

SUPERMAN OR THE FANTASTIC FOUR? KNOWLEDGE COMBINATION AND EXPERIENCE IN INNOVATIVE TEAMS

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This study focuses on effects of knowledge and experience on both mean and variance measures of individual and team innovations. We propose that multiple knowledge domains produce novel combinations that increase the variance of product performance and that extensive experience produces outputs with high average performance. We analyzed innovations in the comic book industry, finding that innovations with extreme success and failure were affected by factors similar to those affecting high-performing innovations. Multimember teams and teams with experience working together produced innovations with greater variation in value, but individuals were able to combine knowledge diversity more effectively than teams.

If an organization were structuring a team for developing an innovation, should the knowledge and experience of this team be different from those of a team for developing a high-quality product in line with the company's past products? Would the answer differ if only a single person could be chosen? The organizational innovation literature currently answers yes to the first question, as it makes a clear distinction between activities that increase variance in performance and activities that increase mean performance. For example, new products that are incremental extensions of a current product will have a positive financial return (high mean performance), but they will not offer significant inordinate profits or losses. Product offerings that are dramatically different from past products offer the potential for extreme profits or extreme losses (high variance in performance), but overall will have a lower expected mean owing to the high likelihood of failure. Another argument in the literature is that organizational exploration, which introduces experiments of uncertain value into an organization's activities, is different from exploitation, which maintains and refines current activities, and that the antecedents of exploration are less well known (March, 1991). Yet both exploitation and exploration can be seen as practices of combining knowledge, one using existing knowledge in

new ways and the other using existing knowledge in well-understood ways (Schumpeter, 1934).

The tension between exploration and exploitation is founded on the view that experimentation with new alternatives slows improvements in existing ones. Conversely, improvements in existing activities make experimenting with new ones less attractive (Levitt & March, 1988). This argument is based on the differing uses of knowledge. Its assumption is that innovations arise from two sources: (1) the knowledge available for an innovative activity (e.g., Ahuja, 2000; Powell, Koput, & Smith-Doerr, 1996) and (2) the ability of individuals and teams to apply the available knowledge (Brown & Duguid, 1991; Tripsas, 1997; Von Hippel, 1988). Simply put, the more diverse the information and knowledge that are applied, the more novel is the output; and the deeper the use of existing knowledge, the less novel but more predictably performing the output. Dysfunctions can occur in both cases: too-diverse knowledge can result in unwieldy and impractical outputs, while too-focused knowledge can result in "competence traps," in which new information is disregarded and teams become locked in their old behaviors (Arthur, 1989; March & Simon, 1958).

The literature on creativity provides a different view of organizing for innovation by focusing on how individuals and teams come to shape knowledge in unique ways. Innovation consists of the creative generation of a new idea and the implementation of the idea into a valuable product, and thus creativity feeds innovation (Nijstod & De Dreu, 2002) and is particularly critical in complex and interdependent work (Drazin, Glynn, & Kazanjian,

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1999). Creativity can be viewed as the first stage of the overall innovation process (Amabile, 1996; West, 2002) or as intertwined with the implementation of innovative ideas (Paulus, 2002). In both views, the creativity literature emphasizes novelty (Morgan, 1953) but stresses that new ideas must be useful and appropriate for the situation at hand (Sternberg & Lubart, 1995). Thus, researchers in this stream have seen creativity as constrained by problems or tasks and have focused on performance enhancement rather than on increased variance of innovation.

Like the innovations literature, the creativity literature frames innovative solutions as arising from diverse knowledge, processes that allow for creativity, and tasks directed toward creative solutions (Gilson & Shalley, 2004). However, it also suggests that creativity requires application of deep knowledge because individuals must understand a knowledge domain to push its boundaries with any nontrivial likelihood of success (Sternberg & O'Hara, 2000), and that work practices can have a significant impact on creative outcomes (Gilson, Mathieu, Shalley, & Ruddy, 2005). Team creativity likewise relies on tapping into the diverse knowledge of a team's members, which can be difficult. In this literature, the distinction between structures and processes that generate highly creative solutions and those that generate high-performing but less innovative solutions is less emphasized than it is in the innovation literature.

Extending the innovation and creativity literatures, this paper examines whether structures that lead to variance-enhancing behaviors differ from those that lead to higher mean performance. The study also addresses an area that has received little attention in both literatures: whether innovations by teams have different causes than those by individuals. We focus on the impact of combining and applying diverse knowledge. In organizations, the availability of diverse knowledge is shaped and constrained by the realities of collaborators, deadlines, resources, and workloads. Innovation is both the creative development of novelty and its application to generation of a new product (Amabile, 1996; West, 2002), with areas of expertise held by individuals or teams within organizations accessed and processed to generate innovations (Amabile, 1983; Ford, 1996; Simon, 1986). We acknowledge that there are many sources of diverse experiences, including the externally observable dimensions of age, ethnicity, and gender (Milliken, Bartel, & Kurtzberg, 2003); however, our emphasis on knowledge use leads us to be principally concerned with the less observable cognitive diversity that

arises from varied work, task, and organizational experience.

We draw on cognitive perspectives on creativity, innovation, and learning to develop a theoretical model to predict both mean performance and variance in performance. We empirically tested our model in a context specifically suited to our questions about knowledge-based activity: the creation and publishing of comic books. Comic book creation is a commercial activity that has the useful properties of being driven by intellectual property and of having a collector valuation of output that allows for empirical determination of the success of the creative effort.

An added merit of the data is that it allows examination of the difference between single individuals and individuals in teams acting in the same innovative context. Despite the acknowledged importance of individual cognition and of teams (Kurtzberg & Amabile, 2001), little research investigates differences in the effects of individual versus team performance on commercial innovation. Here we examine how individual and team knowledge create radical innovations or incremental improvements. To ground our theoretical discussion, in the next section we first describe the innovation context we focused on; we then derive predictions based on a cognitive perspective on innovation and creativity. We divide the discussion into the availability of ideas to individual or to team, and the ability of the individual or team to recognize and implement the available ideas.

THE COMIC BOOK INDUSTRY

Innovation research requires that innovations be understood relative to a context of interest, that the setting be well understood, and that the data be appropriate to the questions of interest. For our study of individual and team innovation, the data needed to allow us to identify specific creators, individuals and teams of creators undertaking the same commercial activities, and creators associated with multiple products, as well as to objectively measure the value of the output and the knowledge domains and experiences of the creators. The comic book publishing industry provides a unique data opportunity that meets these empirical requirements. It is also an industry where innovation is valued and explicitly recognized, both by the market and by the creators.

From the 1897 publication of the first American comic book, *The Yellow Kid*, the comic industry has evolved to the point that products based on the intellectual property generated by the storytelling pictures and words of one title such as *Spider-man*

can generate over a billion dollars of revenues in ticket and DVD sales. The intellectual property of comics has been used by many other media, including movies, television shows, children's cartoons, and video games. In addition, comic-sourced materials are one of few growing areas of the publishing business and have become hotly contested prizes for distributors such as Random House, HarperCollins, Simon & Schuster, and the Time Warner Book Group (Wyatt, 2006).

