

**EXPLOITATION, EXPLORATION, AND PROCESS MANAGEMENT:
THE PRODUCTIVITY DILEMMA REVISITED**

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ABSTRACT

Organization and strategy research has stressed the need for organizations to simultaneously exploit existing capabilities while developing new ones. Yet this increasingly crucial challenge has been accompanied by an ongoing wave of managerial activity and institutional pressures for process management and control. We argue that these pressures stunt a firm's dynamic capabilities. We develop a contingency view of process management's influence on both technological innovation as well as organizational adaptation. We argue that while process management activities are beneficial for organizations in stable contexts, they are fundamentally inconsistent with all but incremental innovation and change. We argue that process management activities must be buffered from exploratory activities. As dynamic capabilities are rooted in both exploitative and exploratory activities, ambidextrous organizational forms provide the complex contexts for these inconsistent processes to co-exist.

More than twenty years ago, Abernathy (1978) suggested that a firm's focus on productivity gains inhibited its flexibility and ability to innovate. Abernathy observed that in the automobile industry, a firm's economic decline was directly related to its efficiency and productivity efforts. He suggested that a firm's ability to compete over time may be rooted not only in simply increasing efficiency, but also in its ability to be simultaneously efficient and innovative (Abernathy, 1978: 173; Hayes & Abernathy, 1980). Strategy and organization theorists have similarly observed that dynamic capabilities are anchored in the ability to both exploit and explore (Ghemawat & Costa, 1993; March, 1991; Weick, 1969). A firm's ability to compete over time may lie in its ability both to integrate and build upon its current competencies, while simultaneously developing fundamentally new capabilities (Teece, Pisano, & Shuen, 1997).

Twenty years after Abernathy's observations, the pressures for organizations to meet multiple, often inconsistent, contextual demands have escalated (e.g. Christensen, 1997; Tushman & O'Reilly, 1997). The notion of balance between exploitation and exploration, or between incremental and radical organizational change has been a consistent theme across several approaches to research in organizational adaptation (e.g. Brown & Eisenhardt, 1998; Burgelman, 1994; March, 1991; Levinthal & March, 1993; Gavetti and Levinthal, 2000; Romanelli & Tushman, 1985). Yet this need for dual organizational capabilities arises in the context of a wave of managerial activity and institutional pressures focusing on process management and control (e.g. Cole, 1998; Winter, 1994; Hackman & Wageman, 1995; Hammer & Stanton, 1999).

Process management, based on a view of an organization as a system of interlinked processes, involves concerted efforts to map, improve, and adhere to organizational processes. Initially building on the seminal work of Deming (1986), Juran (1989), and Ishikawa (1985), process management practices became popular as a central element of Total Quality Management

(TQM) programs in the 1980's (Hackman & Wageman, 1995). Since then, they have continued to spread in practice as a core element of a continuing progression of quality-related initiatives, including the Malcolm Baldrige National Quality Award, the International Organization for Standardization's Series 9000 program (ISO 9000), Business Process Reengineering, and more recently, Six Sigma programs. By 1992 every Fortune 100 firm had adopted TQM practices (Nohria, 1996). Although some have suggested that interest in TQM waned in the 1990's (Powell, 1995), thousands of organizations subsequently adopted ISO 9000 (Quality Digest, 1999), and many companies, including highly visible ones like GE, Honeywell, 3M, Amazon.com, Toshiba, and Ford have recently embraced Six Sigma (e.g. International Quality and Productivity Center, 2000; Gabor, 2001; Feyder, 2001). Process management practices have been institutionally mandated as powerful suppliers or regulating organizations require adoption (e.g. Westphal, et al, 1997, Harrington & Mathers, 1997).

Although process management techniques were first employed in the domain of manufacturing and operations improvement, their influence has migrated to other processes, including those underlying the selection and development of technological innovations (Brown and Duguid, 2000; Sitkin and Stickel, 1996). Process management practices focus on reducing variation and increasing efficiency in organizational routines. As these variation-decreasing activities spread to centers of innovation, or variation-creation activity in organizations, they increasingly affect an organization's dynamic capabilities. Yet there has been a lack of theory development about the effects of these institutionally mandated and pervasive practices on technological innovation or adaptation.

Much of the managerial literature on process management is prescriptive and aimed at educating managers on implementing such practices. Process management's proponents have promoted process-focused practices as universally beneficial for organizations, spurring continuous

innovation that results in efficiency improvements, cost reductions, improved customer satisfaction, and ultimately, higher profits (Hammer & Stanton, 1999; ISO, 1999; Harry & Schroeder, 2000).

