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REFLECTIONS ON THE 2013 DECADE AWARD: "EXPLOITATION, EXPLORATION, AND PROCESS MANAGEMENT: THE PRODUCTIVITY DILEMMA REVISITED" TEN YEARS LATER

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This article reflects on our 2003 article, "Exploitation, Exploration, and Process Management: The Productivity Dilemma Revisited," which received the *Academy of Management Review*'s Best Article Award in 2003 and Decade Award in 2013. We consider the context within which we wrote the original article, with particular reference to the theoretical, empirical, and managerial problems salient at that time, and comment on the likely reasons the article has had a sustained influence in the field. Looking forward, we first ask whether the paradoxes and inconsistencies we discussed are still fundamental organizational challenges, and then go further to consider ways the domain of innovation itself has changed. We suggest that because of fundamental shifts in communication and information processing costs and the increasing modularity of products and services, the nature and locus of innovation have changed over the past decade. These secular trends have profound implications for our theories of innovation and organizations. Our extant theory and research are increasingly uncoupled from the phenomena. We would be well served to revisit the nature, locus, and basic processes of innovation.

This article reflects on our 2003 article, "Exploitation, Exploration, and Process Management: The Productivity Dilemma Revisited," which received the *Academy of Management Review's* Best Article Award in 2003 and Decade Award in 2013. We consider the context within which we wrote the original article, with particular reference to the theoretical, empirical, and managerial problems salient at that time. We suggest that the root of the article's sustained influence has been its focus on a strategically important dependent variable (innovation streams), its counterintuitive stance with respect to an important managerial tool at the time (TQM, Six Sigma, and other process management tools), its cross-level attention to mechanisms, its theoretical scope (e.g., strategy, organization theory, innovation, and top management teams), and its potential to influence practice. The core ideas of the article—the productivity dilemma (and associated paradoxical strategic challenges), innovation streams, ambidexterity, and senior teams—have generated substantial debate and associated research over the past decade (e.g., Birkinshaw & Gupta, 2013; O'Reilly & Tushman, 2013). We briefly review this literature and then focus on opportunities for ongoing research and theory.

Looking forward, we first ask whether the paradoxes and inconsistencies we discussed are still fundamental organizational challenges. We also consider how the nature of innovation itself has evolved over the past decade. What are the implications of the digital revolution for the notion of exploration and exploitation? What are the implications of very low costs of computation, search, and communication for scholars interested in the topics of strategy (especially issues associated with dynamic capabilities), innovation, organization theory, senior teams, and organizational change (e.g., Altman, Nagle, & Tushman, 2013; Benner & Waldfogel, 2015; Di Stefano, Peteraf, & Verona, 2014; Teece, 2014)?

We suggest that the increased modularization of products and services and the simultaneous sharp drop in communication and computation costs spurred by the digital revolution push the locus of innovation beyond the boundaries of the

This invited article reflects on our 2003 *AMR* Decade Award–winning article. We thank Jerry Davis, Roy Suddaby, Mary Ann Glynn, and Ryan Raffaelli for helpful comments on the manuscript. We also thank John Joseph for his helpful insights into Motorola.

firm to open or peer communities (see Adner, 2002, 2012; Afuah & Tucci, 2013; Chesbrough, 2006; Lakhani, Lifshitz-Assaf, & Tushman, 2013; O'Mahony & Lakhani, 2011). Further, because the logic of community or peer innovation is so fundamentally different from more traditional closed (or Chandlerian) innovation logic, the demands on the firm regarding innovation streams, leadership, and organizational evolution may be fundamentally different. While ambidexterity may be an appropriate structural form for traditional innovation streams, it is not clear what the organizational, leadership, innovation challenges, and potential outcomes are for firms that must master innovation in both closed and open contexts.

Finally, we suggest that because of the shift in the locus of innovation and because some of our core organizing axioms (e.g., local search, absorptive capacity, information processing, and transaction costs) may be challenged or fundamentally changed by the digital revolution, the nature of innovation and organizational scholarship may be at a transition point (e.g,. Afuah & Tucci, 2013; Baldwin & von Hippel, 2011). Our extant theories of innovation and the productivity dilemma do not reflect the current more complex context within which organizations operate. Our research and theory are increasingly uncoupled from the phenomena. Research on innovation would benefit from ideas, concepts, and mechanisms that better align with the changed innovation domain (Suddaby, Hardy, & Huy, 2011).[1]

In order to develop fresh theory of innovation and organizations, scholars in our field should return to understanding the basic phenomenon of innovation and the associated productivity dilemma. It is time for more problem-focused research and a shift from mature, deductive scholarship to more inductive and phenomena-driven scholarship (Davis, in press; Edmondson & McManus, 2007; Tushman & O'Reilly, 2007). Our extant theory and research on innovation and the associated productivity dilemma grew from research rich in description (e.g., Abernathy, 1978; Bijker, Hughes, & Pinch, 1987; Hughes, 1983; Landes, 1983; Lawrence & Lorsch, 1967; Woodward, 1965). Perhaps it is a time to go back to more problem-oriented, phenomena-anchored research. Perhaps it is time to go back to the future.

[1] Note that while our article focuses on innovation, Davis has made similar observations on the impact of digitization and modularization on the locus of production (e.g., Davis, in press).

BACK THEN: THE ARTICLE AND ITS INSPIRATION

In 1997, when we first started working on the 2003 article, process management programs like Six Sigma, TQM, ISO 9000, business process reengineering, and the Malcolm Baldrige Award criteria were sweeping businesses, both in the United States and internationally. Consultants and academics alike promoted these programs as a universal panacea for management. Such practices were expected to result in lower costs and higher-quality products while alleviating a range of organizational problems—from boosting profits to spurring innovation. These programs entailed carefully "mapping" the organization's processes (e.g., for procurement, product development, manufacturing, and other organizational activities), analyzing the steps in the processes to remove wasteful or redundant organizational activities, and adhering to the resulting efficient, streamlined processes. TQM practices at Xerox and Alcoa and Six Sigma practices at Motorola (and, subsequently, GE) led to notable improvements and spurred their spread to many other organizations. Measureable successes with process management practices applied to particular processes downstream, such as manufacturing, led further to their implementation in upstream processes—for example, in managing the supply chain or "Design for Six Sigma" for developing new products.