Innovations have always been critically important to companies in the comic industry. For example, the release of the world's most famous comic, *Superman*, in *Action Comics #1*, led to DC Comics becoming a dominant publisher in the comic-publishing industry. Similarly, the early success of another prominent comic-publishing company, Marvel Comics Group, was based on the innovations of the creators Stan Lee and Jack Kirby. Lee and Kirby pioneered innovations such as depicting comic heroes that had real lives and problems (Sassienne, 1994). For example, their comic *Fantastic Four* had a main character, The Thing, who was grumpy, angry, and unhappy at having superpowers; their character the Hulk battled his good and bad sides; and Peter Parker in *Spider-man* was a geek undergoing all the troubles of a teenager while being a superhero.

In the late 1950s up to the early 70s, innovation was constrained as comic creators faced harsh censorship. Dr. Fredric Wertham, a child psychologist, had convinced the U.S. Senate that comic books were a major cause of juvenile delinquency. To avoid federal regulation, the comic industry agreed to self-censor, in 1954 instituting a Comic Code Authority (CCA) to monitor and restrict content. The censorship constrained innovation until Marvel broke the rules in 1971, and soon other publishers followed suit. The modern age of comics is considered to have started after this period of censorship.

The comic industry is composed of creators (e.g., artists and writers) producing comic titles that are published by companies such as DC, Marvel, and Vertigo, and distributed through retail stores and direct sales to individuals. Like most innovative processes, comic book creation can vary widely, but in general it includes functions such as scripting, penciling, inking, and drawing. All of these functions can be done by a single person or by multiple people.

Both single creators and multiple creators struggle with integrating the expertise necessary to produce a comic. It is the ability to combine the art, writing, and structural form that generates an innovative comic. The value of a comic is influenced by

the artwork, layout, arrangement, page composition, writing, and dialogue. For example, the following discussion of a creator's work illustrates how comic innovation is a combination of page structure, art, and storytelling:

Like many innovative artists before him and since, Bendis explores and expands his page layouts here. Tied to the emotions of the main character, not always but at certain key moments, the panels contort to convey angst or fear. Also, Bendis thematic keeps his "hero" characters round and simple, very unthreatening, while the antagonists, the "Hollywood" types, are more angular and rarely open their eyes, showing their narrow view approach of the world. It's a subtle but effective means of visually reminding the reader who we like and who we should be wary of in this. Oh, and one last thing, it's funny. It's very funny. Bendis writes like how your best friend tells a good story to you. He conveys enough detail so you can follow the action, and enough humorous anecdotes along the way to keep you laughing . . . make this book a classic for modern humor comic books. (Messano, 2004)

Comics go from their creator to commercial release in several ways. A comic from an individual creator can be created and sold to a publisher, created and independently published, or created as part of a contract with a publisher to produce a comic. Comics are also created in teams, which generally come about in one of two ways. The first is that a publisher assigns creators to work together; the second is that creators use their informal networks to work with desirable collaborators.

As in many new-product collaborations, the frequency of teams continuing to work together is a product of structure, success, and comfort. Creators who work for the same publisher will often be teamed together. Successful teams may also continue to work together, but it is the experience of working together that is important because the performance feedback of a comic is not immediate, and the financial reward for a creator does not differ substantially for an acknowledged innovative comic.

Comics are grouped in market spaces called genres. The genre creates a shared context, or set of understandings shared by creator and audience (Marks, 2004). A genre both prompts the expectations of the customer and provides a stylistic vocabulary and grammar for the creator. For example, Joe Zabel, an acclaimed comic creator who worked on the comic *American Splendor*, provides the following description of the mystery comic genre in a quote from a 1999 interview). It illustrates the set of expectations, form, limitations, and knowledge

represented when creating in a genre. It also hints at work that crosses genres.

As a genre, the mystery exists within certain boundaries. First, a crime of some sort must have been committed. The tension created by violence and conflict are essential to the mystery's appeal. Second, the story must take place in a realistic setting. That is to say, it's not a fantasy or a science fiction story. Mystery hybrids like *The X-Files* and *Dirk Gently, Holistic Detective* aside, the essence of a true mystery is believability. Third, there should be the presence, in some form, of the unknown. This is the distinction between a mystery story and the more general category of crime fiction. (<http://amazingmontage.tripod.com/mcman.html>)

The best-known genre in comics is the superhero genre. Other popular genres are westerns, comedy, fantasy, horror, adult, crime, science fiction, non-fiction, and romance. Genres represent well-established forms and product expectations, and transitioning from one genre to another requires a creator to learn and apply different domains of knowledge. In much the same way as other products cross market boundaries, comics can cross genre boundaries. Work that attempts to integrate multiple genres has the promise of creatively crossing boundaries and generating valuable products, as well as the downsides of having to meet two sets of genre domain requirements and potential rejection by the market. *Time's* list of the top ten comics of 2004 lauded several comics for their ability to cross and bend genres (Arnold, 2004), but several lists of the worst comics from that same year also included comics that attempted to combine genres.

It is in this rich, creative, and knowledge-intensive context that we tested our hypotheses on innovation and learning.

THE AVAILABILITY OF IDEAS

When investigating how knowledge is combined, it is important to examine all innovations, not just those that are successful, because the novelty of innovations makes them uncertain, causing some to fail. The distinction is important because activities that increase mean performance through exploitation are different from activities that increase performance variance through exploration (March, 1991). For example, in the pharmaceutical industry, where generating variations on existing products or new generic products may result in small financial performance gains, many firms are willing to gamble on potential breakthrough drugs that have lower likelihoods of success, but when successful result in major financial performance gains. Whereas incremental improvements increase aver-

age performance by using existing knowledge, radical innovations are characterized by prior uncertainty and posterior variance in performance. Similarly, in variation-retention models of creativity, creative outputs are viewed as being highly variable (positively and negatively) and facing later selection into successful and unsuccessful work (Campbell, 1960; Simonton, 1999b). Studies that only examine high-valued outcomes cannot distinguish mean and variance effects on innovative performance, leaving open the question of whether individual and organizational factors differently affect the mean or the variance.

The ability to generate novel, high-variance outcomes is based on the availability of ideas. Idea availability can be constrained by local search, in which a limited set of options is considered according to confidently held beliefs (Lyles & Schwenk, 1992). Broader search results in more idea variety and can identify ways to combine knowledge that challenge the beliefs that constrain innovative behavior (Greve & Taylor, 2000). The paradox is that innovative experts also search locally to determine what rules to break, while nonexperts search locally and conform to those rules (Weisberg, 1999). For example, in new-product development, firms attempt to structure the process to facilitate novel combinations of knowledge. Hargadon and Sutton (1997) described how the product development firm IDEO used a formal archive of past design information as a way to access old knowledge for use in new combinations, but also as a record of past design mistakes. This is one way the firm combines efforts that have already demonstrated appropriateness of design and commercial application. The firm also invites designers not associated with a focal project to provide feedback and advice in the initial design stages. In this way IDEO attempts to facilitate the combination of different knowledge domains to generate creative product designs, while locally searching through past knowledge.

Diverse knowledge of multiple domains and deep knowledge in a specific domain can both lead to innovations. Environments in which diverse knowledge domains are available are more likely to produce new ideas and new combinations of ideas that drive the creation of innovations. Diverse knowledge provides more components useful for making innovative combinations, which gives the opportunity for significant advances, but also for innovations that receive low evaluations because the combinations have unanticipated flaws (Fleming, 1999). However, the challenge of implementing the diverse knowledge that arises from broad search makes the generation of usable innovations

difficult. In situations in which creators combine diverse knowledge domains, we expect innovative behavior when the participants are able to effectively combine the knowledge and have well-established expertise (Brass, 1995; Perry-Smith & Shalley, 2003). In situations in which creators draw on a single domain in a practiced manner, we expect incremental improvements instead for nonexperts, and nonincremental improvements for experts.