Reflecting these assumptions, empirical research on process management's effects has been limited to assessing the financial performance implications from process management adoption (eg. Powell, 1995; Ittner & Larcker, 1997; Samson & Terziovski, 1999)¹. The results of these studies have been equivocal. Findings from empirical and case study research suggest that differential outcomes from TQM adoption arise because organizations implement different practices under the TQM umbrella (Westphal et al., 1997, Zbaracki, 1998). Similarly, Sitkin, Sutcliffe & Schroeder (1994) argue that an alternative set of TQM practices be used in task environments with higher uncertainty. While these studies provide insight into possible contingencies, their focus is specifically on TQM programs. Similarly, much of the organizational literature on the topic of process management has been focused on TQM (e.g. Hackman & Wageman, 1995; Easton & Jarrell, 1998; also see the 1994 special issue of AMR, and Cole & Scott, 2000). There has been no attempt to build theory that links this TQM literature to broader concepts of process management or with more recent research on dynamic capabilities (e.g. Teece, Pisano & Shuen, 1997; Eisenhardt & Martin, 2000).

We extend the process management literature by developing a model and testable propositions on the effects of process management activities on both technological innovation and organizational adaptation. We explore how both technological and organizational contexts moderate the relations between process-focused activities and organizational adaptation (e.g. Sitkin et al, 1994). We argue that the utilization of process management techniques stabilizes and

¹ Other empirical research explores implications of more broadly-defined Total Quality Management programs. While process-focused practices may be included in an organization's adoption of TQM, it is not necessarily the case (Westphal, Gulati & Shortell, 1997, Zbaracki, 1998). Further, it is not clear from most research on TQM whether and to what extent the organizations involved undertook practices focused on mapping, improving and adhering to processes, as such, interpreting existing research is hampered by heterogeneity in the practices adopted. The three studies cited break out process-focused activities from other practices within TQM, and are particularly relevant to our topic. We also review the larger body of existing research on process management and TQM later in this paper.

rationalizes organizational routines, while establishing a focus on easily available efficiency measures and the satisfaction of existing customers. These dynamics increase efficiency in the short run. Because of institutional pressures in support of process management and the internal bias for certainty and predictable results, process management activities spread throughout the firm. The diffusion of process management techniques favors exploitative innovation at the expense of exploratory innovation. While exploitation and inertia may be functional for organizations within a given technological trajectory or for existing customers, these variance reducing dynamics stunt exploratory innovation and/or responsiveness to new customer segments (Henderson et al, 1998; Sterman et al, 1997). Finally, we explore how ambidextrous organizational forms provide buffered contexts such that both exploitation and exploration can coexist (Tushman and O'Reilly, 1997; Bradach, 1997).

We proceed in three sections. First, we define process management techniques and explore the empirical evidence of their impact on organizational outcomes. In section 2 we explore the effects of process management techniques on both exploratory as well as exploitative innovation. We also consider the structural features and moderating effects of ambidextrous organizational designs that allow process control activities to be isolated from exploratory activities. In section 3, we explore how process management practices, through their influence on both technological innovation and organizational inertia, affect adaptation, and how these effects are contingent on both organizational form and environment context. Our model is illustrated in Figure 1.

Figure 1 about here

This paper makes several contributions. We extend the process management literature with a more contingent theory and associated testable propositions about the effects of process

management on organizations. Our model helps resolve inconsistent empirical findings and provides a base for further research on the relationship between process management activities and dynamic capabilities. This paper also contributes more generally to research that considers the influence of increasingly stable processes on outcomes like technological innovation, organizational adaptation, and failure (Christensen & Bower, 1996; Henderson & Clark, 1990; Hannan & Freeman, 1984; Nelson & Winter, 1982; Levinthal & March, 1993). Although such research has considered the role of routines in organizational outcomes, it has not addressed the effect of institutionally mandated quality programs that directly target organizational routines and processes. Thus, this paper extends research more generally by illuminating how specific organizational practices (in this case, a meta-process focused on stabilizing and refining other organizational processes) affect an organization's dynamic capabilities.

BACKGROUND: THE PROMISE AND REALITY OF PROCESS MANAGEMENT

The process revolution has been marked by a shift from the view of organizations as a collection of departments with separate functions and outputs, to a view of them as systems of interlinked processes that cross functions and link organizational activities (Dean & Bowen, 1994). Processes are collections of activities that, taken together, produce outputs for customers (Ittner & Larcker, 1997; Garvin, 1998). Customers include not only external consumers of the organization's products or services, but also a series of internal recipients at linkage points between processes, as outputs from upstream processes become the inputs for subsequent processes. Although programs and awards like TQM, ISO 9000, Six Sigma, the Malcolm Baldrige Award, and Business Process Reengineering differ in scope and approach, they share a core focus on measuring, improving, and

rationalizing organizational processes (cf. Harrington & Mathers, 1997; Ittner & Larcker, 1997; Powell, 1995; Repenning, 1999; Winter, 1994; Harry & Schroeder, 2000).