We saw these programs as the instantiation in then-current management practice of the productivity dilemma, where a focus on efficiency and exploitation of existing knowledge would drive out more radical or exploratory innovation that used fundamentally new technologies or that was required for fundamentally new customers. We carefully studied the research and found that little of the existing research considered the possible downside of such programs. Researchers had not questioned the assumptions of universal benefits, and most studies were aimed at empirically demonstrating the programs' expected benefits. While some studies did not find the expected results, these researchers attributed the lack of positive results to incomplete adoption of the practices or to the compelling idea that benefits accrue to early adopters (e.g., adopting

such programs for "technical" reasons and customizing them) but not later adopters—that is, those who succumb to institutional pressures to adopt standardized, and less useful, variants of the programs (Westphal, Gulati, & Shortell, 1997). Still, while acknowledging that benefits might vary for different types of adopting firms, researchers did not consider the possibility that such programs could be *harmful*. We found little curiosity about why these programs were not delivering on their promise and little application of the understandings that organization theorists already had about the connections between and among stable routines, innovation, inertia, and organizational adaptation.

Research in innovation also was not considering the potential influences of process management programs. The idea of technology life cycles unfolding at the industry level was a prominent idea in the innovation literature at the time—that is, cycles of variation, selection, and retention that shifted attention and activities at the industry level from periods of rapid product innovation (variation) to periods of a focus on process improvement and efficiency (retention) once a dominant technological standard emerged (selection; Tushman & Rosenkopf, 1992; Utterback, 1994). Generally, researchers anticipated that activities in organizations would reflect these industry cycles—activities within firms were likely to shift from product innovation to process innovation and incremental improvement once a dominant design or standard emerged, and a shift to focus on process improvement would be an appropriate response within a maturing technological paradigm. But process management practices, imposed on organizations and implemented in the universal way advocates counseled, would spur shifts to a focus on incremental improvement and efficiency regardless of the stage of industry life cycle.

We proposed three main ideas in our article. First, in contrast to the hype and the touted "'promise," we proposed that programs with a focus on process management at their core, such as Six Sigma, TQM, and ISO 9000, were not likely to be beneficial for all organizations or all types of organizational activities. Further, they might be harmful for some organizations and some organizational activities. More specifically, whether they were beneficial or harmful depended on the specifics of industry and organizational contexts. We noted their likely effects: spurring incremental innovation (innovation in existing technologies and for existing customers) and dampening more exploratory innovation (innovation in new technologies and for new customer sets) might indeed lead to increased efficiency and performance in stable contexts but would detrimentally affect an organization's ability to adapt in changing contexts. Since exploratory search and innovation are central to how firms adapt to change, there was clear potential for process management programs to be very bad for some parts of organizations and for some organizations.

Second, we suggested that innovation streams and their associated paradoxical organizational requirements might be a route to long-term organizational viability—that successfully managing the productivity dilemma (i.e., the ability to address these paradoxical requirements) could be a fundamental dynamic capability. We also suggested that innovation streams entailed simultaneously working on exploitative innovation (i.e., incremental innovation focused on current customers) and exploratory innovation (either architectural or discontinuous) dedicated to either existing or new customers. Furthermore, we suggested that the product class (industry) context mattered as well. During eras of incremental change, exploitative innovation would have strategic value, while in eras of ferment, exploratory innovation would have more survival value. Because product classes are always in transition, we suggested that firms would have to simultaneously host both exploratory and exploitative innovation.

The tension faced by incumbents is that exploitative innovation drives out exploratory innovation. Indeed, Abernathy's (1978) productivity dilemma was rooted in the inverse relationship between the need for increased process innovation and the potential of exploratory innovation. In our article we argued that the mechanism underlying the productivity dilemma was the process-stabilizing and variation-reducing actions associated with exploitative innovation, which, somewhat unintentionally, drove out the variance-increasing requirements for either architectural or discontinuous innovation. We saw such process management programs as a likely trigger of crucial trade-offs like the productivity dilemma (in Abernathy's words) or the tensions between exploitation and exploration (in March's words). At the time, these ideas were novel, challenging the proponents of

process management in both academia and practice and explaining how these tensions might arise in real organizations.

The third main idea we proposed was a potential solution to the tensions highlighted by the productivity dilemma. We suggested a way for firms to host process management practices and gain efficiency benefits without dampening innovation. We highlighted the promise of an "ambidextrous organization" that could—through structural separation of process management activities from innovative units within an organization—allow an organization to undertake process management in some organizational activities but buffer the innovation-dampening effects from areas of the organization where innovation, risk taking, and exploration into new domains were essential. We described an ambidextrous organization as one that, by separating different types of activities into different subunits within a business unit, could focus simultaneously on the incremental innovation and measureable efficiency improvements likely to arise from process management, as well as activities focused on exploration into new domains.

We suggested that ambidextrous designs required high differentiation, targeted structural integration at points of leverage between exploitation and exploration, and strong senior team integration. Ambidextrous designs were a form of organization architecture that permitted a single business unit (or corporation) to simultaneously explore and exploit. Such designs build internally inconsistent architectures integrated by senior teams that attend to and deal with paradox and contradiction. In contrast to sequential attention or rhythmic switching between alternative innovation modes (e.g., Brown & Eisenhardt, 1997), vacillating between exploration and exploitation (e.g., Boumgarden, Nickerson, & Zenger, 2012; Nickerson & Zenger, 2002), or inertial responses (e.g., Sull, 1999), such designs simultaneously allowed both exploratory and exploitative innovations.

WHY HAS THE ARTICLE BEEN HIGHLY CITED?