Our theory of individual creativity yields similar conclusions as those for teams. Several dispositional factors affect individual creativity, including personality traits and innate genius (e.g., Feist, 1999; Simonton, 1999a), but we focus on how individuals obtain diverse knowledge and become willing to combine it. Amabile's (1983, 1996) theory of individual creativity has three components that affect the availability of ideas: domain-relevant skills, creativity-relevant skills, and task motivation. Exposure to a greater variety of ideas, including ideas that are inconsistent with current beliefs, increases individual creativity (Parnes & Noller, 1972). In individuals, diverse ideas become available through exposure from past experiences, especially high-commitment exposure such as actually using a knowledge domain to create a new product. Through their career histories, individuals can become proficient in multiple knowledge domains and motivated to combine them. Creativity-relevant skills, such as the ability to suspend judgment, using widely inclusive categories, perceiving things differently than most people, and breaking out of perceptual or cognitive patterns, add to the breadth of ideas that individuals consider in their choice sets. These skills add to the availability and use of diverse knowledge for an innovative solution.

It follows that teams with individuals who each hold diverse knowledge domains will be likely to combine them. In addition, teams allow individuals who do not hold diverse knowledge to become exposed to it through interaction with other members (Nonaka & Takeuchi, 1995). Discussions that start with differing viewpoints result in broader search for information (Nemeth & Rogers, 1996) and more complex reasoning (Gruenfeld & Kim, 1998), which can give new insights that help develop innovations (Van Dyne & Saavedra, 1996). Thus, teams whose members have and share diverse knowledge can obtain higher levels of individual and team creativity (De Dreu & West, 2001).

Cognitive Diversity

Diversity of knowledge in teams has been termed "deep-level diversity" (or "cognitive diversity") to

distinguish it from diversity in surface characteristics such as the demographic variables of age, gender, and race (Harrison, Price, Gavin, & Florey, 2002; Jehn, Northcraft, & Neale, 1999). Although the theory of knowledge combination holds that diverse knowledge components generate performance variance (Fleming, 1999), the information processing perspective on team diversity holds that greater cognitive diversity leads to higher performance potential. Work group creativity is enhanced when a work environment provides rich knowledge stimuli, sufficient resources, and a challenging workload (Amabile, Conti, Coon, Lazenby, & Herron, 1996; West, 2002). Working in groups exposes individuals to a broader set of perspectives, and cross-fertilization of ideas results in more creative outcomes (Perry-Smith & Shalley, 2003; Tesluk, Farr, & Klein, 1997). When knowledge components are diverse, uncertainty about the value of each component increases the uncertainty of the output, however, and so does uncertainty about the optimal way to combine components. The result is that multicomponent innovations have greater variance in quality evaluations, resulting in perceived failures as well as in breakthroughs (Fleming, 1999; Fleming & Sorenson, 2001).

A high number of creators is an important source of diverse knowledge (West & Anderson, 1996). Individuals have different cognitive strategies and career experiences, leading to variation in knowledge and problem-solving approaches that can help teams identify and use multiple knowledge components. A high number of creators also increases the likelihood that creative processes such as considering exceptions, challenging well-worn scripts, or playing with ideas will occur (Amabile, 1996). The role of career experience in generating unique individual stocks of knowledge is especially important for work done in creative or problem-solving teams in settings such as consulting (Hansen, 1999), product development (Hargadon & Sutton, 1997), and creative industries (Miller & Shamsie, 2001). In such work, individuals develop their own knowledge and network ties with other knowledgeable persons, both of which help them to retrieve and apply knowledge components useful for a given task. As a result, the size of a team drives diversity in knowledge and ability to innovate (Jackson, 1996). Thus, we predict a positive relation between team size and the variance of product evaluations:

Hypothesis 1. As the number of creators increases, they are more likely to generate products that have extreme (best or worst) outcomes.

It has been argued that communication in large groups has a process cost that reduces group outputs (Kurtzberg & Amabile, 2001; Steiner, 1972). An integration of the influences from a broader set of inputs and more costly communication in large teams would seem to predict a curvilinear or even an inverted-U-shaped relation between team size and innovativeness. This proposition is most relevant for teams that are larger than those that observed in this study, only 1 percent of which had more than six members, so we were not able to evaluate this argument with the available data.

Holding constant the effect of team size, teams in which the members have had exposure to more diverse knowledge will have access to more knowledge components and will as a result be more creative, but they will also have greater potential for team conflict (Williams & O'Reilly, 1998). Because the diversity literature has focused on problem-solving rather than creative tasks, the research measures the mean of performance rather than its variance, and often seeks to separate the effects of deep-level and surface diversity on performance and to investigate how conflict mediates this relation (e.g., Harrison et al., 2002; Jehn et al., 1999). The primary effect of task conflict is to reduce team performance (De Dreu & Weingart, 2003), whereas high performance in cognitively diverse teams is possible when a socially cohesive and participatory environment allows members to freely apply and contribute their knowledge (Chatman, Polzer, Barsade, & Neale, 1998; De Dreu & West, 2001). Thus, diverse teams will have both highly positive and highly negative outcomes from their innovation attempts.

For individuals, combining diverse experiences does not have the coordination or access problems that arise in teams, so an individual can have more integrated, diverse knowledge without the interpersonal conflicts present in teams. As a result, an individual creator is less likely to make compromises in the creative process. Although negative extremes might occur, they will be due to the intrinsic risks of experimentation and not to difficulties in communicating or reaching agreement. As a result, individual knowledge combination should give even greater performance variation than that of teams. These arguments generate the following hypotheses:

Hypothesis 2. As the knowledge diversity of creators increases, they are more likely to generate products that have extreme (best or worst) outcomes.

Hypothesis 3. Increased knowledge diversity has a stronger effect on extreme (best or worse)

outcomes for individual creators than for teams.

Innovating from Available Ideas

Having available ideas is only one part of generating useful innovations: The ideas must be turned into innovations under the organizing structure of the work. One dimension of the structure of work—being organized for creativity—is taken for granted in the innovations literature, as it is the goal of the process. The creativity literature has stressed that having both the task motivation for creativity and creative processes in place are important in generating creative outcomes (Amabile, 1983; Drazin et al., 1999).

Organizations in creative industries value innovativeness as a way to generate occasional (but highly profitable) blockbuster products, even though it is recognized that many creative products are not highly valued in the market. Because creative products are a goal and are recognized to generate variance in product evaluations, high variance in outputs is a measure of creative teams effectively using their diverse knowledge. As noted earlier, creators are allowed a degree of control over team selection and continuation in creative industries and may dissolve a team that experiences conflict or a creative drought. As a result, creative works that are brought into production tend to come from teams whose members are comfortable working with each other, which is a selection mechanism that reduces the effects of team conflict on the observed innovations.

