on individual motivation and creativity in crowdsourcing leaves the identification and impact of the knowledge-sharing process underexplored. Moreover, even when motivated individuals use

[1] Innovation tournaments generally hide each contestant's idea and rationale underlying the idea (Afuah and Tucci 2012).

[2] This is based on Amabile's (1988) notion of creativity as the generation of novel and useful ideas. Similarly, Anderson et al. 2014 (p. 1298), define creativity and innovation interchangeably as the process, outcomes and products of attempts to develop and introduce new and improved ways of doing things". Most researchers agree that creativity is a first step of innovation, and therefore part of the innovation process. We use creativity and innovation interchangeably throughout the paper acknowledging how "intimately related [are these] areas of inquiry" (Ford, 1996, p. 1112).

[3] We adopt Klein & Kozlowski's (2000, p. 55) definition of emergent as "originating in the cognition, affect, behaviors or other characteristics of individuals, is amplified by their interactions, and manifests as a higher level, collective phenomenon." Following Kozlowski and Chao (2012), we characterize innovative solution outcomes as emergent compilations not compositions of individuals since they represent divergent perspectives, albeit one affected by the interactions.

appropriate structures designed for collaborative innovation, innovative outcomes will not occur if the knowledge sharing process not conducive (Faraj et al. 2011). Thus, research is needed to determine the appropriate knowledge sharing process for emergence of innovative outcomes from the crowd. We pose the following exploratory question:

> ***Is there a process of knowledge sharing in collaborative crowdsourcing that leads to the emergence of innovative solutions vis-à-vis a process that does not?***

Findings presented pertaining to the above question are based on the analysis of all the contributions made by participants in seven different collaborative crowdsourcing events sponsored by different companies. Chief Innovation Officers in the companies judged the innovativeness of solutions that emerged from these events. We found that the order in which knowledge was contributed affects the emergence of innovative solutions in crowds.

CONCEPTUAL DEVELOPMENT

Faraj et al. (2011) argue that the difficulty of balancing convergence and divergence cycles needed for innovation is a key challenge in the knowledge-sharing process of crowds. Crowds may offer such widely divergent ideas and views of the problem that convergence on solutions becomes impossible. Or, the crowd may converge too quickly on a few ideas such that the solutions that emerge may be only small incremental improvements rather than novel solutions (Malhotra and Majchrzak 2014). This convergence-divergence dilemma is not unique to collaborative crowdsourcing. Researchers have observed similar tensions in the context of new product development teams and creative groups (Anderson et al. 2014; Hulsheger et al 2009; Zhou 2014). We develop a framework for understanding innovation in crowds. This framework is developed based in part on aspects of creative groups that are similar to aspects of collaborative crowdsourcing.

There are several aspects of creative groups that are similar to collaborative crowdsourcing. As with groups expected to be creative (Gilson and Shalley 2004; Unsworth 2011; West 2002), collaborative crowdsourcing typically focuses the collective on solving problems that are challenging, interdependent and purposefully ill defined to foster alternative and innovative perspectives on problem definition, lateral connections and solutions (Hutter et al 2011). Creative collectives exhibit a similar convergence-divergence tension (Sheremata 2000). Collectives entrusted with creative objectives, whether in small groups or large crowds, require incentives and structures to be in place to encourage helping one another, constructive feedback, and building on each other's ideas (Füller et al. 2008; Majchrzak and Malhotra 2013). Successful new product development projects are those that identify a large number of alternative problem solutions (Sheremata 2000). Similarly, successful crowdsourcing for innovation involves the identification of a large number of alternative solutions from which company executives can choose (Malhotra and Majchrzak 2014).

Despite the similarities, the differences require modification of any group-based framework for the unique circumstances of crowdsourcing. Instead of a small set of individuals devoting large amounts of time to the innovative task, crowd members spend relatively little effort, and may only participate once or twice (Kane et al. 2014). Creative groups rely on repeated contributions by the same individuals in (Dahlander and Frederickson 2012). However, in large scale crowdsourcing, innovation results from the layering of many small contributions made by a diverse range of individuals (Hutter et al. 2011). In essence, there are often many more individuals engaged than in a typical small group. Unlike groups, crowd participants are neither assigned nor selected; rather they self select into the innovation task by responding to a general challenge call. They share a general passion for the topic, but have few organizational norms or a central hierarchical authority (Dahlander and Frederickson 2012). The expertise of crowd members may not be deeply related to the innovation problem posed to them, nor will they have shared experiences or similar expertise for which to draw upon (Jeppessen and Lakhani 2010). Social cues, personal profiles, and members' expertise are rarely known to each other because of pseudo-anonymity (Faraj et al. 2011). Crowd membership fluctuates as individuals come and go, leaving the persistence of the knowledge shared via the information system to be the sole form of organizational memory (Butler 2001). Dialogue consists not of pairwise conversations as expected in groups (Hargadon and Bechky 2006; Tsoukas 2009), but rather as contributions (or posts) to an online platform where problem descriptions and solution ideas are offered and commented upon for public consumption (Füller et al. 2008; Majchrzak and Malhotra 2013). Finally, the crowd's convergence is not as an implicit consensus on problem definition or reflective reframing as is the case in small groups (Hargadon and Bechky 2006); convergence occurs through a collective action manifest in the number of contributions made on a topic (Faraj et al. 2011) or voting on preferred solutions (Majchrzak and Malhotra 2013). Therefore, these differences between groups and crowdsourcing must be taken into account when developing a framework for explaining the emergence of innovative outcomes in crowds using group-level theories.