Why has our article been influential? Although clearly it is not possible to say with certainty the drivers of interest in—and citations of—a paper, we speculate on four main reasons we believe our article has been highly cited. Further, we think our reasons explain in general why papers are seen as "interesting" and are highly cited.

First, the article challenged strongly held beliefs. We challenged widely held beliefs about the universal benefits of particular organizational activities—in this case, process management. We provided a plausible set of arguments about the likely influences of these practices that sharply contrasted with prevailing understandings. Our claim aligns with Murray Davis's arguments: "Interesting theories deny certain assumptions of their audience, while non-interesting theories affirm certain assumptions of their audience" (1971: 309). We denied several assumptions of the audience and provided some careful arguments about why the outcomes would be different than asserted by process management's proponents.

Second, the article bridges theory and practice. Specifically, it builds on and extends organization theory to develop a mesolevel theory about how process management practices work in organizations, which helps us understand a phenomenon of interest to managers. Our article illuminates, through an understanding of organization theory, the challenges actual managers face in managing actual organizations (the ostensible topic of organization theory). In the spirit of Stokes' (1997) criteria that research be both rigorous and relevant, our *AMR* (2003) article, as well as a separate paper published in *Administrative Science Quarterly* (*ASQ*) (Benner & Tushman, 2002), provided theoretically and empirically interesting midrange theory that had the promise of managerial impact (see also Tushman & O'Reilly, 2007).

Third, the article speaks to multiple scholarly audiences. Just as process management programs were implemented by—and influenced—several different functions and processes within organizations, academics across management, marketing, operations, strategy, OB, and accounting disciplines were also conducting research on this managerial fad. In developing our theory on the likely outcomes for business units and firms undertaking process management activities, we developed theory at lower levels of analysis, allowing us to theorize about mechanisms and influences on individual and group behavior, in multiple functions and processes in organizations (see Mom, van den Bosch, & Volberda, 2009, and Taylor & Helfat, 2009). Further, because of our attention to innovation streams as a strategic requirement for organizational success over time,

our ideas on ambidexterity and industry context were also linked to the emerging work in strategy on dynamic capabilities (see Di Stefano et al., 2014, and Peteraf, Di Stefano, & Verona, 2013).

Finally, the article helped create a nascent scholarly "conversation" on paradox. There was a subsequent increase in interest in the topics of paradox, balancing exploitation and exploration, forms of ambidexterity, and firm dynamic capabilities (and all of these were topics with managerial relevance). Our article was an early contributor in this conversation. In our concurrent *ASQ* article (Benner & Tushman, 2002), we developed deeper theory specifically addressing how increasing engagement in exploitative process management activities would influence firms' innovations. Building on our *AMR* (2003) article, we suggested that increased process man agement activities would be associated with increased exploitative innovation, decreased exploratory innovation, and a proportional shift away from exploratory innovation. We carefully tested our theory with third-party longitudinal data on ISO 9000 certifications and firms' patenting activity in both the paint and photography industries. We sought to understand how the increasing use of process management over time influenced the extent to which firms' patenting built on the prior knowledge of the firm (that it had previously used in its patenting) versus building on knowledge in domains new to the firm. We found that as organizations embraced the increased exploitation inherent in process management activities, they shifted toward more exploitative innovations—and away from more exploratory innovations. Thus, while paradox might be an important determinant of a firm's ability to survive over time, it appeared (in both industries) that the natural tendency of firms was to default to exploitation in the context of process management activities; efficiency, and associated exploitative activities, seemed to be the enemy of exploration.

Beyond the results of our large-sample study, there are notable anecdotes that have unfolded since our article was published that have drawn further attention to paradox and the associated productivity dilemma. The inventor and major proponent of Six Sigma, Motorola, has not succeeded long term, at least not in the way we typically think of "success" (i.e., survival or performance) in management research. The stories told about Motorola combine its success in increasing efficiency and reliability with Six Sigma and other process focused practices with the struggle to innovate beyond the very successful, breakthrough RAZR mobile phone product such that Motorola was unable to regain its leadership position in the mobile phone industry. Granted, Apple was a formidable competitor, and many mobile phone providers have been challenged by the iPhone. However, it is notable that Motorola's problems are often attributed to a shift toward incremental improvements and product extensions in the RAZR after its initial success. Recently, the company was split in two, with Motorola retaining its government operations business and Google first acquiring the mobile phone segment of the company,, followed by Lenovo. This story echoes the arguments in our *AMR* article about the likely influences of process management on firm innovation and subsequent ability to adapt in changing environments.

Similarly, a few years after our article was published, stories emerged of 3M's struggle to reinvigorate innovation after implementing Six Sigma, led by James McNerney from GE (Hindo, 2007). Upon replacing McNerney, new 3M CEO George Buckley said, "One of the mistakes that we made as a company—it's one of the dangers of Six Sigma—is that when you value sameness more than you value creativity, I think you potentially undermine the heart and soul of [an innovative] company like 3M" (quoted in Hindo, 2007). Separately, at GE (a major proponent of Six Sigma), stories similarly emerged of dramatic efforts by CEO Jeff Immelt to spur "breakthrough innovation," after decades of adherence to process management under the leadership of Jack Welch. Of course, we cannot make causal claims about these anecdotes, but they do clearly echo the ideas outlined in our article that effectively implementing highly touted process management practices such as Six Sigma was not associated with the innovation necessary (and that the CEOs of these companies realized was necessary) for longer-term success and adaptation.

GOING FORWARD: THE RELEVANCE OF OUR IDEAS A DECADE LATER

Going forward, we suggest that there are four important issues for ongoing research on innovation, exploration and exploitation, and the associated productivity dilemma. Two issues

discussed in our *AMR* article continue to be relevant for research ten years later: (1) the (false) promise of universal "best practices" and (2) the importance of addressing the productivity dilemma—that is, the challenge of managing paradox and the potential for organization design to address this challenge. Two other issues have emerged over the past decade that are directly relevant to exploration and exploitation and the productivity dilemma: (1) a fundamental change in the phenomenon of innovation and (2) our research stance toward the study of innovation going forward.