An important characteristic of team composition is the experience that the members have in working together. Teams go through a process of socialization that makes communication easier as members adapt to each other (Katz, 1982). The result is that low or diverse member tenures in teams create communication difficulties (Pfeffer, 1983), which increase the negative effects of member diversity on communication (Pelled, Eisenhardt, & Xin, 1999). Conversely, teams with sufficient experience to have established efficient communication can more easily utilize member diversity (Harrison, Price, & Bell, 1998; Harrison et al., 2002). When teams work on projects of short duration, team experience is often better expressed as the number of projects that a given team has worked together on than as the duration of prior work together, because it is repetition of the creative phase in the start of a project that improves cooperation. Also, teams are more likely to re-form for new projects when their members are satisfied with a previous work process, so the gain in collaboration from experience is

amplified by selectivity in assembling teams that work well together.¹ Thus, teams with many prior collaborative projects have better communication and are thereby more likely to fulfill the goal of obtaining more creative outputs. These teams are also more likely to develop standardized practices for operation, which result in higher mean performance outcomes (Gilson et al., 2005). For the same reasons, teams with many prior collaborative projects should be able to raise the average quality of their outputs. These arguments lead to the following predictions:

Hypothesis 4. As the team experience of creators increases, they are more likely to generate products that have extreme (best or worst) performance.

Hypothesis 5. As the team experience of creators increases, they generate products with higher mean performance.

Learning by refining existing products and procedures increases mean performance rather than increasing the dispersion of performance—indeed, procedures that encourage incremental improvements tend to reduce the dispersion of performance (Benner & Tushman 2002; March, 1991). Incremental improvements occur through learning by doing, which is a process of making minor experiments, observing the results, and adopting those experiments that are seen to improve performance (Argote, Beckman, & Epple, 1990). Experience leads to opportunities to experiment and improve, but opportunities come at a decreasing rate as the potential for improving performance through incremental changes runs out. In consequence, efficiency improves proportionally to the total volume of production, as is captured in the well-documented learning curve (Argote, 1999). Learning by doing is subject to decay and obsolescence (Argote et al., 1990), so it is most effective when recent production is high. It follows that a work unit with a full workload is likely to perform better than one that is underemployed.

Although the learning curve is well documented for cost reductions in industrial production, it is not known whether learning also improves creative performance. Against the learning curve, one may argue that the processes of experimentation and routinization are unlikely to positively affect such

unique tasks as developing a new product that changes the frontiers of knowledge; further, one may argue that tastes change too fast for learning to have much value over time. An observation in favor of learning by doing in creative tasks is the finding that heavy (but not excessive) workload improves creativity in organizations (Amabile et al., 1996; West, 2002), as learning by doing would predict. The theoretical argument against learning curves in creative work also seems weak, as it discounts the usefulness of cumulative knowledge for creative tasks and the ability of creators to anticipate or follow shifting tastes. It is more parsimonious to maintain the usual learning curve in this context as well, leading to the following prediction:

Hypothesis 6. Creators with heavy workloads generate products with higher mean performance.

Learning curves have different shapes, depending on the nature of the learned task. Tasks can be learned at different speeds as a learner gains experience, and they can be forgotten at different speeds if the learner has a low workload (Argote et al., 1990). Thus, the relative importance of total cumulated experience and recent workload in determining performance will differ with type of task. If creative tasks are highly dependent on a set of basic skills that can be applied in many situations, then total experience will matter most. If creative tasks are instead dependent on volatile knowledge such as shifting audience tastes, then recent workload will matter more. If we assume that there is a set of learnable basic skills useful in creative tasks, we can also hypothesize the following effect of total experience:

Hypothesis 7. As the tenures of creators increase, they generate products with higher mean performance.

Investing in work facilities can also increase efficiency. In industrial production, this observation leads to the obvious positive relation between amount and quality of production machinery and production efficiency. For creative work, a technical and administrative support system that relieves creators of routine tasks has the same effect, as does organizational slack devoted to improving the knowledge of the innovators (Cohen & Levinthal, 1990). These considerations predict:

Hypothesis 8. As organizational resources increase, creators generate products with higher mean performance.

¹ This argument can be verified by the data. We found that first-time collaborations were more likely to be dissolved when the product received a low evaluation, but after the first collaboration there was no longer a relation between product success and group re-formation.

METHODS

Data and Sample

We analyzed data on comic books published from 1972 through 1996. We chose 1972 as the beginning year for our data, as the censorship of comics by CCA, and hence constrained innovation, ended in 1971. We ended the study in 1996 for two reasons. First, we wanted substantial time to have elapsed from the end of our data set that early valuations resulting from company marketing strength or speculation would no longer affect the perceived market value of a comic. Second, after 1996, the comic bubble generated by an influx of speculators (a consequence of widespread recognition of comic art as valuable) burst, and the industry saw massive structural changes. Many publishers went out of business, and even Marvel filed for bankruptcy (Duin & Richardson, 1998). To avoid this noise in the data, we stopped the study before these structural changes occurred.

The ability of the comic-trading market to perceive and respond to differences in product quality made these data particularly attractive. The collector values of comics in the data represent retrospective market judgments of quality and innovativeness, with the impact of temporary perturbations caused by nonqualitative product gimmicks greatly reduced by the time span between publication and collector value assessment. The collector value of a comic book is a natural version of Amabile's (1982, 1996) consensual assessment technique for creativity, as collectors provide independent expert judgments of products, which are compared against each other rather than against an absolute ideal. The evaluators of comics are increasingly adult; a survey by the largest comic distributor, Diamond Comics, revealed that the average age of (avid) comic readers is 34.

The unit of analysis was the individual comic book. The price and comic data we used came from the electronic source Comicbase, which we tapped in 2004. Supplemental data for identifying authors and publishers were obtained from the 2003 *Overstreet Comic Book Price Guide* and the 2002 *Standard Catalogue of Comic Books*. The value information in the Comicbase data is drawn primarily from analysis of actual sales transactions collected from online auctions, dealer sales, shop sales, and convention sales. For a reliability check, we compared the prices our primary source listed for a random sample of 250 comics to prices in another data source, the *Overstreet Comic Book Price Guide*. The correlation between the two sources was .99. The data on each comic book used in our analysis include the date issued, its creators, and

the organization that published it. We began the data collection by identifying all comic books published in the United States between 1972 and 1996. For each of these, we then captured the creator and company data. We then examined the data, removing duplicates and other inconsistencies. Finally, we eliminated comics released with marketing gimmicks such as gifts to allow comparability. After the clean-up, a total of 4,485 comic books with 234 publishers remained. Not surprisingly, Marvel and DC, the two largest comic publishers, accounted for almost 54 percent of all the comics in our data. Thus, the findings may be weighted toward the experiences of creators in these large firms.