Process management is composed of three main practices: mapping processes, improving processes, and adhering to systems of improved processes. Once underlying processes have been recorded through process mapping, process improvement involves developing measures of how well a process meets customer requirements, and using statistical methods to continually eliminate variation in processes and outputs (Hackman & Wageman, 1995; Harry & Schroeder, 2000).

Process improvement not only involves rationalizing individual work processes, but also streamlining the handoffs between processes (Garvin, 1995; Harry & Schroeder, 2000).

Organizational participants are trained in effective ways to facilitate cross-functional team meetings and learn standard approaches for identifying and solving problems. These tools, by design and intent, help integrate and coordinate a broad set of activities throughout the organization (Repenning, 1999).

The last element of process management is adherence to processes that have been mapped and improved. This ensures that processes are repeatable, allowing for ongoing incremental improvement, and the realization of benefits of improvement efforts (Hackman & Wageman, 1995; Harrington & Mathers, 1997; Mukherjee, Lapré, & Van Wassenhove, 1998). The ISO 9000 program, in particular, has a strong, explicit focus on adherence to documented processes. As part of ISO 9000 certification, third-party auditors ensure that an organization is following its documented practices (Harrington & Mathers, 1997; Cole, 1998). Similarly, the final stage of Six Sigma implementation is coordinating standardized best practices throughout an organization (Harry & Schroeder, 2000).

Proponents of process management have long cited the expected benefits of these practices. Non-value-added activities are removed as processes are streamlined, resulting in reduced costs and

efficiency improvements in the form of increased yields and less rework and waste. Tighter intra-organizational linkages increase efficiency by streamlining the handoffs between activities, and speeding development and delivery times (Dean & Snell, 1996; Garvin, 1995). Further, these products are likely to better satisfy customers, leading to increases in revenues. Ultimately, as revenues increase and costs decrease, profits are expected to improve.

Yet, empirical research on the effects of process management practices fails to yield conclusive evidence of these promised benefits. The few empirical studies that consider the implications of process-focused techniques show no evidence that these techniques are consistently helpful. Powell (1995) and Samson & Terziovski (1999) found no relationship between measures of process management utilization and organizational performance. Ittner & Larcker (1997) found the use of process management techniques associated with increased performance in the automobile industry, but decreased performance in the computer industry. Others have noted that poor financial performance has followed the process-focused efforts necessary for winning the Baldrige Award (Garvin, 1991; Hill, 1993). Winners like Motorola, Cadillac and Federal Express have suffered subsequent financial setbacks, leading some Wall Street analysts to recommend shorting the stocks of Baldrige Award winners (Garvin, 1991).

Related research has explored the organizational effects of TQM program adoption. However, as TQM may include actual implementation of different sets of practices within each organization (Hackman & Wageman, 1995; Westphal, Gulati, & Shortell, 1997), it is difficult to determine whether organizations implement the process-focused techniques. Even so, this research has also produced conflicting or paradoxical results. Wruck and Jensen (1994) and Kearns and Nadler (1992) report on TQM efforts that led to substantial organizational improvements. Similarly, event studies have found performance benefits from adoption of a TQM program (Easton & Jarrell, 1998) and winning a quality award (Hendricks & Singhal, 1996), and Dean & Snell

(1996) found that TQM as one component of Integrated Manufacturing was associated with performance benefits.

In contrast, Analog Devices' adoption of a TQM program resulted in short-term improvements in efficiency, such as higher yields and less waste, but this was soon followed by financial performance far worse than the industry average (Sterman, Reppenning, & Kofman, 1997). Similarly, proactive quality efforts at Alcoa initially led to competitive gains (Kolesar, 1993). Yet soon after this quality effort was initiated, Alcoa's CEO Paul O'Neill lamented the slow pace of change and initiated a "quantum-leap improvement" (Kolesar, 1993: 161). Henderson et al. (1998) found that despite significant returns to process improvements at Hewlett Packard these activities were underfunded out of concerns that process-focused efforts would impede product innovation. Sitkin and Stickel (1996) found that TQM efforts in an R&D setting led to organizational conflicts, distrust, conformity and, in turn, to decreased innovation. Staw & Epstein (2000) found that while TQM adoption was associated with higher CEO compensation, there was no association between adoption and financial performance.

Other empirical research has been aimed at resolving these inconsistent findings. This work suggests that outcomes fall short of anticipated benefits because while firms adopt TQM, they fail to fully implement the associated efficiency-generating practices (Zbaracki, 1998; Westphal, et al., 1997; Easton & Jarrell, 1998) or fail to give them sufficient time or the right culture to work (e.g. Cameron and Barnett, 2000; Sterman et al., 1997). It may also be that the effects of process management activities are contingent on the technological and organizational contexts to which they are applied. Process management activities have spread beyond their origins in manufacturing and operations into other activities, such as processes for selecting and developing technological innovations. Indeed, the 9001 version of the ISO 9000 program involves processes for product design, development, and service, while Design for Six Sigma similarly promotes extending process

control techniques into R&D, including product design and development activities (ISO, 1999, Harry & Schroeder, 2000). Similarly, these practices have also been applied to senior team processes (e.g. Garvin, 1995; Ghoshal & Bartlett, 1995; Hammer & Stanton, 1999).