We suggest that because of fundamental changes in innovation—that is, the dramatic reduction of communication and information processing costs and the increasing modularization of products and services triggered by digitization and the internet—the fundamental mechanisms and locus of innovation have shifted over the past decade. The intrusion of community or peer innovation shifts the locus of exploratory and exploitative innovation from the firm (and associated closed or Chandlerian logic) to the community (and associated open logic). This shift in logic has profound implications for research and theory on innovation and organizations. Many of our core organizing assumptions and associated research and theory may be outdated. We suggest that the nature of our research and theorizing must reflect this change in the nature of innovations and organizations. If the nature of innovation has shifted, then our research and theory on innovation must shift back to more inductive or problem-centered work (see also Davis, in press; Lawrence & Dyer, 1983; Stokes, 1997). Our increasingly deductive and disciplinary approach to research on innovation runs the risk of missing the changing nature of innovation itself (Suddaby et al., 2011). We risk knowing more and more about a type of innovation that is being displaced.

The Continued False Promise of Universal Best Practices

More than a decade after our article challenged the promise of a widely popular "best practice," the false promise of universal best practices persists. Faced with uncertainty, managers search for solutions to their challenges often by looking to "experts," such as consultants, or to other successful organizations for promising approaches. Although organization theorists know that there are unlikely to be universal best practices, such practices continue to be touted, even in academic research. Back then it was programs like business process reengineering, the Malcolm Baldrige Award criteria, Six Sigma, TQM, and ISO 9000 that were rapidly diffusing, following pressure by academics, consultants, government agencies, and large purchasing organizations. The popularity of those specific practices may have waned over time, but they have been replaced by talk of new best practices, including ERP systems, Lean Six Sigma, the balanced scorecard, and, even more recent, techniques for big data and data mining, design thinking, rapid prototyping, the "Lean Startup," and many more promoted as universally relevant.

Thus, process management persists, making our story relevant a decade later. The continued rise of these new programs, promoted as universal panaceas for organizational challenges, again suggests the importance of a careful understanding of how popular practices influence organizations—that is, the mechanisms or "cogs and wheels" underlying their effects (Davis & Marquis, 2005), the organizational and industry contexts where each of these new practices are relevant, or, conversely, the conditions under which such practices may have unexpected outcomes or even be harmful for organizations.

Research on Ambidexterity in the Past Decade and the Growing Challenge of Managing Paradox

Two core ideas captured attention in our *AMR* (2003) article. One was in reframing the productivity dilemma into a strategic challenge, suggesting that there was strategic value in organizations that were able to deal with and successfully manage paradox. The other was that organization design might be a way to attend to and deal with the paradoxical strategic challenges of simultaneously exploring and exploiting (see also Tushman & O'Reilly, 1997). Thus, an ambidextrous organizational design, one with internally inconsistent architectures, targeted structural integration between structurally distinct units, and strong senior team integration, might permit a firm to simultaneously explore and exploit. We further developed and empirically deepened these ideas in our *ASQ* (2002) article.

Because we built on March's (1991) formulation, the idea that there was strategic value in exploring and exploiting through innovation streams was not viewed as controversial (see also Birkinshaw & Gupta, 2013). Researchers did, however, propose fundamentally contrasting approaches for dealing with this tyranny of efficiency and associated inertia. Our ideas on structural ambidexterity were challenged by scholars proposing alternative organizational approaches for attending to exploration and exploitation, including rhythmic switching, sequential attention, and vacillation (e.g., Brown & Eisenhardt, 1997; Nickerson & Zenger, 2002); contextual ambidexterity (e.g., Adler, Goldoftas, & Levine, 1999; Gibson & Birkinshaw, 2004); the creation of independent organizations or spinouts (e.g., Christensen, 1997; Christensen & Bower, 1996); or the default focus on inertia in the ecological tradition (e.g., Hannan & Carroll, 1992). The locus of integration between the opposing forces of exploration and exploitation and the role of agency varied systematically between these points of view. While the locus of integration is the business unit's senior team for structural ambidexterity, it is at the corporate level for the spinouts or independent units, and it is decentralized throughout the firm for contextual ambidexterity. In contrast, captured by inertial forces, leaders in the ecological tradition squander their agency (e.g., Rosenbloom & Christensen, 1994; Sull, 1999).

Over the past decade there has been an explosion of research on when, if, and how organizations attend to the challenge of Abernathy's productivity dilemma or to March's challenge of balancing exploration and exploitation (see reviews by Birkinshaw & Gupta, 2013, and O'Reilly & Tushman, 2013). Hundreds of empirical papers have addressed these issues (e.g., Nosella, Cantarello, & Filippini, 2012), even as theory and review papers (e.g., Lavie, Stettner, & Tushman, 2010; O'Reilly & Tushman, 2008; Simsek, Heavey, Veiga, & Souder, 2009), special issues of the *Academy of Management Journal* (2006) and *Organization Science* (2009), and an *Academy of Management Perspectives* symposium (2013) have been devoted to these topics.

This research suggests that the ability to both explore and exploit is positively associated with organization outcomes, results found using multiple measures of exploration and exploitation and multiple outcome measures (see Junni, Sarala, Taras, & Tarba, 2013). Further, these results have been found at the business unit, corporate, and interorganizational levels of analysis (e.g., Danneels, 2011; Jansen, Van den Bosch, & Volberda, 2006; Lavie et al., 2010; Rothaermel & Alexandre, 2009). The positive effects of innovation streams are accentuated under conditions of product class uncertainty.