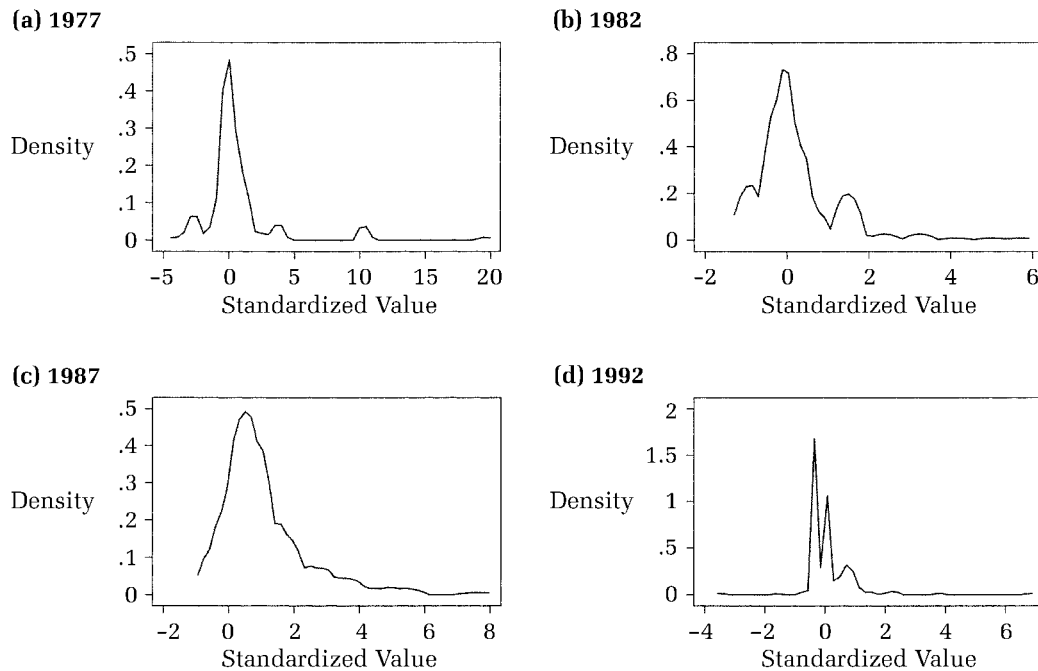
We analyzed the collector value of comics as reported in the Comicbase data for the year 2003, leaving at least five years between the publication of a comic and its evaluation. We standardized these values to have a mean of zero and a standard deviation of unity in each year. The evaluation of comic values differs a great deal, so the standardized values show extreme outliers to the right-hand side (very innovative comics with very high collector value). On the left-hand side there are also outliers, but less extreme ones, as comics cannot have a negative value. Figure 1 shows the distribution of values at four five-year intervals starting in 1977. The distributions place most of the observations in the center ("normal" comics), but with left and right tails of unusually low and high values, respectively.

Measures

Dependent variable. As noted earlier, our dependent variable was the within-year standardized collector market value of a comic in the year 2003. We also obtained the collector values from 2000 through 2002 and used these to verify that the values were stable. We found that the pairwise correlations of adjacent years were on average .92 for all the comics. This correlation is quite high, given that values may change as a result of reevaluation of the artistic value of a comic as well as in response to new information about its scarcity and demand. We examined the correlations of values for the last five years of comics in the data (1992–97) separately to check for instability in the evaluation of recent comics but found that these correlations were also high: the adjacent-year correlation was .97 on average.

To further test that the upper values were comics perceived to be innovative, we sent a survey to 20 industry experts identified in the *Overstreet* and *Wizard* comic guides asking for a list of which 25 published comics in the modern comic era they

FIGURE 1
Value of Comics for Four Years



considered most innovative. Thirteen of the experts responded; the average percentage of agreement was 76 percent for the top 25 and 85 percent for the top 10. This is an impressive level of agreement, given that the raters had the entire universe of published comics to draw from. We also calculated an interrater agreement between the possible combinations using Cohen's kappa (Cohen, 1960; Landis & Koch, 1977). The results showed significant agreement between the lists, with mean Ks of .46 for the top 25 and .67 for the top 10 most innovative comics ($Z < .000$ for both). We generated a list of 50 comics by combining the lists. The innovations included comics such as the 1987 *Maus: A Survivor's Tale*, the first comic nominated for the National Book Critics Award and a winner of the Pulitzer Prize; the 1962 *Amazing Fantasy #15*, the first depiction of a hero with personal problems (Spider-man); and the 1982 *Love and Rockets*, which showcased ethnic sensibility and stylistic sophistication. We compared the survey results to the price data. Of the 50 innovative comics identified by the experts, 64 percent were in the top 10 percent of the comic values in our data, and the innovative comics were on average at the top 13.3 percent of standardized values.

Independent variables. To test Hypothesis 1, we included number of creators, measured as a count of the writers and artists involved in a comic. A creator can act as both writer and artist, but typi-

cally a team of creators develops a comic. Adding team members on a comic often adds different perspectives to the creative process. The use of different views in the process is illustrated by this quote from an interview with Geoff Johns, a writer for the Superman comic among others. "I love co-writing. It's a blast to sit in a room or talk over dinner or just throw around ideas with another writer. It's the best thing in the world if you're working with someone you really gel with creatively and personally. . . sometimes we fight over it and do it all over again eight times" (Hays, 2005). Some of the qualitative data suggested that a creator acting as both writer and artist might denote a special creative process. For example, award-winning comic creator James Sturm stated: "Working alone allows you to have a single focus—the art, writing, everything is purely directed by your vision, without having to make compromises" (personal interview, November 2003). To address this possibility, we also included an indicator value for single creator.

To test Hypothesis 2, we coded diversity of backgrounds as the number of genres in which creators had worked over the year prior to the publication of a focal comic. This variable, genre experience, was a count of all genres that the creators on a team had worked with in their careers, omitting double-counts of genres that more than one creator had worked with. This variable captured a team's range of genre knowledge domains. Comicbase catego-

rized comics into 22 genres but associated some comics with multiple genres (e.g., a graphic superhero novel). To test Hypothesis 3, we interacted this variable with the indicator variable for single creator.

To test Hypotheses 4 and 5, we calculated team experience as the number of times a creative team had worked together previously. That is, we kept track of the team number of collaborations rather than the number of collaborations between the members of a team (who might have collaborated as parts of different teams). We also tried a measure counting all collaborations between members of a team, which gave the same findings. In these data, the two measures correlated nearly perfectly (.96). To test Hypothesis 6, we included a workload variable, the average number of comics that the creators of each comic had produced in the past year. To test Hypothesis 7, we measured the number of years elapsed since each team member's first published comic and took the highest as our variable for tenure. Though the data we analyzed start in the modern period (1972), we based the tenure and genre variables on data going back to 1930 to correctly measure experience before 1972. To test Hypothesis 8, we measured organizational resources as the sum of the standardized values of the number of comics published, total circulation, and number of affiliated creators per year for each publisher ($\alpha = .92$; average $r = .80$). We constructed this measure using a data set in which each firm-year contributed one observation in order to avoid overweighting the large firms.

Initial circulation of a comic was used as a control for scarcity effects on comic value. Because multigenre comic titles might be evaluated differently than single-genre titles, we entered the variable genre count, which equaled the number of genres in which a focal comic was classified. We created an indicator variable with a value of 1 if the average workload of creators had significantly increased (more than fivefold) over the previous year. We included the highest-value comic any of the creators had made in the past in order to control for creator ability differences and attempts to repeat past successes (Amburgey & Miner, 1992).

To control for observations lost through missing data on creators or publishers, we computed an inverse Mills ratio from a logit model predicting complete data and included it in the model (Lee, 1983). Finally, we included indicator variables for five-year spans (1978–82, 1983–87, 1988–92, and 1993–96, with 1973–77 as the omitted category). To keep the tables brief, the coefficient estimates for these indicator variables are not shown. We lagged all independent variables by a year.