We propose a framework for a bounded divergent knowledge sharing process in crowds building on Harvey's (2014) theory of group creativity as a dialectic creative synthesis process. In a creative synthesis process, group members iteratively share their different understandings about the problem. This leads to an iterative and tentative integration of their different perspectives of the problem so as to surface connections between previously unrelated concepts. Such integration provides a new way of understanding the problem or new questions to ask. The integration also creates temporary solutions that raise more problems and questions. This process is repeated over and over again involving idea generation, problem understanding, and idea evaluation occurring concurrently and continuously. The view of the value of divergence is that it leads to contribution of independently offered diverse ideas (Surowiecki, 2005). In contrast, the creative synthesis view suggests the different understandings that are brought to the problem are *not* used to increase divergence, but to find *similarities* between the differences. Collectives innovate not through isolated and completely divergent creative breakthroughs, but by members sharing knowledge about the problem and ideas iteratively in a process that "focuses the collective attention [of the group],

enacts ideas and builds on similarities within their diverse perspectives" (Harvey 2014, p.325). The group is guided in this process through "exemplars". Exemplars are embodiments of the temporary synthesis of multiple understandings and the group's reactions to those embodiments. From exemplars, the collective infers the rules or assumptions that underlie how the multiple perspectives are synthesized. Exemplars help to focus the collective on productive directions likely leads to breakthrough ideas. Even if exemplars contain inaccurate views of the problem or someone's preferred solution idea that is different than others, exemplars still facilitate further communication within the group by focusing on obtaining new meaning.

In the creative synthesis model proposed by Harvey (2004), groups start their knowledge sharing process with a shared understanding of the dominant prevailing paradigm that has been used in the past to solve the problem. The group then considers emerging ideas in light of the dominant paradigm. In addition, the same set of individuals in the group engage in the iterations. However, a crowd will not share such a dominant paradigm because of the participants' differences in expertise and experience with the problem. Moreover, participants are unlikely to iterate because of the high rate of fluidity in participation (Faraj et al. 2011). Nevertheless, with some extensions, the creative synthesis model may help to explain how crowds (even with fluctuating participants) proceed in iterative cycles to eventually emerge with innovative solutions.

First, we extend the creative synthesis model to consider the emergence of exemplars in the form of knowledge sharing pattern of multiple sequential individual contributions. These sequential individual contributions when considered together as a sequence, offer a temporary synthesis of the multiple understandings of the crowd at a point in time. The exemplars also depict the crowd's reaction to the synthesis. Second, we extend the creative synthesis model to consider these emergent exemplars as a form of behavior guidance for further knowledge sharing that ultimately leads to emergence of innovative solutions. Together, we see these two extensions as ways for the crowd to engage in "bounded divergence".

For the crowd, exemplars may help to provide bounded divergence by "send[ing] cues to others as to expected behaviors (Gong et al. 2012, p 829)." The shared exemplars may bind the extreme divergence naturally to be expected in a crowd. By focusing on an exemplar as a temporary synthesis, the crowd can collectively discuss the substantive content of the exemplar, moving the content in the exemplar forward creatively and intellectually. Implicitly included in the exemplar is the crowd's reaction to the synthesis. This implicit signal sets expectations for knowledge-sharing norms as to how to contribute to get the crowd's attention.

Specific to managing the divergence/convergence tension, there are two types of knowledge that have been given significant attention in the group innovation and creativity literature. The two knowledge types are: a) information about the problem, and b) paradoxes. We suggest that the exemplars that emerge from the crowd for these types of knowledge may affect the

emergence of innovative solutions from the crowd because they foster an iterative creative synthesis process. As the literature is quite equivocal about innovation-prone exemplars for crowdsourcing, we offer some exploratory questions in this direction. The exploratory questions below pose alternative and contradictory forms exemplars might that lead to innovation in collaborative crowdsourcing. We test both sides of the contradictions in our empirical analysis.

Identifying Exemplars for How Information About the Problem is Used to Stimulate Early Idea Generation:

Sharing Facts and Analogies To: (a) Stimulate Early Divergence OR (b) Refine And Converge On Early Solution Ideas. Knowledge about the problem is considered an important element in creative thinking (Mumford et al. 1997a). Getzels and Csikszentmihalyi (1976) found that activities associated with understanding the problem (referred to as problem finding actions) influenced originality. Highly creative groups spend more time than less creative groups on generating new information about the problem (Goor and Sommerfeld 1975). Therefore, it is critical to examine which problem knowledge sharing patterns encourage innovation in crowds. Several types of knowledge about the problem have been suggested as important for creative thinking. We focus on three specific knowledge types in this section: facts, analogies and initial ideas.

Analogies serve an important function in encouraging innovation (Dreistadt 1968; Langley and Jones 1988; MacCrimmon and Wagner 1994). As Sternberg (1988) noted, "insights are especially likely to occur when insightful problem solvers recognize analogies between new problems they are currently facing and problems they have solved before (p. 3)". Analogies about the features of a problem provide broader representational relations that help to make diverse categories more conceptually similar (Mumford et al 1997b). "The production and use of analogies can be a critical part of the innovation process. Analogies involve comparing otherwise disconnected and incompatible ideas or objects by drawing on existing knowledge to explain and predict solutions to new problems. Analogies can therefore shape new ways of understanding problems. …Analogies may be particularly valuable for groups because they directly connect members' otherwise diverse perspectives by helping one group member reframe his or her knowledge in terms of another's experiences. This should enhance communication between the two" (Harvey 2014, p. 334).

In addition to analogies, another type of knowledge that past group creativity research has demonstrated as related to innovation is the sharing of a set of content-rich facts about the problem. Facts are essential for making connections between existing ideas so as to create new novel solutions to the problem (MacCrimmon and Wagner 1994; Perry-Smith 2006; Russ 1993). Facts may describe observations that one has about the current state of the system being addressed by the problem, explanations for the problem, prevalence of the problem or the importance of the problem. Such facts can stimulate convergent thinking (Houtz et al. 2003; Isaksen et al. 2003)

Finally, knowledge shared in the crowd can be in the form of initial ideas. These initial ideas can become the constituents for later solutions. Finke et al. (1992) describe "preinventive structures" that facilitate creativity as structures of loosely formulated ideas. The loosely formulated ideas are elaborated upon, tested and interpreted in an ongoing cyclic process of creativity. Facts and analogies that help to formulate or refine these preinventive structures may serve as exemplars for the generation of later innovative solutions. The existing literature offers two alternative views of these possible exemplars: one in which facts and analogies are used to formulate the preinventive structures, the other in which preinventive structures are formulated based on random variation and then refined with facts and examples.