But how is ambidexterity executed? It appears that the nature of the structural form and the locus of integration between exploration and exploitation are contingent on product class conditions and time, and that structural ambidexterity is important early in a product class' evolution. During eras of ferment, structural separation of exploratory efforts from exploitative efforts is crucial to buffer experimental efforts from inertial efficiency requirements (as long as there is the ability to leverage across these units). When exploratory efforts achieve strategic and customer legitimacy and are less vulnerable to being "crowded out" by the focus on exploitation within the firm, the firm shifts to contextual ambidexterity—where both exploration and exploitation are executed throughout the same firm or business unit (e.g., Raisch & Tushman, 2014). Thus, structural and contextual ambidexterity, vacillation, and rhythmic switching between forms may each characterize how firms evolve as a product class unfolds. If there are not complementarities—that is, opportunities to create greater value by combining exploration and exploitation activities within the same firm—then a spinout option (i.e., making the exploratory unit a separate entity) dominates either ambidextrous option.

The debate about structural forms to deal with the paradoxical challenges of exploration and exploitation may be reaching closure. While ecological forces clearly operate, some firms do enact organizational structures to deal with Abernathy's productivity dilemma. It is, however, increasingly clear that structure is a necessary but not sufficient condition to deal with challenges of strategic paradox. The ability to host contradiction and then make transitions from structural to contextual ambidextrous designs is also dependent on the senior team's ability to deal with paradoxical strategic requirements as well as the need for shifts in the locus of integration over time (e.g., Jansen, Tempelaar, Van den Bosch, & Volberda, 2009; Smith, 2014; Smith & Lewis, 2011). Managing paradoxical strategic requirements is also associated with

the ability to manage framing contests (e.g., Gilbert, 2005; Kaplan, 2008), identity transitions and/or the development of an overarching identity (e.g., Navis & Glynn, 2010; Nelson & Irwin, 2014; Pratt & Kraatz, 2009; Schultz & Hernes, 2013; Tripsas, 2009; Tripsas & Gavetti, 2000), organizational transitions (e.g., Jay, 2013; Raisch, Birkinshaw, Probst, & Tushman, 2009), an overarching set of core values (e.g., O'Reilly & Tushman, 2008), and relations with institutional audiences outside the firm (e.g., Benner, 2010; Benner & Ranganathan, 2012; Greenwood & Suddaby, 2006; Rothaermel & Deeds, 2004). Thus, the challenges of managing paradox are not only structural but also cultural and cognitive in nature.

Over a decade ago we examined the paradoxical tensions managers face as they try to simultaneously host an exploitative, efficiency-oriented process management approach while still maintaining exploration and innovation in opposition to the requirements of process management. We studied how this paradox arose from institutional pressures to adopt best practices that were possibly beneficial, but not universally so. A decade later, the paradoxical challenges facing organizations have become more numerous and strategic (Besharov & Smith, 2014; Smith & Lewis, 2011). Beyond the innovation challenges of exploration and exploitation, organizations are now challenged to be local and global (e.g., Marquis & Battilana, 2009), doing well and doing good (e.g., Battilana & Lee, 2014; Margolis & Walsh, 2003), social and commercial (e.g., Battilana & Dorado, 2010), artistic or scientific and profitable (e.g., Glynn, 2000), high commitment and high performance (e.g., Beer & Eisenstadt, 2009), and profitable and sustainable (e.g., Eccles, Ioannou, & Serafeim, 2014; Henderson, Gulati, & Tushman, 2015; Jay, 2013). These contradictions are more prevalent, persistent, and consequential. Further, these contradictions can be sustained and managed, but not resolved (Smith, 2014).

In a growing stream of research, scholars have explored the challenges of engaging in activities within one organization in a way that meets competing and conflicting requirements of contrasting institutional environments (e.g., Kellogg, 2009; Pache & Santos, 2010). Many of these paradoxical challenges involve reconciling contrasting organizational forms and associated institutional logics (Greenwood, Raynard, Kodeih, Micelotta, & Lounsbury, 2011; Thornton, Ocasio, & Lounsbury, 2012). Much of the work on hybrid organizing, where firms are organized to operate in contrasting institutional logics, is similar to the challenges of simultaneously attending to the contrasting demands of exploratory and exploitative innovation. The work on hybrid firms has investigated how hybrid organizations adjudicate the organizational and institutional dissonance in attending to contrasting performance recipes (e.g., Battilana & Lee, 2014; Stark, 2009). For example, Battilana and Dorado (2010) explored how differential attention to organization structure, selection, and culture affected the performance of two microfinance organizations.

Finally, the focal actor has been the firm and senior team in dealing with these paradoxical innovation and/or institutional demands (e.g., Battilana & Dorado, 2010; Finkelstein, Hambrick, & Cannella, 2009; Greenwood & Suddaby, 2006; Smith & Tushman, 2005). The senior team is at the interface between external institutional forces for change and internal inertial forces for the status quo (e.g., Chandler, 1990; Hambrick & Mason, 1984; Thompson, 1967). In terms of Abernathy's productivity dilemma, these senior teams look forward and backward (e.g., Gavetti & Levinthal, 2000), deal with paradox (e.g., Andriopoulos & Lewis, 2009), are consistently inconsistent (e.g., Smith, 2014), build organizational contexts that support exploration and exploitation (e.g., O'Reilly & Tushman, 2008), and shape their institutional context to support the focal firm's strategy (e.g., Rao, 1994; Tushman & Rosenkopf, 1992).

The senior team's agenda is to shape strategy and structure—to create high-discretion contexts and associated dynamic capabilities where complex business models and associated actions create and sustain value for their firms (e.g., Eisenhardt & Martin, 2000; Finkelstein et al., 2009; Markides, 2013; Teece, 2014). According to Chandler's (1962), Thompson's (1967), and Barnard's (1968/1938) notions of the activities of executives, leaders exercise discretion, have agency, build complex hierarchical firms and associated capabilities, and act to control external contingencies for their focal firm's benefit. But in radically shifted information and communication contexts, some of these assumptions and findings of past research—about leadership, institutions, and organizations—may not be accurate or realistic. We discuss how the change in the context within which innovation occurs may affect

research on innovation and the associated productivity dilemma.