Model Specification

Because our focus on innovations as extreme values was novel, we tried three modeling approaches to test the hypotheses. The first approach uses linear regression analysis on the standardized level of performance and deviation from mean performance. We standardized performance to have a mean of 0 and a standard deviation of 1 in each year. Thus, it expressed performance relative to other comics in the same year. We expressed the performance deviation as the absolute deviation from the mean of the standardized variable (which is 0). The second approach was linear regression on percentiles, in which we rank-ordered the observations according to ascending performance within each year and then calculated the rank percentile. This approach has assumptions about performance similar to those of linear regression, except that it focuses on rank rather than on absolute level of performance. The third was linear regression analysis deleting the top and bottom 1 percent of observations as a check for influential outliers. These approaches gave consistent results except as noted in the text, and we present the results of the first approach, linear regression on standardized performance, with no deletions.

Table 1 provides the descriptive statistics and the correlation matrix. As expected, the variables with high correlations were single creator and multiple creators, workload increase and workload average, and publisher size and single creator. None of the other variables had high correlation coefficients. Preliminary analysis showed that the results were stable when subsets of the variables were omitted from the model.

RESULTS

We first report results of analyzing the data without distinguishing individual creators and multi-person creative teams and then show models that distinguished the effects of individual creators. Table 2 shows the result of the analyses of performance level and deviation. Because Hypotheses 1 through 5 concern innovative (variance-increasing) behaviors, we first describe model 2, which examines the performance deviation from the mean. Hypothesis 1 states that having many creators increases the chance of producing extreme outcomes. This hypothesis is supported, as seen in the positive and highly significant coefficient for number of creators in the regression on the standardized deviation of performance. However, it is not supported in the regression on rank deviation, so the finding is sensitive to the treatment of extreme out-

TABLE 1
Descriptive Statistics and Correlations^a

Variable	Mean	s.d.	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Circulation	0.02	0.01													
2. Number of genres	1.19	0.41	-.17												
3. Workload increase	0.11	0.32	-.09	.10											
4. Lowest-value comic	-0.46	1.39	.05	.02	.11										
5. Single creator	0.27	0.45	-.17	.12	-.06	-.17									
6. Number of creators	2.17	1.31	.05	.11	.12	.07	-.55								
7. Genre experience	2.56	1.54	-.02	.21	.02	-.02	-.11	.19							
8. Team experience	3.35	6.53	.10	-.14	-.14	-.01	-.31	-.02	-.06						
9. Highest-value comic	4.66	18.27	.04	-.07	-.08	-.08	-.02	.01	-.00	.03					
10. Workload average	14.73	10.41	.19	-.10	-.46	-.14	.12	-.15	.04	.11	.09				
11. Tenure	16.63	11.14	-.03	.15	-.12	-.12	.14	.16	.05	-.07	-.04	.17			
12. Tenure squared/100	4.01	5.26	-.08	.20	-.09	-.12	.21	.11	.05	-.12	-.05	.18	.96		
13. Publisher size	0.74	0.98	.25	-.10	.00	.02	-.33	.07	.07	.17	-.05	.12	-.27	-.30	
14. Inverse Mills ratio	0.52	0.23	.22	-.22	-.13	-.07	-.01	-.17	.03	.10	.15	.30	.28	.02	.02

^a Correlation coefficients with a magnitude greater than .03 are significant at the .05 level.

liers in the distribution. Next, Hypothesis 2 states that diversity of creator background increases the performance variance. The variable for genre experience had a significant, positive effect, in support of the hypothesis. Hypothesis 3, stating that this effect is stronger for individual creators, is tested in model 4.

Hypothesis 4 states that increased team experience increases variance in performance. The positive and significant coefficient estimate of team experience strongly supports this hypothesis.

These findings show that teams with diverse knowledge and much experience working together produce comics with extremely high or extremely low performance, in support of our theory of the effect of knowledge combination on innovativeness. The analysis of deviation from the mean thus provides strong support for three of our hypotheses on factors that increase the likelihood of teams making innovative products with extreme (high or low) evaluations.

TABLE 2
Results of Linear Regression Analysis of Level and Deviation of Performance^a

Variables	Model 1: Level	Model 2: Deviation	Model 3: Level	Model 4: Deviation
Circulation	10.16** (1.77)	4.62** (1.71)	10.13** (1.77)	4.59** (1.71)
Genre count	-0.04 (0.05)	-0.01 (0.05)	-0.05 (0.05)	-0.01 (0.05)
Workload increase	-0.22** (0.06)	-0.14* (0.06)	-0.21** (0.06)	-0.13* (0.06)
Highest value comic	0.02** (0.00)	0.02** (0.00)	0.02** (0.00)	0.02** (0.00)
Single creator	-0.12* (0.06)	-0.04 (0.05)	-0.22* (0.09)	-0.16 [†] (0.08)
Number of creators	0.00 (0.02)	0.04* (0.02)	0.01 (0.02)	0.05** (0.02)
Genre experience	0.040** (0.012)	0.027* (0.012)	0.031* (0.014)	0.016 (0.013)
Genre experience × single creator			0.044 (0.028)	0.053* (0.027)
Team experience	0.011** (0.003)	0.011** (0.003)	0.011** (0.003)	0.010** (0.003)
Workload average	-0.004 [†] (0.002)	-0.003 (0.002)	-0.004 [†] (0.002)	-0.003 (0.002)
Tenure	-0.01 (0.01)	-0.01 (0.01)	-0.01 (0.01)	-0.01 (0.01)
Tenure squared	0.01 (0.01)	0.00 (0.01)	0.01 (0.01)	-0.00 (0.01)
Publisher size	-0.18** (0.04)	-0.07 [†] (0.04)	-0.18** (0.04)	-0.07 [†] (0.04)
Inverse Mills ratio	0.50** (0.10)	0.23* (0.10)	0.51** (0.10)	0.23* (0.10)
Constant	-0.25 [†] (0.14)	0.08 (0.14)	-0.24 [†] (0.14)	0.09 (0.14)
R ²	0.15	0.11	0.15	0.12

^a n = 4,485. Standard errors are in parentheses.

[†] p < .10

* p < .05

** p < .01

Two-sided tests.

Next, model 1, on the level of performance, was used to test our predictions on learning made in Hypotheses 5 through 8. First, the statement in Hypothesis 5 that the team experience of creators increases average performance is supported, as the coefficient estimate of team experience is positive and highly significant. Hypothesis 6, stating that a heavy workload increases performance level, is not supported. Instead, the coefficient estimate is negative and marginally significant, contrary to prediction. Tenure has an insignificant effect on the level of performance, indicating a lack of support for Hypothesis 7. Finally, publisher size has a negative and significant effect on performance, contrary to the prediction made in Hypothesis 8, that organizational resources increase performance. The analysis strongly supports a positive effect of team experience but provides highly mixed results for the other hypotheses on mean-increasing effects in comic book creation.

These models also provided some interesting findings that were not predicted. Genre experience had a significant and positive effect on the level of performance, suggesting that broad expertise on a creative team increased mean performance in addition to having the predicted effect of increasing the variance of performance. A similar mean-increasing effect was also found for the highest-value past comic. In these data, the role of expertise in jointly spurring creativity and raising average performance is so strong that it overwhelms the theorized trade-off between exploration and exploitation (March, 1991). A trade-off may still exist within each individual team, but the teams differ so much in knowledge and experience that the factors that predict level of performance resemble those that predict variation. Also, a workload increase reduces both the level of performance and (for the standardized variable only), its deviation. Thus, the creators with high workloads had lower performance, and increased workloads resulted in lower-quality, less innovative comics.