Process management practices may be adopted because of bandwagon effects created by their adoption by other high status organizations (Abrahamson & Rosenkopf, 1993; Abrahamson, 1996; Meyer & Rowan, 1977; Staw & Epstein, 2000). As these techniques are embraced by highly-visible organizations like IBM, GE, 3M, Amazon.com, among others (Hammer & Stanton, 1999), they become taken-for-granted, and viewed as sensible approaches for operating organizations (cf. Meyer & Rowan, 1977). Once adopted, the spread of process management gives rise to unintended effects on innovation and adaptation. The ubiquity of process management techniques works to reduce variation in organizational processes and routines. Variance reducing activities drive out variance increasing activities and, as such, affect an organization's ability to innovate and adapt outside of existing trajectories (e.g. Weick, 1995; Levinthal and March, 1993; Sutcliffe et al, 2000). Core capabilities may become core rigidities (Leonard-Barton, 1992). Thus, although process management activities are employed to help organizations adapt, to the extent that these practices increase inertia and limit variation-creation, they may instead impede adaptation in all but routine contexts (e.g. Levinthal, 1997a). Yet, there has been no effort to build testable theory to explore these broader implications of process management activities for innovation and adaptation.

PROCESS MANAGEMENT AND TECHNOLOGICAL INNOVATION

Technological innovation is a central engine of organizational adaptation (Nelson & Winter, 1982; Tushman & Nelson, 1990; Levinthal, 1991; Brown & Eisenhardt, 1997). As such, to understand how process management techniques affect organizational adaptation, we first address

how it affects exploratory as well as exploitative innovation. A firm's ability to innovate provides its senior team with options to either reinforce or destabilize a technological regime (Burgelman, 1994; McGrath, 1997; Tushman & Murmann, 1998). Innovations generated within or absorbed by firms provide variation to proactively shape or reactively respond to technological transitions (Brown & Eisenhardt, 1997; Cohen & Levinthal, 1990; Tushman & O'Reilly, 1997). An organization's dynamic capabilities depend on simultaneously exploiting current technologies and resources to secure efficiency benefits and on creating variation through exploratory innovation (Ghemawat & Costa, 1993; March, 1991; Teece et al., 1997). As process management techniques focus on continuous improvement in routines and variation reduction (Anderson et al., 1994; Hackman & Wageman, 1995; Harry & Schroeder, 2000), their increased utilization in an organization affects the balance between exploratory and exploitative innovation.

The effects of process management on technological innovations arise in several ways. First, they stabilize the resource allocation and decision processes that determine which technological projects will be supported (cf. Christensen & Bower, 1996). Process management techniques also tighten internal communication linkages and affect the types of technological changes that are recognized and addressed (cf. Henderson & Clark, 1990). In addition, process management activities also influence technological innovation directly through adherence to particular product development or design processes. For example, Design for Six Sigma (DFSS) ensures that processes for invention and innovation conform to tight statistical standards, while the ISO 9001 program entails certification in product design and development (Harry and Schroeder, 2000). Process management activities will facilitate some innovation types, but dampen others. We first need to clarify innovation types.

Types of innovations

Innovations can be classified along two dimensions, in terms of proximity to the current technological trajectory, and in terms of proximity to the existing customer/market segment (Abernathy and Clark, 1985). On the technological dimension, different innovation types have contrasting determinants and organizational effects (Morone, 1993; Tushman and O'Reilly, 1997). Incremental innovation, characterized by small changes in a technological trajectory, builds on the firm's current technical capabilities, while radical innovation fundamentally changes the technological trajectory and associated organizational competencies (Green, Gavin & Smith, 1995; Dosi, 1982). Innovation can be further categorized by how it affects existing subsystems and/or linking technologies (Baldwin & Clark, 2000; Henderson & Clark, 1990; Tushman & Murmann, 1998). Modular innovations affect subsystem or component technology, leaving linking mechanisms intact, while architectural innovations involve changes in how subsystems are linked together (Henderson & Clark, 1990; Iansiti & Clark, 1994). For example, the addition of a stepper motor was a modular innovation in the photolithography industry, while the move from 14 to 8 inch disk drives was an architectural innovation in the disk drive industry (Christensen & Bower, 1996; Henderson & Clark, 1990).