The random variation model of group creativity, also referred to as the chance-based theories of the creative process, suggests that the creative process begins with a "process of idea formation through random variations (Harvey 2014). This idea formation phase is followed by a process of evaluation that leads to selective retention of the best ideas" (Lubart 2001, p. 300). In such a model, the preinventive structures of loosely formulated early ideas are expected to be randomly generated by the crowd. These early ideas are then followed by a sharing of facts and analogies to evaluate, elaborate and refine these early ideas. Innovative solutions then result from a process initially of "unstructured, subjective thoughts that yield ideas that are then shaped by the reality-based, controlled, evaluative process" (Lubart 2001, p. 300). An exemplar sequence of knowledge sharing would then consist of an initial idea contribution followed by the contributions of facts and/or analogies as evaluative qualifiers of that idea. Such an exemplar will encourage an iterative process that later evolves into an innovative solution as carefully evaluated and focused derivatives of the content offered in early preinventive structures. Such an exemplar encourages the crowd to engage in a process of randomly suggesting early ideas, followed by sharing of facts and analogies to evaluate and elaborate on the early ideas. This exemplar will bound divergence by encouraging divergent ideas early, and then keeping the crowd's attention focused on elaborating ideas already generated.

An alternative model of an exemplar innovation creation sequence may be the inverse of the one suggested above. Participants wait to offer preinventive structures of loosely formulated ideas until there is a greater synthesis about problem. This is similar to the Harvey's (2014) explanation of group creativity processes as first involving the group sharing their multiple understandings of the problem before ideas synthesizing these understandings are posed. Similarly, Schön (1993) proposes that analogies help the innovation process when they are used to understand how problem features fit together *before* solution ideas are generated. Fact-based analogies when offered prior to idea generation foster creative thinking (Mumford et al. 1997b). An exemplar sequence of knowledge sharing in this alternative model would be the initial contribution of facts and analogies followed by the contribution of an idea. Such an exemplar would encourage innovativeness of later solutions since the preinventive structures would represent one of many possible creative syntheses of an understanding of multiple perspectives of the problem. As new knowledge about the problem is added, new ideas as

syntheses are then offered, with the innovativeness derived from the attempt to synthesize across the many different perspectives represented in the crowd. The exemplar sequence also encourages the crowd to follow a particular process in which ideas are built upon problem knowledge, and not just randomly generated (as was the case in the sequence described earlier where loosely formulated ideas are contributed first, followed by facts and analogies). As such, the divergence becomes bounded not after an idea is offered and thus refined, but before the idea is offered as problem information is shared. Given the minimal research conducted in crowdsourcing about either of the two alternative knowledge contribution sequences, we ask the exploratory question:

> ***Q1: Are innovative solutions more likely to emerge later in the process when the crowd shares facts and analogies in order to stimulate early ideas? Or, do innovative solutions emerge later when the crowd begins with an unbounded idea that is then refined by sharing of facts and analogies?***

Identifying Exemplars About How Contradictory Objectives (or Paradoxes) are used

There has been substantial research on the effect of paradoxes on creative outcomes (Blasko et al. 1986; Bilton and Cummings 2010; Defillippi et al. 2007; Martin 2009; Miron-Spektor et al. 2011). In the innovation and group creativity literature, paradoxes refer to situations in which two objectives cannot, on the surface, appear to be simultaneously satisfied (Andriopoulos and Lewis 2009). Innovation, particularly breakthrough innovation, requires paradoxes (Andriopoulos and Lewis 2009; Leonard-Barton 1992). However, the use of paradoxes as exemplars in collaborative crowdsourcing has not been studied. Moreover, in the group innovation and creativity literature, there are contradictory suggestions about how paradoxes help to manage the convergence-divergence balance. Two areas of contention in the literature are apparent: the use of single versus multiple paradoxes, and how problem information is used in concert with paradoxes.

Use of (a) A Single Paradox OR (b) Multiple Paradoxes. Paradoxes are simplified polarizations that help actors make sense of the world. In a new product development context, paradoxes are often incompatible conditions or constraints about the problem (such as low cost but looking expensive). Some scholars argue that paradoxes support creativity because they activate paradoxical frames that allow the contradictions to be embraced (Miron-Spektor et al. 2011). Others have argued that paradoxes serve to focus a group's attention on creating significant solutions that negotiate both sides of the paradox rather than focusing on incremental changes (Majchrzak et al. 2012). Paradoxes also help create a abrasion that focuses teams on creative disagreements and leads to breakthrough thinking (Carlile 2004; Leonard-Barton 1992).

The value of paradoxes for creativity, in combination with the creative synthesis model, suggests the early surfacing of paradoxes. Paradoxes surfaced early in the sharing process clarify different perspectives on the innovation problem and may help to synthesize those

different perspectives into innovative solution ideas. Multiple constraints on a design problem help a team focus its efforts, provided the constraints are not too many (Onarheim 2012). Practices of highly creative organizations (e.g., IDEO) suggest that information related to the problem, including paradoxes, be surfaced early on, so that a comprehensive understanding of the problem is shared (Kelley 2007). As such, then, an exemplar that may contribute to the later emergence of innovative solutions is the sequential surfacing of different paradoxes. Such an exemplar informs the crowd of the extensiveness of the problem's paradoxes early on. At the same time, the exemplars create a norm that sharing of one paradox after another paradox fosters collective creativity.