Next, models 3 and 4 present the analysis that takes into account the difference between individual creators and multiperson creative teams. As before, the analysis supports the three hypotheses on factors that increase the variance of performance, but model 4 provides additional detail. Now, the main effect of genre experience on extreme outcomes (Hypothesis 2) is not significant, but the interaction of genre experience and individual creators is positive and significant. This finding is in support of Hypothesis 3, stating that knowledge diversity in an individual has a stronger effect than knowledge diversity in a team. Combined, these findings are a clear demonstration of process

loss: genre experience held by a single individual has an effect on innovation, but genre experience dispersed over team members does not.

To show the substantive effect of these interactions, we graph them in Figures 2a–2b. In both panels, genre experience is on the horizontal axis and is graphed from 0 to the mean plus two standard deviations. The performance of a team with no genre experience (a team of novices) is set to 0, and the regression coefficients of the single-creator indicator, genre experience, and their interactions are used to compute the curves. Figure 2a shows that single creators start with a lower level of performance, as the negative indicator variable indicates, and then have a marginally higher improvement as they gain experience, leading the curves to cross at five genres. However, the interaction effect is not significant in the performance-level equation, so we cannot be sure that the climb really is higher. Figure 2b shows the curves for the deviation of performance, where the interaction effect is statistically significant as well as larger in magnitude. Although single creators start out with lower innovativeness, their curve crosses that of teams at three genres. Hence, genre experience is especially valuable for increasing individual innovativeness. Conversely, combining diverse knowledge from multiple persons results in process costs that offset the benefits.

We performed two additional analyses to explore the conditions under which experience affects innovative output. First, we suspected that experience without diverse knowledge might not increase the variance of outputs, and might even decrease it. Using an interaction of experience and an indicator variable for whether a team had experience from only one genre, we found that the first of these conjectures was true. This interaction variable had a negative and significant coefficient in the analyses of performance deviation and performance level, and the coefficient was exactly large enough to cancel out the positive main effect of experience. Experience increases variation when combined with diverse knowledge, but not otherwise. Second, we thought that large organizations might have lower performance because their formalization prevented learning from experience in teams and thus entered an interaction of size and experience to test this conjecture. The findings were un-supportive, as the coefficient estimates on performance were insignificant.

DISCUSSION AND CONCLUSION

This paper follows the research tradition of using cultural industries to investigate competitive dy-

FIGURE 2a
Interaction Effects on Performance Level

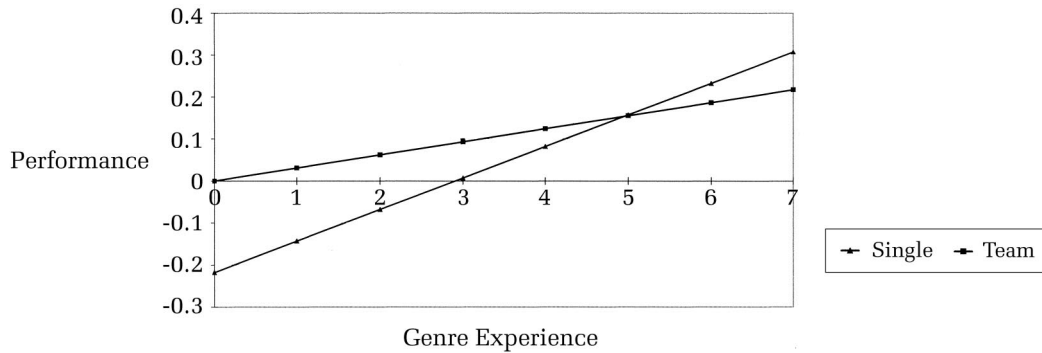
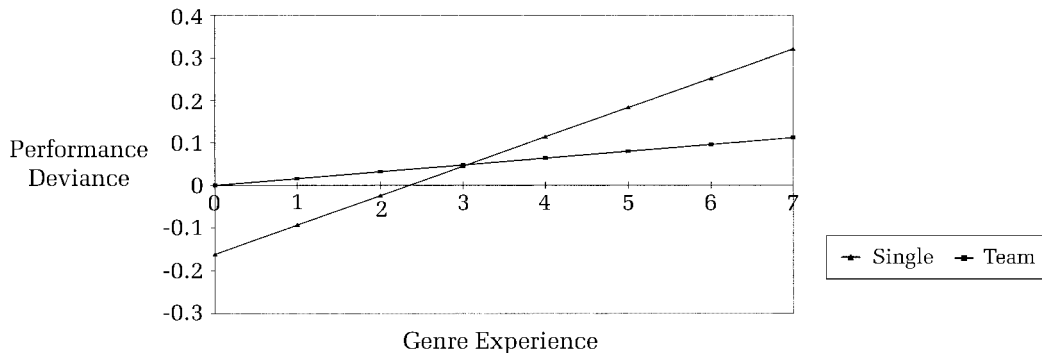


FIGURE 2b
Interaction Effects on Performance Deviance



namics (Hirsch, 1972), as in work on music (Allmendinger & Hackman, 1996; Bougan, Weick, & Binkhorst, 1977); book and magazine publishing (Levitt & Nass, 1989; Thornton & Ocasio, 1999); film (Mezias & Mezias, 2000; Miller & Shamsie, 1996); and radio broadcasting (Greve, 1995; Greve & Taylor, 2000). We use the comic-publishing industry to examine the relationship between creative and learning processes and subsequent commercially recognized value. We distinguish factors that increase the performance variance and factors that increase the mean performance level. Uniquely, we examine exploration activities that result in outcome extremes, as seen in increased variance of performance, rather than just enhanced performance.

We found higher variance of performance in teams with multiple members, experience from multiple genres, and a history of working together. The positive effect of genre experience on variance was largely attributable to single-member teams, however, suggesting that individuals are capable of more creative integration of diverse experiences than teams are. These findings were supportive of our hypotheses. We also found that large organiza-

tions and high workloads reduced the variance, although production of high-value output in the past predicted high variance. We found a higher level of performance in individuals and teams with experience from multiple genres, and team experience working together also increased performance. We also found that large organizations and high workloads reduced the level of performance, and single creators had lower performance than teams, on the average. The results show an interesting pattern. Innovation and creativity as variance-increasing activities have clearly distinguishable causes in line with predictions, but there was much less support for the hypotheses on mean-increasing activities. In addition, some of the factors hypothesized to increase performance variance also increased the mean.

The results substantiate our argument that combining knowledge requires a deep understanding of knowledge, rather than information scanning or exposure. The variables that reflect a deep understanding—experience in diverse knowledge domains, team experience, and previous innovation experience—drove the increase in variance behavior. Number of creators, the variable that captures

exposure but not understanding, provided mixed results. The findings suggest that it is not enough to have access to new knowledge; commitment and significant experience in a knowledge domain are also needed to generate innovations (Tripsas, 1997). The results on multiple creators suggest that without a deep understanding by the participants, variance may be increased at the cost of lower mean performance. On the other hand, knowledge-building experience, often considered the bane of innovation, was an important positive factor.