Innovations have also been classified by whether they address the needs of existing customers or are designed for new or emergent markets (Christensen & Bower, 1996). Products designed for new customer sets are often organizationally disruptive and require significant departures from existing activities. For example, the advent of digital photography represented not only a technological change from chemical-based film, but also involved new distribution channels for electronic cameras. The change in marketing and distribution presented an equal or greater challenge as did the technological change for some photography firms (Tripsas & Gavetti, 2000). Similarly, progressively smaller disk drives were innovations for emergent customer sets in the disk

drive industry. These technologically simple innovations created organizational challenges for incumbents and they found it difficult to respond (Christensen, 1998). Incremental technological innovations and innovations designed to meet the needs of existing customers are exploitative, and build upon existing organizational knowledge. In contrast, radical innovations or those for emergent customers or markets are exploratory, as they require new knowledge or departures from existing skills (March, 1991; Levinthal & March, 1993).

Effects of Process Management Activities on Innovation

As the implementation of process management techniques initially entails an explicit focus on innovation and change in organizational activities, it is likely to spur innovation (Winter, 1994). Tacit organizational routines are revealed and made explicit (Brown & Duguid, 1991) leading to richer cognitive models of organizational activities (Repenning, 1999); firms can learn before doing (Pisano, 1996). Team approaches to problem solving, decentralized decision-making, and co-located information facilitate the search for solutions to help drive initial improvements in efficiency in organizational activities (see also, Wruck & Jensen, 1994; Hackman & Wageman, 1995). In under-performing firms the organizational changes associated with process management may well be radical (e.g. Kearns and Nadler, 1992). Or in the case of lethargic competitors, process management efforts can lead quickly to substantial performance gains (eg. Kolesar, 1993).

While this innovative phase of process management entails substantive change, such change is focused on improving efficiency within an existing technological trajectory. The founders of process management focused on incremental and exploitative innovation, rather than radical, architectural, or exploratory innovation. The associated process oriented tools and techniques are aimed at making an organization more efficient through incremental improvements in processes and outputs (Anderson, et al., 1994; Harry & Schroeder, 2000). For example, prescriptive literature encourages organizations to view improvements as controlled experiments that involve repetition of

practices and measurement prior to making small, testable changes (e.g. Harry & Schroeder, 2000). Moreover, process improvement techniques apply to the organization's current activities; innovation and change in those activities is accomplished by paring from existing routines. Once changed, these improved routines become standardized best practices.

After this initial phase of innovation, repetition of organizational routines through adherence to best practices leads to deepened competence (e.g. Pisano, 1996). As an organization learns and increases its efficiency through repetition of a set of activities, subsequent innovation is increasingly incremental (Levitt & March, 1988; Levinthal & March, 1993). Thus, while process management activities drive innovation, the focus on variation reduction, search for incremental improvements in routines, and increased proficiency through repetition of organizational activities ensures that this innovation will be in the neighborhood of existing capabilities. As process management activities extend in an organization over time, more and tighter linkages between routines further constrain innovation to incremental changes in existing activities and outputs.

Proposition 1: Increases in the extent of process management activities will lead to increased incremental innovation.

Process management activities are also focused on delivery to the organization's target customers. Organizational processes and the outputs they produce are driven to continuously improve by better meeting customer requirements. As the locus of decision-making is pushed down in the firm, multiple levels of the hierarchy are focused on meeting, if not exceeding, customer needs (Winter, 1994). Measures of customer satisfaction are used as the basis of improvement and coordination efforts (Cole, 1998; Garvin, 1988; Hackman & Wageman, 1995; Powell, 1995), and such efforts are reinforced by supportive resource allocation systems. Von Hippel (1988) and Christensen & Bower (1996) showed how persistent resource allocation processes among equipment suppliers and disk drive manufacturers channeled innovation away from product

development for emergent customer sets. Thus, as process management creates an organizational focus on better understanding and satisfying existing customers, it also channels innovation into areas that benefit existing customers.

Proposition 2: Increases in the extent of process management activities will lead to increased innovation that benefits existing customer sets.

Henderson and Clark (1990) found that in the photolithography equipment industry, increasingly stable routines and communication linkages within firms constrained their ability to initiate and respond to changes in subsystem and linking technologies. Seemingly minor architectural innovations were treated as incremental innovations by incumbent firms with disastrous results. Process management techniques stabilize organizational routines and tighten the linkages between them, yet make cross boundary, cross community linkages more difficult (Sitkin and Stickel, 1996). Organizations focused on incremental enhancements of current technology treat architectural innovation as merely incremental, fail to forge linkages across organizational boundaries, and in turn, underperform (Lawless & Anderson, 1996; Henderson, 1993; Tripsas, 1997). Although incremental innovation may in some circumstances actually accommodate architectural or modular innovations, adherence to standardized best practices ensures repetition of practices through these stable linkages within local domains, and an organization's ability to actually take advantage of subsystem and linking technologies is stunted.