In contrast to the value of surfacing multiple paradoxes early, research on innovation teams has found that surfacing multiple successive paradoxes can stall the creative process (Majchrzak et al. 2012). A substantial amount of cognitive energy needs to be expended to resolve both sides of a paradox simultaneously (Miron-Spektor et al. 2011). When multiple paradoxes are offered consecutively, it may force the crowd into a task that is too cognitively complex (Perry-Smith and Shalley 2003). Therefore, while paradoxes may be helpful to a crowd, too many paradoxes contributed independently and consecutively may harm innovation. Trying to resolve multiple paradoxes can pull the collective in too many different directions (Perry-Smith 2006), creating an unbounded divergence. This suggests that in contrast to the arguments above, a sequence of multiple paradoxes being contributed by the crowd sequentially may *not* be an exemplar for innovative solution generation in collaborative crowdsourcing.

Instead of multiple paradoxes, then, it may be more productive to focus the crowd's cognitive attention on a single paradox (Miron-Spektor et al. 2011), and then immediately offer a solution that solves the single paradox. Harvey (2014) suggests that group creativity is more likely when a paradox becomes a synthesis of the different perspectives because it has the immediate effect of galvanizing the group toward solving the paradox. Moreover, other researchers have found that groups typically respond to only a single paradox when innovating (Carlile 2004; Majchrzak et al. 2012). This would then suggest that an exemplar for a knowledge sharing process leading to innovative solutions is one in which a paradox is not used for iteration, but rather for solution generation, provided the solution resolves both sides of the paradox.

In sum, we have three alternative possibilities of exemplars with respect to the quantity of paradoxes: no paradoxes, single paradox or multiple paradoxes.

> ***Q2. Is one paradox sufficient to immediately stimulate an emergence of innovative solution in crowdsourcing? Or, is a sequence of multiple consecutive paradoxes needed to stimulate innovative solutions? Or, does a sequence of multiple consecutive paradoxes stifle innovative solutions in crowdsourcing?***

Using Paradoxes to Disagree with Facts to Foster More Divergence OR Using Facts to Make Paradox More Credible for Crowd Convergence. Disagreements and differences based on creative conflict have been argued to spur creativity in groups (Hoffman et al. 1962; Jehn et al.

1999; Kutzberg and Amabile 2001). These disagreements are often inconsistencies between competing views. In the creative synthesis view, these inconsistencies arise through the continuing social interactions within the group. The surfacing of these disagreements provide the "opportunities for diverse views to be integrated" (Harvey 2014, p. 329) into more innovative solutions. One form in which collectives can easily observe disagreements is when paradoxes are offered as a response to complexify a simplified fact about the problem (Boland and Tenkasi 1995). For example, if a fact is contributed (e.g., "the average age of the customers"), a paradox may then be contributed indicating a more complex view than the simple fact would indicate (e.g., "the actual age distribution is bimodal, such that any solution to the problem will need to satisfy the conflicting needs of both old and young customers"). These two successive contributions[4] help to surface the disagreement between the paradox and the initial fact. Consequently, the crowd is now made aware that there are two different perspectives on the profile of the customers.

Not all paradoxes may be helpful for a creative process. Some paradoxes may create untenable conflicting demands or focus the collective on pathways that are neither productive nor necessary (Bledow et al. 2009). Therefore, for later emergent innovation, an exemplar in which paradoxes are followed by facts confirming the importance of the paradox provides credibility for the collective to focus on that paradox (Miron-Spektor et al. 2011, p. 239). This exemplar type of sequence – paradox first, then fact - encourages the crowd to not only resolve the credible paradox, but also encourages a process in which facts should be shared when they support or provide clarity to a paradox.

The two alternative exemplar sequences constituting facts and paradoxes (fact-then-paradox OR paradox-then-fact) may facilitate later innovative solution-generation. Thus, we explore the question:

Q3: Is crowd collaboration more likely to culminate in innovative solutions when paradoxes immediately follow shared fact? Or, do more innovative solutions emerge when paradoxes are followed by facts about the problem?

RESEARCH METHODS

Data Collection

We used data from seven crowdsourcing events varying by company but with similar ill-defined problems as prompts. Examples of the problems posed to the public included:

- What are some of the services-led strategies… that create new markets and new customers? (US Telecom Infrastructure Co.)
- What new and disruptive products, services and/or business models can our company pursue to grow…? (Toy Manufacturer in the US)

[4] Facts followed by contradictory facts may serve the same purpose, although the crowd rarely can offer such clear statements of contradictions.

- How might mobile technology be used to improve our employee and client experience? (Data storage & analytics solutions provider)

We selected these 7 crowdsourcing events because the ill-defined nature of the prompts was similar, they each ran for similar lengths of time (7-10 days), and the crowd was offered similar incentives for participating. We selected more than one crowdsourcing events to increase the generalizability of our findings.

The number of registered participants in the events ranged from 30 to 100. The total posts ranged from very small crowdsourcing events with only 12 posts to ones with as many as 264 posts. Overall, the data consisted of 580 posts across the seven events.

Coding the Posts for Knowledge Types Contributions

Independent raters categorized each of the 580 posts. This ensured that there was no bias in coding and the coding was as accurate as possible. Coders used the definitions of the four knowledge categories provided to the crowdsourcing participants (Table 1). To categorize each post, a procedure was developed in which both the title of the post and the entire thread were read prior to coding to ensure content understanding within the thread context.

First, the first two authors categorized 30 posts individually. Then the categorizations were compared, with differences discussed and definitions updated. Two research assistants were then trained using the categorization instructions to code the remaining posts. There was a good inter-rater agreement between the raters (Cohen's Kappa Coefficient $\kappa = 0.74$; $p < 0.001$) (Landis and Koch 1977). Any disagreements were resolved through discussion. Next, we describe the measures based on the categorization of the posts.

Table 1: Categorization Scheme

Knowledge Sharing Category	Short Description	Sample Contribution
Facts about Problem	*Any facts (data or statistics or charts or established practices) related to the problem.*	"There are currently 10,000 people who use this tool; there will be a new product coming out next year; our competitors are doing xxx; we have these types of problems at our company."
Analogies	*Contribution indicates how a similar type of problem was solved elsewhere*	"Check out how Bank of America solved the problem"
Paradoxes	*Identify issues or conflicting requirements that could be hard to achieve simultaneously.*	"How do we sell the software cheaply but don't lose our high-end market, how do we increase the revenue for maintenance and yet not lose clients."