Innovation and Open Boundaries: The Productivity Dilemma in the Context of Distributed Innovation

Innovation has traditionally taken place within hierarchical, control-oriented firms and/or with selected partners (Chandler, 1977; Thompson, 1967). Innovation research has been grounded in an awareness of the transaction and information processing costs and intellectual property challenges associated with distant search (e.g., Afuah & Tucci, 2013; Grandori, 2001; Tushman & Nadler, 1978; Williamson, 1981). Information processing, storage, and communication costs have been constraints on innovation, spurring the internalization of innovation activities within firms. Local search, boundaries, and boundary spanning have been central to this research stream (e.g., Levinthal, 1997; Santos & Eisenhardt, 2005; Tushman, 1977).

Yet, over the past decade, technical progress has led to dramatic decreases in information costs (Altman et al., 2013). In an increasing array of contexts, information costs approach zero and the typical constraints on firms that lead to local search are no longer relevant. Firms are now able to engage communities of developers, professionals, and users for core innovative activities through platform-based ecosystems and by direct user innovation (see Altman et al., 2013, and Lakhani et al., 2013). Although innovation in the past was also conducted via "external" modes, such as alliances and acquisitions (e.g., Ahuja & Katila, 2001; Davis & Eisenhardt, 2011; Lavie & Rosenkopf, 2006), "open" innovation has become dramatically cheaper and easier over the past decade, pushing innovation increasingly outside of firm boundaries and challenging our received wisdom on the nature of innovation. Where the firm is the focal actor in the traditional closed Chandlerian tradition, the community is core for open innovation (e.g., Baldwin & von Hippel, 2011; Benkler, 2006).

Two secular trends drive the increasing importance of open innovation. The first is the increasing prevalence and importance of "digitization" (Greenstein, 2010). Initially confined to information products and software production, digitization now affects large parts of the economy. The information component of any material object can now be represented as a digital good (Baldwin & Clark, 2000). Thus, material and physical objects can be created, represented, and modified with the same relative ease as software goods. The second trend is modularity associated with task decomposition (Baldwin & Clark, 2000). These drastic shifts in information processing costs and increases in modularity have, in turn, important implications for the locus of innovative activities.

In contexts where computational costs are low and widely available and distributed communication is inexpensive, open or peer innovation communities displace organization-based innovation (Benkler, 2006; O'Mahony & Lakhani, 2011). In these contexts, communities of peers spontaneously emerge to freely share information on innovation production as well as problem solving. Such radically decentralized, cooperative, self-organizing modes of problem solving and production are in sharp contrast to organizationally centered innovation (Lakhani & von Hippel, 2003; Murray & O'Mahony, 2007; von Hippel, 2005; von Hippel & von Krogh, 2003)

Open innovation is most clearly seen in open source software development, which depends on many individuals contributing their time, for free, to a common project. Legally, participants retain copyrights for their contributions but license them to anyone at no cost (see Benkler, 2006, for more detail). These self-organized communities develop their own emergent social structure (e.g., Fleming & Waguespack, 2007; O'Mahony & Ferraro, 2007). Such communities of developers rely on the availability of easy communication, the modularity of the project, and a mix of extrinsic and intrinsic motivation. This open software innovation regime creates robust products and is equivalent to private market software development methods in features, functionality, and quality (Lerner & Schankerman, 2010; Raymond, 1999).

Community-based innovation is not limited to software development. Peer modes of innovation, where actors freely share and co-create innovation, have been documented in a range of product domains. For example, von Hippel as well as his colleagues have documented peer (or user) innovation in heart-lung machines, gas chromatography, mountain bikes, and many other products (von Hippel, 2005; Franke & Shah, 2003). In each of these examples, user communities spontaneously emerge to create new

markets. Once the product is developed, only then do traditional firms enter and shift the nature of innovation to cost and scale.

While communities are associated with the creation of new markets and the adjudication of uncertainty during eras of ferment, autonomous problem solving also occurs through prize- and contest-based mechanisms that allow free entry but emphasize competition between peers. Perhaps the most famous early example of an innovation contest is the British government's contest to find a way to accurately gauge longitude at sea (Sobel, 1995). While contests are associated with prizes, the prizes are typically small, and most problem solvers do not win. Yet analyses of these tournament settings reveal large-scale entry into tournaments, far above predictions from an economics perspective (Boudreau, Lacetera, & Lakhani, 2011; Che & Gale, 2003).

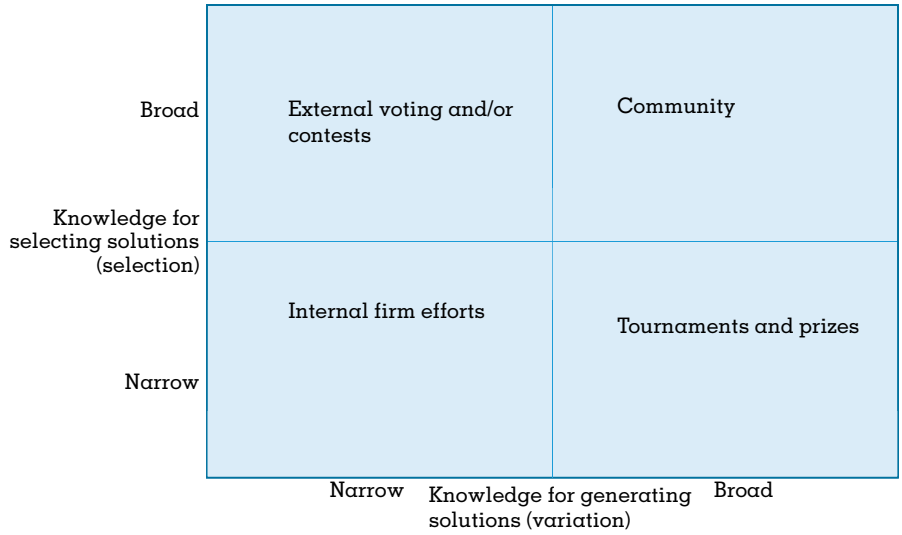
Both community- and contest-based problem solvers are motivated by a heterogeneous blend of intrinsic and extrinsic motivations and the emergent social properties of interactions in online settings (Boudreau et al., 2011; Fleming & Waguespack, 2007, Gulley & Lakhani, 2010; Lakhani, & Wolf, 2005). When problems are modular in nature, such communities of problem solvers have had a dramatic impact on problem-solving outcomes (see Kogut & Metiu, 2001, and Lakhani & von Hippel, 2003). These anonymous communities are self-motivated, self-selected, and self-governed (Boudreau et al., 2011; Dahlander & Gann, 2010; von Krogh, Spaeth, & Lakhani, 2003). In these anonymous contexts, self-selection drives both participation and effort (Boudreau & Lakhani, 2009; von Krogh et al., 2003). For example, at LEGO the Mindstorms robot kit became successful only after the firm opened its boundaries to permit a committed set of users to independently develop and select a range of Mindstorms products (see Hatch & Schultz, 2010).