Proposition 3: Increases in the extent of process management activities will lead to less architectural innovation.

Process management techniques, by design and intent, exploit existing capabilities. In the face of short-term performance pressures, demands of existing customers, and ease of measurement, exploitation overwhelms exploration (March, 1991; Levinthal & March, 1993; Sitkin et al., 1994). Process management affects variation-creation through the use of statistical techniques designed to

reduce variation, and also through repetition of linked sets of streamlined organizational processes. Rapid exploitation as employees carry out activities in coordinated processes produces measurable, short-term benefits. As an organization achieves faster new product introductions, cost reductions, or improvements in customer satisfaction, these outcomes drive organizations to persist with greater zeal in extending process activities and linking disparate parts of the organization (Levinthal & March, 1993). Managers with documented successes from process management may be promoted and charged with extending such activities to more domains. Those opposed to the encroachment of process management in creative or innovative domains may opt out of the organization, further increasing the influence of process-intensive activities (Brown and Duguid, 2000).

As systems of improved routines are repeated throughout an organization, an organization becomes more competent and efficient, but variation in the outcomes of those activities decreases (March, 1991). The objective of stabilizing organizational routines and “attacking variation” (Harry & Schroeder, 2000) contrasts with the variation-increasing roles played by internal corporate venturing units (Burgelman, 1983), or redundant and overlapping information designed to increase organizational innovation and variety (Nonaka & Takeuchi, 1995). This explicit focus on incremental innovation and increased proficiency with local search makes it unlikely that process management activities will produce innovations that significantly depart from the neighborhood of an organization’s existing technological or market competencies.

Further, over time, process management further influences variation creation by affecting the selection of innovations. Short-term, easy-to-measure efficiency improvements make vague, uncertain, difficult-to-quantify exploratory activities less attractive (March, 1991; Levinthal & March, 1993). As process management practices spread in an organization, the predominant measures of effectiveness are increasingly focused on speed, efficiency, and reductions in costs or waste. These dynamics lead to selecting innovations that leverage efficient, streamlined

manufacturing or distribution processes, or that utilize materials that are cost-effectively obtained from streamlined purchasing processes. Such innovations build on existing firm capabilities and will tend to be closer to existing products. As innovation development and selection processes are linked with other improved processes, the focus shifts away from creating variation. A focus on refining project selection processes to yield continuous improvement in the speed or success rates of new products tips project selection toward those with greater predictability, lower variation, and increased certainty. Thus, as the reach of process management activities extends further into research, R&D project selection activities, or product development, radical innovation projects increasingly give way to more certain, incremental activities (e.g. Henderson, et al, 1998). As process intensity increases, even structures designed to produce radical innovations (e.g. heavy weight teams or independent units) will increasingly produce innovations close to past innovations (e.g. Tripsas and Gavetti, 2000; Sitkin and Stickel, 1996; Brown and Duguid, 2000).

Incremental innovation associated with process management reduces significant exploratory activity and learning outside the existing technological trajectory (March, 1991; Levinthal & March, 1993). The path-dependent nature of innovation suggests an even longer-term effect of process management practices. Past innovative activities play a role in future innovation by providing a firm with a knowledge base that allows it to absorb technological competence from external sources (Cohen & Levinthal, 1990; Levitt & March, 1988). An organization that lacks exploration in one period may be excluded from areas of future exploratory activity by the lack of a relevant knowledge base (e.g. Teece et al., 1997; Cohen & Levinthal, 1990). As process management techniques reduce a firm's exploratory activities, its absorptive capacity will be stunted. As such, a firm's likelihood of subsequent innovations that incorporate new technologies is reduced.

Proposition 4: Increases in the extent of process management activities will lead to less radical innovation.

Measures of customer satisfaction drive improvement efforts through an increasingly coordinated system of processes. As improved manufacturing or distribution processes create measurable improvements for existing customers, process management will drive innovations that continuously improve products for existing customers. Emergent customer sets or market segments often do not lend themselves to measurement or are highly uncertain (Von Hippel, 1988; Sitkin, et al, 1994). Thus, exploratory innovation into new markets becomes increasingly unattractive compared to the short-term, tangible, measurable successes from further improvement in existing capabilities (Leonard, 1992; Christensen, 1998). Through process management practices, an organization becomes increasingly skilled at producing outputs that leverage existing knowledge about inputs, technologies, manufacturing techniques, or distribution channels. New innovations that further utilize these capabilities will benefit from these efficiencies and lend themselves to even more measurable successes. As these codified and tightly linked processes begin to further influence the development and delivery of technological innovations, innovations for emergent or new markets are squeezed out. This is likely to further exacerbate the tendency to innovate for existing customers that Christensen and Bower (1996) observed in the disk drive industry.