Initial Ideas	*Short statements that present early ideas.*	"Could we do it this way…, I was thinking that maybe we could.... I'd like to propose...."
Solutions	*A solution that builds on previous knowledge shared by the crowd by explicitly referring to the knowledge that was integrated or idea seeds that were combined with other shared knowledge*	"I was thinking that if we put Joe's idea with John's idea, we could get...." or "We could take that idea, and add it to the new app that was proposed, offering a mobile solution for our inventory problem."

Chronological Identification of Knowledge Sharing Sequences

For each post categorized as *solution*, the set of contributions made prior to that solution were identified and chronologically ordered[5]. Lengths of the contribution sequences were normalized to be between 5 and 50 contributions (mean sequence length = 33 contributions preceding the set of 107 rated solutions in our sample). A minimum of 5 contributions was needed since chronological sequences less than 5 generally had only 1 added unique post compared to a previous sequence, and therefore not enough to examine the unique effect of knowledge sequence exemplars. This resulted in excluding 23 chronological sequences with fewer than 5 contributions from the original 130. This truncation limit of 50 also guarded against including contributions that occurred much earlier than the solution, which would have made it hard to associate the impact of the very early contribution with the solution. The presence of six exemplar sequences of interest (see Table 2) were identified by visually inspecting each of the 107 chronological sequence sets that resulted in a solution emerging from the crowd, and were composed of unique knowledge added prior to the emergence of the solution. This ensured that the exemplar sequences were unique to one of the 107 chronological and were not repeated in other chronological sequence sets. Examples of sequences from our sample are shown in Table 2.

[5] The chronological ordering was done across top-level threads (top-level threads that preceded the solution), and then within threads (posts within top-level threads that preceded the solution) to ensure sub-sequences are from a consistent conversation and not jumping across threads.

Table 2: Exemplar Sequences

EXPLORATORY QUESTION	EXEMPLAR SEQUENCE	SAMPLE
Q1: Are innovative solutions more likely to emerge later in the process when the crowd shares facts and analogies in order to stimulate early solutions ideas? Or, do innovative solutions emerge later when the crowd begins with an unbounded idea that is then refined by sharing of facts and analogies?	FACT AND/OR ANALOGY → IDEA SEED → ..... → SOLUTION	[**FACT**] I think an internal training app would be great. For those that travel, the time spent at the airport could be turned into something meaningful by reading/listening/watching a short segment on applicable topics. [**IDEA SEED**] More and more people are using their phones or tablets to do business rather than laptops or desktop computers. The target audiences vary greatly as well. Weaver currently launches a Client Satisfaction Survey. It may be beneficial to launch it for mobile devices as well to reach multiple audiences. Mobile-friendly surveys could be useful for other outlets as well such as recruiting, conference, events, etc. [**SOLUTION**] A mobile app that could be used in meetings and/or walkthroughs to record and recognize each person's voice and transcribe the content of the discussion. We lose a lot of tidbits when we take notes, and sometimes we forget things, because we dont have the opportunity to write up the information within a couple of days. A tool, something like Dragon Dictation, but could recognize the various participants and transcribe an entire meeting would help increase efficiency in being able to cut/paste and modify the written dialogue, rather than having to take notes, remember the main points of the discussion, write up the information, and then synthesize the information. Rather, you would be able to focus on the discussion during the meeting and then synthesize the information when reviewing the written dialogue.
	IDEA SEED → FACT AND/OR ANALOGY → ..... → SOLUTION	[**IDEA SEED**] Adding reviews to Wedding and Baby registry scanners [**ANALGOY**] 6 days ago Motorola has a generic product for this already. http://www.motorola.com/web/Business/Products/Mobile%20Computers/Handheld%20Computers/MC17/_Documents/Static%20Files/MC17CaseStudy_Feneberg.pdf [**SOLUTION**]: BV could hire a team of evangelists that travel around to retailers and spend a day at a location assisting consumers use ratings in their buying decisions. They would have a device or phone app to quickly look up reviews on the retailer's site and spread information about the retailer's app. Not the most efficient approach, but modeling the review search behavior, could be effective. It also is another touch point with the retail clients that shows that we are more than a web technology company.

Q2. Is one paradox sufficient to stimulate an emergence of innovative solution in crowdsourcing? Or, is a sequence of multiple consecutive paradoxes needed to stimulate innovative solutions? Or, does a sequence of multiple consecutive paradoxes stifle innovative solutions in crowdsourcing?	PARADOX → SOLUTION	[**PARADOX**] There are a lot of good ideas posted on how it would be possible to implement ways to improve information sharing with clients, but you risk losing the personal touch that has to go along with good client service. It may be easier for US to have an app to update the client on the progress of the audit/ tax return or to send answers their inquiries, but some clients might take that as the lazy approach when it wouldn't take us much more time to make a phone call than it would to update an app. [**SOLUTION**] I realize that as we are preparing tax return closer to the deadline, most of our clients have one or two loose end open items such as their W-2s, 1099s from the bank, K-1s, and etc. My idea is creating a Tax App. for client to use their mobile device to take pictures of these documents and post it to the [company name] Tax Prep. App. For example, Bank of America allows their users to use their mobile device to deposit checks to their bank accounts. We can leverage from this technology and create an app. that will give guidelines on how to take a good document picture and post it to the Weaver Tax Prep. App for that client. To be further on this process, we can engage an automatic reader to read the document posted and populate onto the tax return:) This can streamline the process of us asking our clients for the last few items where they can just use their mobile device to take pictures without locating a scanner or fax.
	PARADOX → PARADOX → PARADOX → …… → SOLUTION	[**PARADOX**] When on your phone - even when it's for work - it's easy to get distracted with text messages, updates, push notifications, social media, etc. No different than the internet, increasing the use of mobile technology could add (even more) to the list of workplace distractions. [**PARADOX**] Good point! Sometimes technology is a a good break in the day and other times it can be distracting. Also, updates or push notifications can get annoying at times if you have too many on your phone. One drawback is people may unsubscribe from alerts, text messages, etc. if they are getting sent out too often. [**PARADOX**] I agree. Some of the mobile technologies couldn't really be used at the client either. There is no way for the client to distinguish between working on the phone and playing angry birds.