The availability of inexpensive computation power and ease of communication permit a fundamentally different form of innovation—a mode of innovation rooted in free choice, sharing, and openness absent formal boundaries and formal hierarchy. In these open contexts, variation, selection, and retention are all done beyond the firm's boundaries. Thus, these nonmarket, peer innovation methods complement and, under some conditions, displace firm-centered innovation (e.g., Wikipedia's substitution for Encarta and Encyclopedia Britannica). For incumbent firms, community-based innovation modes stand in sharp contrast to their historically based hierarchical, control-oriented innovation modes.

Under what conditions do the open and closed innovation modes dominate? Based on a variation and selection approach to innovation (see also Murmann & Frenken, 2006, and Vincenti, 1994), King and Lakhani (2011) developed a knowledge-based approach to the locus of innovation (see also Grandori, 2001, and Nickerson & Zenger, 2004). They argued that if the knowledge needed to accomplish either knowledge generation (creating possible solutions to an innovation problem) or selection (selecting the appropriate solution[s] from multiple potential alternatives) is widely distributed among independent external actors, the associated innovation boundary is fundamentally different than when such knowledge is narrowly held within a firm. The more either solution generation or selection knowledge is broadly held, the greater the use of open innovation processes. In contrast, to the extent that either solution or selection knowledge is narrowly concentrated in the firm, the more internal boundaries dominate (see Figure 1).

For those innovations where the knowledge needed to both generate alternative solutions and select among them is concentrated within the firm, traditional intrafirm organizing dominates (e.g., Apple's internal management of the user interface). For those innovations where solution generation is narrowly held but where selection knowledge is broadly distributed, voting or approval contests dominate. For example, in the world of fashion, firms like Zara and ModCloth engage customers to determine demand and associated production runs (see also Cappetta, Cillo, & Ponti, 2006). For those innovations where solution knowledge is broadly distributed but where selection knowledge is concentrated, innovation contests and tournaments dominate (e.g., Lifshitz-Assaf, 2015). Organizations in this quadrant may sponsor their own tournaments or choose to work with external platforms like InnoCentive or TopCoder (Boudreau & Lakhani, 2009). Finally, when the knowledge to both create solutions and select among them is widely distributed, the locus of innovation shifts from the firm to firms collaborating within open communities (e.g., open source software) and/or creating fully independent markets (e.g., Apple's App Store).

FIGURE 1
The Locus of Innovation.



Adapted from Lakhani et al. (2013: Figure 19.3).

In contexts where a product's core tasks can be modularized and the costs of communication are low, traditional modes of organizing for innovation are not comparatively effective. Under these ubiquitous conditions, open innovation, open communities, and open contests transform the economics and social organization of innovation activities (Baldwin & Von Hippel, 2011; Benkler, 2006; Murray & O'Mahony, 2007). Traditional organizing models based on cost minimization, local search, hierarchy, power, control of contingencies, and extrinsic motivation, and where the locus of innovation is either within the firm or with the firm and trusted partners, must be supplemented with organizing models rooted in logics of openness, sharing, choice, distant search (that is low cost), intrinsic motivation, and communities.

What are the contingent variables that push innovation from more traditional closed and hierarchical to more open and distributed modes? Lakhani et al. (2013) suggest that the fundamental contingent variables in selecting innovation modes and associated boundaries are the extent to which the product/service is integrated in nature and the extent to which problem-solving knowledge is distributed. When core tasks are integrated in nature (e.g., Apple's consumer experience, NASA's advanced exploration, or LEGO's plastic brick toys) and problem-solving knowledge is concentrated, then more traditional intra-firm innovation logic applies (see also Nickerson & Zenger, 2004). Under these conditions firms internalize R&D and build an innovative culture, capabilities, absorptive capacities, and processes that locate solution search and evaluation knowledge within the firm and/or with trusted partners (see Apple's integration of mobile hardware). These intra-firm boundaries vary from simple functional boundaries to more complex ambidextrous designs to relations with external partners (e.g., Lavie et al., 2010).

In contrast, when the product can be decomposed (or modularized) and when problem-solving knowledge is broadly dispersed, the locus of innovation shifts to communities or markets outside the firm. Such a shift in innovation locus requires incumbent firms to engage with external communities in open, democratic, collaborative relations (e.g., NASA's relations with external problem solvers, LEGO's relations with its involved users, and Apple's relations with applications suppliers and anonymous operating system collaborators [Lakhani et al., 2013]). When costs of collaboration are low, the greater the task's modularity and the greater the knowledge dispersion, the more open innovation and its associated complex organizational boundaries displace traditional innovation processes.

Thus, as products and services become more modularized and as communication costs drop such that dispersed knowledge is widely

available, open innovation communities emerge that increasingly displace closed innovation (Benkler, 2006; O'Mahony & Lakhani, 2011). Under these ever more common conditions, open community innovation does not complement firm-based innovation but, rather, substitutes for it (e.g., major record label EMI was unable to deal with new forms of music generation, funding, production, and distribution). If so, incumbents may be pushed out of generating anything but incremental and/or process innovation (von Hippel, 2005). It may be that new entrants dominate incumbents in new product creation by relying on community innovation for all substantive innovation except for innovation in customer experience and/or product integration.