Our investigation provides an interesting observation on the difference between exploration and exploitation. Four of the variables included in the model increased variance: diverse knowledge (cross-genre experience), team experience, previous innovation success, and number of creators (though the latter had somewhat mixed effects). The first three of these also increase the mean performance. This finding suggests that although exploration and exploitation may be two different processes, experience affects both positively. Application of diverse knowledge is a variance-increasing process, yet applying experience is necessary for both exploration and exploitation. It may be that knowledge-intensive activities are united by the need for understanding but differ in the direction of the effort. Knowledge combination is inherently difficult, and it occurs most easily when a team has past experience working together. This finding is consistent with accounts in the team formation literature of stages of team activity in which much of the early activity is focused on learning how to work together rather than on the team task. It also suggests that the dichotomy between exploration and exploitation at the organizational level is driven not by the differing knowledge assets used, but by the differing goals and expectations for the tasks. An organization may trade off exploitation and exploration when assigning a research and development team the goal of making a radical innovation versus improving an existing technology or product, but a team composition that gives high performance on an exploration task also gives high performance on an exploitation task. It is not the selection of people that determines the degree of exploration, but what they are asked to do.

Our findings on mean-increasing variables are generally weak, with many insignificant effects. The typical experience effects appear weak or absent in the creative task of generating comic books; these effects may exist but be absorbed by other variables, such as past innovation experience. The impact of organization also was not as expected, as the results show that larger organizations have poorer overall performance. Generalizing this result is problematic given the dominance of Marvel

and DC as publishers in the field we examined, because it may be indicative of the negative impact of these two organizations on the performance of creators. This interpretation was suggested, prior to the empirical analysis, by interviews with creators who had worked both independently and with larger organizations, and who felt that the constraints imposed by these organizations reduced the quality of their work. The findings proved them right.

The results also highlight the methodological contribution of the study. By analyzing performance levels, past innovation research has only looked at the upper tail of the impact of undertaking innovative behavior. Exploration is variance-inducing, and that variance can yield both positive and negative innovative outcomes. The empirical results support this argument, as the conditions that caused positively evaluated innovations also caused negatively evaluated innovations. Studies that examine only positive results of innovative activities meld the results of variance- and mean-increasing activities, and thus they fail to provide insights on either one. In addition, explicitly modeling the negative impact of exploration more accurately allows empirical measurement of the risks associated with innovation.

This research has some limitations that we hope to address in future work. First, although the task of producing comics involves technical skills such as writing, layout, inking, and coloring, it does not use technology in the same way as products that require engineering. Nor does this task occur under the limitations for safe and ethical experimentation that face, for example, medical teams developing new procedures. In recognition of the possible role of constraints on innovations, we chose not to analyze comics from the censorship period, and we believe findings from an uncensored period are more generalizable. Censorship is a constraint that operates directly on creative output, however, and is thus different from the constraints on the creative process imposed by technology and safety concerns. Innovations in comics may be a relatively unconstrained creative task, so additional research is needed to establish whether technological, safety, or other constraints would modify these findings.

Second, an important theoretical issue is that of partial team replacement. There is a difference between a team becoming effective as a result of past interactions of the team as a whole and a team becoming effective as a result of past dyadic interactions of members in previous teams. Individual members can be replaced without fear of worse outcomes if the latter process is the more impor-

tant, but not if the former is. Unfortunately, these data showed a dominant pattern of replacing all members or none, so measures of dyadic and full-team experience correlated too highly for these effects to be distinguished. A context in which partial replacement is more common may be necessary to address the difference between these processes of team learning.

Third, the data may be susceptible to effects from the historical period under investigation. In any data based on individual career outcomes, it is worthwhile checking for influences from specific cohorts and periods. We found the distribution of career cohorts and time periods of the creative works to be quite even, and thus there were no numerically influential cohorts or time periods in the data. Like other cultural products, however, comic books are available for other creators to study and mimic, and the broad agreement on which comics are most successful created a shared history that influenced these creators. We believe that the long duration of this study—1972 to 1996—provides reasonable insurance against shared-history effects because the history available to the creators changed substantially during this period.

Future research should focus on innovations as novelty and examine more closely how organizations create extreme outcomes. This project would require research designs to identify all innovative products, not just the successful ones. Such designs will give more incisive analysis because they will allow empirical tests of the theoretical distinctions between mean-increasing and variance-increasing influences on innovation, which may be important for work on team diversity. The tension between diverse teams containing more information and having greater difficulty using it has persistently troubled the diversity literature (Williams & O'Reilly, 1998). It could be that a focus on average outcomes has exacerbated these difficulties because the net effect of diversity is unclear when one is measuring average performance, but its effect should be increased variance in performance because of the contrast between diverse teams that function well and those that do not.

More important, however, may be the suggestion that the real driver of innovation is combining diverse knowledge. Our focus on the genre experience of creators was empirically very powerful, as it supported our predictions on performance deviance and gave an unexpected finding on performance level. This pattern of findings indicates that future research should focus on concrete measures of the career experiences of team members rather than on surface-level diversity. Just as comic cre-

ators get expertise from working in different genres, members of product development teams gain expertise from working on products and technologies. Future research should investigate how career experiences yield expertise in specific knowledge domains that affects the innovative performance of teams.

These findings have important implications for managers organizing new-product development teams. Most important is the effect of diverse knowledge on the production of innovations. Combining knowledge domains is not just a strong lever for generating variance; in our data it also raised the level of performance. Clearly, our findings imply that individuals' career experiences should be considered when teams are assembled, and they also imply that careers should be managed so that an organization has a broad stock of knowledge to choose from. One career management issue is whether to encourage specialization or broad experience. We found that although combining knowledge domains appeared to affect the level of performance in teams as well as in individuals, we could only prove the effect for individuals. Although we cannot tell for sure with these data, it is reasonable to infer that the process cost implied by this finding means that a given set of knowledge domains will be less efficiently combined the more persons are needed to assemble the domains in a team. In product development, specialization can be costly. In addition, when managers staff new-product teams with cross-functional and cross-knowledge individuals, it is essential that the included members have deep understandings of their respective knowledge domains. Finally, our results show that teams that have previously worked together are superior to newly assembled teams. These findings suggest that when seeking innovation in knowledge-based industries, it is best to find one "super" individual. If no individual with the necessary combination of diverse knowledge is available, one should form a "fantastic" team, with each team member having deep knowledge and experience working with the other team members.

Finally, the findings suggest that managers do not have to make a trade-off between exploration and exploitation when assembling teams. The characteristics that increased exploration (extreme outcomes) also increased exploitation (higher level of outcomes). It is not team composition, then, but rather the task and context given to a team that creates a trade-off between exploration and exploitation in product development. It may be the process of setting goals and prefiltering options that results in performance differences, not a difference

in the core number of new ideas or proposed options.

We used fine-grained data to reveal processes that have been implicitly assumed but not explicitly tested in the literature on innovation through combining knowledge. Our findings are consistent with, and extend, many of the results found in the prior research on team innovation grounded in psychology and organizational behavior. Uniquely, we were able to measure the value of different creative team configurations with a real commercial outcome—the collector value of a comic. In addition to documenting the role of knowledge combination in creating innovations, this research also raises interesting questions of a possible dampening effect of large organizations on innovative behavior and performance level. We expect further work on exploration through variance-increasing activities to yield additional new insights.

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