		[**SOLUTION**] Some sort of secure internal and client directory application that is accessible by mobile devices. Would be helpful if you need client or colleague contact information while on the go.
Q3. Is crowd collaboration more likely to culminate in innovative solutions when paradoxes immediately succeed and raise conflicts with shared facts? Or, do more innovative solutions emerge and when paradoxes are followed by facts about the problem?	FACT→ PARADOX → ….. →SOLUTION	[**FACT**] I wish it could power my devices that I connect to it so that I don't have to watch haplessly when my phone goes to 5% charge and have to run to an outlet. :-) [**PARADOX**] Cisco changed from perpetual software licensing to subscription there would be a drastic reduction in short-term revenues. What are ways that this could be offset? For example, revenue from SMEs adoption of what was previously prohibitively expensive due to large up front costs. What other ways? [**SOLUTION**] The transition to Cloud is expected to account for 30% of all IT spend by 2020. Half of this demand is for cloud infrastructure and the other half for XaaS offers. Cisco can partcipate more aggressively in the XaaS market, both directly and indirectly, to become Services-Led. These XaaS offers also need significant up-front professional services, including business process re-design of the customer's internal processes. These up-front consulting services could further enable Cisco and it's partners to become Services-Led; followed by the offer which then provides the technology itself packaged as a service. The network itself can be packaged as a service i.e. NaaS.
	PARADOX → FACT→ ….. →SOLUTION	[**PARADOX**] Another possible idea would be charging customers more money for supporting old software if they don't upgrade. That way, you are ensuring that either customers are buying the newest software (which is more revenue since right now, they may not upgrade immediately), or they are bringing in more revenue by being charged more. [**FACT**] Having spent over a decade in the partner community I am very familiar with the sometimes artificial division between sales and services (or pre versus post sales efforts). In my experience the single best way to sell services is to have a real-world understanding of performing services [**SOLUTION**] If Cisco is able to shift to a software centric company, then encouraging software upgrades would be a good idea.

Operationalization of Innovativeness of Solutions Contributed by Crowd

In order to operationalize and measure innovativeness of solutions, we adopted Ford's (1996) definition of creativity as referring to an attribute of a solution that is subjectively judged by members of a particular domain for the novelty and value at that point in time. "By specifying the target of creativity assessments, the nature of the judges providing those assessments and the domain served by those judges, this definition could allow creativity and innovation researchers to compare empirical findings within and across domains" (Ford 1996, p. 1116). To rate the solutions generated by the crowd we used two criteria: "1) there has been an explicit judgment by relevant stakeholders of the ideas (e.g., end users), and 2) each idea is perceived to be at least an interim problem solution (i.e., it could potentially be implemented as a solution to the creative task or project in question)" (Montag et al. 2012, p. 1370).

To assess innovativeness, we followed the procedure used by Lamastra (2009) in which the executive at each of the companies holding the crowdsourcing event served as a subject matter expert to provide the foundational knowledge on innovativeness in the industry and instructional guidance to independent raters coding all remaining solutions and ideas. The executive (the Chief Innovation Officer) was asked to rate all of the solutions for those events with few solutions, and 20% of the solutions of those with a large number of solutions. By having executives only judge 20% of the solutions avoided rater fatigue. The solutions were rated according to two criteria - novelty, and competitive advantage potential - then grouped into a 3-point scale: solution high in novelty and competitive advantage, solution low on either criteria, and solution medium on both criteria. Subsequently, two independent raters first replicated the logic of the executives. The two raters also independently examined *The Gale Business Insights Complete Collection of Business and Company Resources* about the organization's current product offerings and strategies, as well as those of competitors. This information was used to determine if the organization or its competitors in the industry had already used the solution as market offerings. Using the same independent raters to rate the innovativeness of solutions across all the crowdsourcing events overcomes the limitation that the executives only judged the solutions for innovation in the event pertaining to their company. The independent raters' judgments of all 107 solutions across the seven crowdsourcing events demonstrated a significant correlation with executives' judging. This 3-point scale led to the coding rubric shown in Table 3. An inter-rater reliability for categorical data of 76.6% was obtained (Landis and Koch 1977). The raters' assessments of innovation were significantly correlated with the executives' assessments ($r = 0.5$, $p<.001$).

Table 3: Coding Rubric for Rating Solutions

Innovativeness Rating of Solutions	
Low	Something the company and its competitors are already doing. "Just do it better ideas" using organization's readily accessible existing assets. Solution does not address an underserved or a growing market.
Medium	Repackaging of existing services and products in a new way. A new way of using existing technology of the organization. New to the organization but similar products or services may already be offered by competitors.
High	Brand new product or services not offered already by the organization or its competitors. These offerings service the customer in a completely new way. These new to organization and the industry offerings generally require the company to acquire new assets and capabilities.

Data Analysis

To normalize for the length of chronological sequence sets, the variables used in the analysis were proportions. Proportions were calculated as the number of exemplar sequences in the chronological contribution sets divided by the total number contributions in the chronological set. Therefore, six exemplar sequence variables were created as proportion of a chronological contribution set consisting of:

- Facts and analogies shared in order to stimulate early solutions ideas (FA/AN→IS)
- An unbounded idea is refined by sharing of facts and analogies (IS → FA/AN)
- One paradox sufficient to stimulate an emergence of innovative solution (PA)
- Sequence of multiple consecutive paradoxes (PA→PA→PA)
- Paradoxes immediately succeed and raise conflicts with shared facts (FA→PA)
- Paradoxes are followed by facts about the problem (PA→FA)

Control Variables

We also included three additional variables that are likely to affect innovativeness of a solution. Proportion of Prior Solutions in the Chronological Set That Were Rated Highly Innovative was included to ensure that highly innovative solutions were not simply building on previous highly innovative solutions. Chronological Order of the Rated Solution was included since later contributions would have the benefit of all previous contributions and thus likely to be more innovative. Finally, the Number of Crowd Participants in the Event were included because a larger number of participants were likely to have more diverse perspectives with an increased potential for innovation.