Open innovation, enabled by low-cost communication and the decreased costs of memory and computation, has transformed markets and social relations (Benkler, 2006). In contrast to firm-centered innovation, open innovation is radically decentralized and peer based and includes intrinsic and prosocial motives (Benkler, 2006; von Hippel, 2005). While a body of literature is developing around the community nature of peer innovation, and while we understand the nature and social structure of these communities (e.g., O'Mahony & Ferraro, 2007; O'Mahony & Lakhani, 2011; Rosenkopf, Metiu, & George, 2001), the impact of this innovation mode on the firm is not well understood. We do not have a theory of the firm, either for incumbents or new entrants, that takes into account community innovation. The impact of open innovation on the organizational literature, strategy literature, and innovation literature is minimal (for exceptions see Afuah & Tucci, 2013, and Argote, 2011).

The organizational theory and innovation literature is firmly rooted in the focal firm's management of its transaction costs, minimization of its dependence on its context, and building of absorptive capacity based on R&D and combinative relations with selected partners. Open, peer innovation with its fundamentally different organizing assumptions, is at least a complement, if not a substitute, for firm-based innovation. If so, our theories of innovation, organizational design, and leadership for innovation must be informed by these contrasting innovation modes. The literature on exploration and exploitation, and more generally the management of innovation, has been built on a base of industrial product–oriented research in a world where communication costs across boundaries were substantial. Exploration now increasingly resides outside the boundaries of the traditional firm. It is inconceivable that today's models of organizations and innovation reflect the reality of innovation in a world that is ever more open and modularized. Our organizational, innovation, and leadership literature need to reflect and reconcile the implications of open innovation models.

Implications for Theory and Research on Innovation and the Productivity Dilemma

Our *AMR* (2003) paper was fundamentally about streams of innovation. Pivoting on March's ideas on the survival value of exploring and exploiting, we suggested that structural ambidexterity was a way to deal with Abernathy's productivity dilemma. Over the past decade, the field has learned that structural and contextual ambidexterity are complementary—that firms vacillate as a product class evolves. We have also learned that structure is necessary but not sufficient to deal with the strategic paradox of Abernathy's productivity dilemma. These relatively complex organization designs must be enacted by an overarching set of core values and identity, social networks, and leader cognition and behaviors that can attend to paradox. Much research remains to be done on these complements to organization design.

Yet, at the same time, the past decade has witnessed radical shifts in the context within which organizations reside. Historically anchored axioms like local search, satisficing, boundary spanning, absorptive capacity, and organizing to minimize transaction and information processing costs may be inaccurate or obsolete in a world where communication and information processing costs approach zero (Altman et al., 2013). When products and services can be modularized and when information processing costs plummet, variation and selection processes shift from the firm to the community. Where the firm is the focal unit in closed innovation, the community is the focal unit for open innovation (see Adner, 2002, 2012; Afuah & Tucci, 2013; Fjeldstad, Snow, Miles, & Lettl, 2012; Gulati, Puranam, & Tushman, 2012). The organizing logics and principles of the community are fundamentally different than in closed contexts (e.g., Benkler, 2006), and open innovation is increasingly dominant. Thus, our theories of innovation,

organizational design, leadership, and organizational change must capture the tensions between these contrasting innovation modes.

There is a mismatch between our extant theory and the phenomena of organizations and innovation. Our current theories of innovation and organizations may not be up to the task at hand. Echoing Suddaby et al. (2011) and Davis (in press), these theories may be out of date (or "living museums" [Davis, 2010]). Influential theories can become detached from the phenomena they purport to explain (Davis, in press; Suddaby, 2014). If so, this is a moment to go back to basics—to go back to deeply studying and carefully describing the phenomena of organizations and innovation. Indeed, our core concepts and understanding of innovation, organization, and change originated in close descriptions of the phenomena (e.g., Abernathy, 1978; Allen, 1977; Bijker et al., 1987; Burns & Stalker, 1961; David, 1985; Landes, 1983; Lawrence & Dyer, 1983; Simon, 1947; Stinchcombe, 1965; Vincenti, 1994).

Such phenomena-driven, problem-oriented research may be required again to help the field generate new constructs, mechanisms, and patterns associated with exploration and exploitation (see also Davis & Marquis, 2005, and Stokes, 1997). The domain of innovation is itself in an era of ferment; we might make more progress moving back from mature theory and research to more nascent theory and research (e.g., Edmondson & McManus, 2007).[2] It may be that the focus on "contributions to theory" required for publishing research in our major journals exacerbates these issues (Davis, 2010) and spurs what Suddaby calls "theoretical 'fetishism,' where theory becomes an exercise in writing and interpretation, but is detached from the empirical world" (2014: 408).

In sum, a decade after publication of "Exploitation, Exploration, and Process Management: The Productivity Dilemma Revisited" the narrow structural question of how and when firms organize to deal with innovation is mostly settled. Broader questions on how organizations effectively manage strategic paradox remain even as the number of paradoxical pressures facing organizations has substantially increased. This increasing pervasiveness of paradox also corresponds to the shift in the locus of innovation from the firm to the community. The logic of the open community is fundamentally different from the logic of the traditional Chandlerian firm. As organizations now face many dilemmas (i.e., not just a productivity dilemma), they also face fundamentally different organizing logics. We are at a juncture in our field in how we think about and understand innovation and organizations. This era of ferment requires us to reflect on how we talk about, research, and understand innovation and organizations. We encourage scholars undertaking research in innovation to not only understand prior research but to go back to describing first principals of innovation, organizations, and associated paradoxical dilemmas.

[2] We highlight these issues particularly as they pertain to the phenomenon of innovation, the topic of our 2003 article. But we agree with the recent views of our colleagues suggesting that theory detached from phenomena applies beyond the domain of innovation, to our understanding of organizations more broadly (Davis & Marquis, 2005; Suddaby, 2014).

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