Proposition 5: Increases in the extent of process management activities will lead to less innovation that benefits new customers.

Exploration, Exploitation and Ambidextrous Organizations

Abernathy (1978) highlighted the inconsistencies between activities focused on productivity improvements and cost reductions and those focused on innovation and flexibility. He questioned whether it was possible for organizations to pursue both types of activities simultaneously. While

both types of activities are important for organizational survival, exploration and exploitation are contradictory organizational processes (March, 1991; Adler, Goldoftas, & Levine, 1999; Teece et al., 1997). How can organizations balance these potentially conflicting activities? While organizational literature has stressed the importance of a balance between efficiency and exploration, there are multiple points of view on how organizations actually strike this balance.

Hedberg, Nystrom and Starbuck (1976) suggest that organizations engage in multiple forms of learning by switching back and forth between alternate organizational designs and by being alternatively consistent and inconsistent in their actions. Similarly, Brown and Eisenhardt (1998) suggest that dynamic capabilities are rooted in an organization's ability to rhythmically switch between more organic and more mechanistic structures. In contrast to switching between organizing modes, others argue for creating loosely coupled organizations where the experimenting units are highly buffered from the exploiting units (Weick, 1976; Levinthal, 1997b). For example, Burgelman (1991) describes buffered induced and autonomous processes at Intel, while Leonard (1995) describes experimenting units failing forward, distinct from units focused on more incremental innovation. At the extreme, Christensen (1998) suggests that because of the disruptive nature of the technology, experimenting units must be completely separated from exploiting units. In these loosely coupled organizational forms it is unclear where the integration required to drive streams of innovation is accomplished.

Ambidextrous or dual organizational forms are organizational architectures that build in both tight and loose coupling simultaneously (Tushman and O'Reilly, 1998; Sutcliffe et al., 2000; Bradach, 1997). These organizational forms are not loosely coupled, nor do they switch between contrasting structures. Rather, ambidextrous organizations are composed of multiple tightly coupled subunits that are themselves loosely coupled from each other. Within subunits, the tasks, culture, individuals and organization arrangements are consistent, but across subunits, tasks and cultures are

inconsistent and loosely coupled. Strategic integration, the ability to drive innovation streams and take advantage of contrasting organizational capabilities, occurs at the senior team level of analysis.

In contrast to Lawrence and Lorsch (1967), ambidextrous organizational designs are composed of highly differentiated but weakly integrated subunits. While the exploratory units are small and decentralized with loose cultures and processes, the exploitation units are larger, more centralized with tight cultures and processes. Exploratory units succeed by experimenting, by creating small wins and losses frequently (Sitkin, 1992). As process management tends to drive out experimentation, it must be prevented from migrating into exploratory units and processes. In contrast, exploitation units that succeed by reducing variability and maximizing efficiency and control are an ideal location for the tight coordination associated with process management efforts. These contrasting, inconsistent units must be physically and culturally separated from each other, have different measurement and incentives, and have distinct managerial teams (Nonaka, 1988, 1991; Bradach, 1997; Sutcliffe et al., 2000; Tushman and O'Reilly, 1998). For example in HP's Scanner Division, the more routine flatbed scanners had a completely different organizational architecture than the emerging consumer/knitting technology scanners. These distinct units were physically separated from each other and had their own management teams.

Because dynamic capabilities are rooted in driving streams of innovation in a product class (Teece et al., 1997; Morone, 1993), these highly differentiated but loosely coupled subsystems must be strategically integrated by the senior team. Such strategic linkage is anchored by common aspiration levels and a senior team that provides slack to the experimental subunits and holds the differentiated units to fundamentally different selection and search constraints (Levinthal and March, 1993; Levinthal, 1997b). To be effective, ambidextrous senior teams must develop their own processes such that they can establish new forward-looking cognitive models for exploration

units, while allowing backward-looking experiential learning to rapidly unfold for exploitation units (Gavetti and Levinthal, 2000; Louis and Sutton, 1989).

To create dual organizational structures, senior teams must develop techniques that permit them to be consistently inconsistent as they steer a balance between the need to be small and large, centralized and decentralized, and focused short-term and long-term simultaneously (Weick, 1995, Hedberg et al., 1976; Gavetti and Levinthal, 2000). If the locus of strategic integration is low in the firm, experimentation is stunted as the short-term successes of rapid exploitation drive out exploration. If this integration is at too high a level in a multidivisional firm or done across independent firms (e.g. Christensen, 1998), the underlying understanding of an innovation stream's dynamic is dampened and the ability to drive disruptive or radical change is restricted. For example at HP, when the division's general manager and his senior team provided the integration between the unit's two highly differentiated units, the division was able to effectively both explore and exploit. However when the general manager was promoted, the consumer unit was spun out to a sector executive. As this corporate executive did not deeply understand the competitive issues in the scanning industry, he cancelled the more exploratory consumer unit when it did not show quick profits.