A two-stage regression was conducted with the sample size of 107 solutions rated for level of innovativeness. In the first stage, the control variables were introduced. The 6 exemplar sequence variables were introduced in the second stage of the regression. The results of the regression are shown in Table 3.

Table 3: Regression Results

Dependent Variable: Novelty of Solution	Model 1	Model 2
Controls		
Chronological order of the rated solution relative to all other Contributions	-0.10 (-0.97)	-0.11 (-1.20)
Proportion of prior solutions in a chronological contributions set rated highly innovative	0.08 (0.43)	0.03 (0.30)
Number of crowd members in an event	0.13 (1.17)	-0.02 (-0.15)
Exemplar Sequences Main Effect		
Facts and analogies shared to stimulate early solutions ideas (FA/AN→IS)		0.33** (2.75)
Unbounded idea refined by facts and analogies (IS→FA/AN)		-0.24* (-2.24)
One paradox sufficient to stimulate innovative solution (PA)		0.24** (2.70)
Sequence of multiple consecutive paradoxes (PA→PA→PA)		-0.31** (-3.17)
Paradoxes immediately succeed shared facts (FA→PA)		-0.17 (-1.04)
Paradoxes followed by facts (PA→FA)		0.43** (2.67)
Adjusted R^2	0.03	0.20
ΔR^2		0.017
F (d.f.)	2.23 (3,103)	3.95*** (9,97)
Fchange		4.57*** (6,97)

*** p<0.001, ** p < 0.01, * p < 0.05 (t-statistics are shown in the brackets)

Results

Three specific exploratory questions were posed about exemplar knowledge exchange sequences that lead to contributions of innovative solutions by the crowds. The summary of results is shown in Table 4. The findings show that the emergence of innovative solutions in collaborative crowdsourcing is more likely when:

- The initial ideas are germinated based on problem facts and analogies rather than idea seeds merely refined based on problem facts and analogies.
- A paradox is immediately followed by an innovative solution.
- When the crowd avoids raising too many paradoxes.
- Paradoxes confirmed with problem facts

Table 4: Summary of Results

EXPLORATORY QUESTIONS		EXEMPLAR SEQUENCE	RESULTS
Q1	***Are innovative solutions more likely to emerge later in the process when the crowd shares facts and analogies in order to stimulate early solutions ideas?***	FACT AND/OR ANALOGY → IDEA SEED → …… → SOLUTION	**POSITIVE**
	Or, do innovative solutions emerge later when the crowd begins with an unbounded idea that is then refined by sharing of facts and analogies?	IDEA SEED → FACT AND/OR ANALOGY → …… → SOLUTION	**NEGATIVE**
Q2	***Is one paradox sufficient to stimulate an emergence of innovative solution in crowdsourcing?***	PARADOX → SOLUTION	**POSITIVE**
	Or, is a sequence of multiple consecutive paradoxes needed to stimulate innovative solutions? Or, does a sequence of multiple consecutive paradoxes stifle innovative solutions in crowdsourcing?	PARADOX → PARADOX → PARADOX → …… → SOLUTION	**NEGATIVE**
Q3	***Is crowd collaboration more likely to culminate in innovative solutions when paradoxes immediately succeed and raise conflicts with shared facts?***	FACT→ PARADOX → ….. →SOLUTION	**NOT SIGNIFICANT**
	Or, do more innovative solutions emerge and when paradoxes are followed by facts about the problem?	PARADOX → FACT→ ….. →SOLUTION	**POSITIVE**

*… iterative discussion

DISCUSSION

In this section the contributions of this research to theory on collaborative crowdsourcing research are first summarized. Next, the broader implications for research on group innovation and creativity literature are described.

The findings suggest that there are particular exemplar sequences of knowledge exchange by crowds that are more likely to lead to the emergence of innovative solutions in collaborative crowdsourcing. These exemplars are manifested as very short sequences of knowledge contribution actions pertaining to the sharing of problem facts, analogies, paradoxes, and initial idea seeds. We found that across seven collaborative crowdsourcing events, theoretically-derived sequences are either positively or negatively related to the emergence of innovative solutions. The findings show that a crowd is more likely to offer an innovative solution when it bounds its divergence by a knowledge-sharing process of facts, analogies, and singular paradoxes, rather than engaging in too convergent idea refinement and paradox overload.

These findings have to be seen in light of a few caveats. It is hard to establish if the crowd actually used these sequences as exemplars to generate innovative solutions as per the conceptual development. All that can be established is that the presence of these sequences was correlated with emergence of innovative solutions. Robustness checks were conducted to ensure that innovative solutions were not a function of previously contributed innovative solutions, or repeated contributions from a small set of individuals. Future research should explore whether the results of this research are replicable with other ways of measuring the innovativeness of emergent solutions. Research should also explore if the results hold for other forms of crowdsourcing not focused on ill-defined problems. Finally, the results presented in this paper are obtained from seven collaborative crowdsourcing events that were on the low end of "crowd" size, but substantially larger than small groups. Future research should explore if the results are robust for very large-scale crowds that may become typical as crowdsourcing becomes more frequently used for open innovation.

Our extension to Harvey's (2014) process of creative synthesis offers new theorizing for collaborative crowdsourcing. The creative synthesis process is characterized by iterative and highly intertwined idea generation and problem descriptions contributed by diverse crowd participants. The process consists of cycles of idea generation as temporary syntheses that evolve as new problem information surfaces. Such an evolution is catalyzed by exemplar sequences of knowledge exchange that push the crowds toward increasingly innovative solutions. These sequences of knowledge exchange help the crowd to place boundaries around the divergence within the crowd.

The findings may offer suggestions for other "open innovation" efforts than collaborative crowdsourcing. As one example, Kane et al. (2104) examined a Wikipedia article in which innovative phrasing of articles was needed to integrate multiple divergent perspectives about

the topic of the article. The innovations in phrasing emerged and were accepted by the community of Wikipedia participants only after the multiple perspectives were surfaced, and attempts at creative synthesis were repeatedly offered and challenged. As another example, Lee and Cole (2003), in their research on open source software, suggested that the community-based knowledge creation process proceeds as a process of challenges to the status quo, followed by suggestions and critical evaluations of ideas. It may be that those challenges to the status quo fostered the greatest knowledge creation when participants shared facts, analogies, and paradoxes in particular sequences. As such, it may not be the challenges to the status quo per se that are critical to the knowledge creation process. Instead, creative outcomes result from how the knowledge sharing process by the challenges are offered. Therefore, the specific exemplar sequences identified in this research provide specific hypotheses for future research on emerging collaborative structures for innovation.

While the promise of open source has been well documented, a majority of new open source projects fail (Howiston and Crowston 2014). An implication of our findings is that failure results not only from lack of motivation and capability, but also from an inadequate knowledge sharing process. That process can be inadequate because it allows for unbounded divergence, or because it fosters a convergence too fast. The research findings presented in this paper also have a contribution to make to research on user innovation communities (Dahlander and Frederiksen 2012). It is usually suggested that user communities succeed when members give and receive good comments (Jeppesen and Frederiksen 2006). Our research suggests that successful open communities may succeed because there is an appropriate sequencing of comments and not just random commenting. Comments that surface multiple perspectives about the problem being solved have to initiate further commenting. The subsequent commenting in the form of exemplar sequences identified in this research, should lead to iterative cycles of creative synthesis. Therefore, our "bounded divergence" process of innovation in collaborative crowdsourcing may be applicable beyond the events that formed the context of this study. Further, the specificity of "bounded divergence" suggested may make the other open collaboration structures more productive by enabling innovation. Research in other open innovation contexts may also discover bounding sequences that are different from the ones found in the research presented in this paper.

We acknowledge that no design of platform will be fully able to ensure knowledge exchange sequence desired for innovative outcomes through crowdsourcing. For this reason, it may be productive for future research to focus on the role of process facilitators in encouraging and ensuring "bounded divergence". Such research should focus on how facilitators could identify when an exemplar sequence is needed, and ask the crowd to meet that need. For example, if idea brainstorming is occurring, with little attempt to ground the ideas in facts and analogies, a process facilitator could suggest that more facts and analogies be posted. Conceptual development and empirical research is needed to determine the extent to which the crowd is willing to accept such direction. Too much direction and the crowd will no longer feel the necessary control over processes and outcomes or may converge too quickly; too little direction may lead the crowd to diverge untenably (Shah 2006).

The operationalization and examination of the effect of exemplar sequences on crowd innovation used in this paper is fairly new. Following other researchers who have suggested the need to conduct research on sequences of work, information, and conversational flows (Abbott 1992; Pentland 1995), sequencing the types of knowledge helps us to identify collaborative process patterns that had not been previously identified. While sophisticated text analysis cannot as yet correctly and automatically classify text knowledge sequences. The research presented in this paper has shown that the human classification of knowledge sharing sequences is possible. Such human effort based content sequence analysis is fruitful for increasing our understanding of sequences of knowledge sharing in non-routine contexts (e.g. innovative tasks and open innovation structures).

While our conceptual development built extensively on group creativity literature (Gong et al. 2013; Hargadon and Bechky 2006; Kurtzberg and Amabile 2001; van Knippenberg et al. 2004), the findings presented in this paper have not been tested and confirmed in small group settings. While we began by articulating the significant differences between small groups and large crowds, it would be interesting to determine the extent to which the sequences apply to groups. The knowledge types that were used to construct exemplar sequences were derived from group creativity literature (Andriopoulos and Lewis 2009; MacCrimmon and Wagner 1994; Perry-Smith 2006; Russ 1993). As such, it is quite possible that the exemplar sequences may themselves be equally relevant for small groups tasked with innovation. This may be the beginning of theory development that allows researchers to loosen up the boundaries on groups, and to begin to cross-fertilize theory-building between traditional small groups and new organizational forms.

The conceptual development in this paper built on the notion that innovation requires balancing divergent and convergent forces. Research has found that the relationship of the balance between the forces and successful is mediated by the problem-solving process that is used by an organization (Atuahene-Gina 2003). The findings of this research elaborate on the specific elements of such a problem-solving process. These elements include careful attention to the order in which knowledge is shared in the group, referred to as the "flow of creative interactions" (Harvey 2014, p. 338). In addition, our exploratory questions posed two alternative pathways to managing a collaborative problem-solving process in crowds. The findings clearly show that one pathway (knowledge sharing sequence) led to innovative outcomes vis-à-vis the alternative pathway. The productive pathways found in this research align with Harvey's (2014) creative synthesis view. The findings also supports research that found traditional brainstorming approach of sequentially offering numerous ideas to be counterproductive (Girotra et al. 2010).

Finally, as groups become seen as more open systems of networked structures rather than tightly bounded stable groups with stable memberships (Marks et al 2005), the modifications we have made to the Harvey (2014) model may be increasingly important. We extended the Harvey (2014) model by depicting exemplars as a sequence of knowledge sharing actions

constituting both a contribution that synthesizes multiple understandings as well as the collective's reaction to the synthesis. Consequently, such sequences guide the process and substance of idea development. Future research should consider the knowledge process role of exemplars in research on group creativity and innovation. This may yield s counterintuitive findings pertaining to the role of paradoxes as well as early idea refinement. In sum, our research has addressed a call from the group literature, not just the open innovation and crowdsourcing literature, that there is a "quite notable paucity of research exploring the processes inherent in creativity and innovation…We call for reinvigorated attention to [in situ] process studies" (Anderson et al. 2014, p. 1319).

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