While complex and politically difficult, ambidextrous organizational forms permit a firm with highly differentiated units to drive process management with its associated variation-reduction and control, as well as exploration and option creation. Experimental units provide variation from which the senior team can learn about and, in turn, bet on the future, even as the exploitation units build capabilities for short-term effectiveness (McGrath, 1999). These internally inconsistent operating modes are strategically linked by the senior team through their aspirations, actions, and through a limited set of core values (Hambrick, Nadler and Tushman, 1998). We depict such units integrated through the senior team in Figure 2.

The impact of process management activities on innovation outcomes will be contingent on organizational context. In ambidextrous organizational forms, process management activities drive exploitative innovation even as they are buffered from intruding on exploratory innovation.

Proposition 6: In the context of an ambidextrous organizational form, increases in process management activities will lead to greater increases in exploitative innovations, but will have less effect on exploratory innovations.

PROCESS MANAGEMENT AND ORGANIZATIONAL ADAPTATION

Process management activities affect a firm's technological capabilities. As technological capabilities affect organizational fate, process management activities may also affect organizational adaptation. Process management activities, through their impact on organizational processes, also accentuate organizational inertia. This inertia, in turn, affects organizational responsiveness to technological transitions. We now explore process management's effects on organizational adaptation in contrasting technological contexts.

Technology cycles

Organization environments are characterized by cycles of technological variation, alternating between periods of incremental change and periods of rapid innovation (Sanderson & Uzumeri, 1995; Tushman & Anderson, 1986, Abernathy & Utterback, 1978). Discontinuous technological advances are often introduced by organizations outside an industry and trigger periods of rapid innovation and change (Foster, 1986; Sull et al., 1997). This period of rapid innovation, or era of ferment, ends when a dominant technology design emerges (Abernathy, 1978; Anderson & Tushman, 1990; Tushman & Rosenkopf, 1992). With the emergence of a dominant technological regime, the nature of technical change shifts from product innovation to a relatively

long period of process innovation and incremental refinements of the selected technology (Abernathy & Utterback, 1978; Ettlie & Reza, 1992; Utterback, 1994). This period of incremental technical change is, in turn, punctuated by the subsequent technological discontinuity. Thus in the videocassette recorder (VCR) market, after a period of variation between alternative formats, VHS became the industry standard. Once this standard emerged, subsequent innovation focused on incremental improvements and cost reductions in VHS technology (Cusumano, 1994). Similar innovation dynamics have been found in a range of industries including typewriters, televisions, computers, disk drives, operating systems, browsers, and microprocessors (see Tushman & Murmann, 1998; Van de Ven, Angle and Poole, 1989).

Adaptation in stable environments

The shifting nature of innovation requirements embedded in technology cycles require that organizations develop capabilities to move with, if not shape, these cycles (Henderson, 1993; Tushman & O'Reilly, 1997). During eras of incremental change, organizations that sustain incremental innovation will be more effective than those that initiate variance-increasing innovation.

As process management activities stimulate incremental innovation, these activities will benefit organizations when technological environments are characterized by incremental refinements of an existing technological design. Greater consistency and efficiency will be beneficial in periods of incremental change. Rapid improvements in customer satisfaction while reducing waste and costs is likely to further enhance organizational effectiveness.

Organizations with routines and procedures stabilized through process management activities are thus likely to do well in stable or predictable contexts (Donaldson, 1995; Hannan & Freeman, 1984). Indeed, Ittner & Larcker (1997) found that process management was positively associated with performance in the stable auto industry but not in the more dynamic computer

industry. These environmentally contingent results are also supported by Sitkin et al., (1994) and Sterman et al., (1997).

Proposition 7: Increases in the extent of process management activities will lead to better performance in eras of incremental technological change.

Further, tighter coordination and repetition of activities in best practices increases an organization's speed and efficiency. As processes for identifying and addressing problems and opportunities in the environment are further refined and routinized by process management's influence, decision-making and problem solving becomes faster (Miller, 1993). Increasing organizational proficiency in recognizing and addressing recurring challenges leads to stable and increasingly efficient communication channels and information filters (Henderson & Clark, 1990; Tyre and Orlikowsky, 1994). These stable patterns of communication and interaction lead to the development of norms, rules, and roles which further channel individual and group behavior into streamlined activities that more efficiently carry out an organization's mission (Hackman, 1992; Nadler & Tushman, 1998; Repenning, 1999). Over time, stable procedures and norms also drive increased demographic homogeneity within the organization, which further speed decision-making and problem solving (Keck & Tushman, 1993; Williams & O'Reilly, 1998). For example, the rapid screening and selection of innovations that leverage the efficient and tightly coordinated processes for manufacturing and distribution allows for fast response to incremental technological change.

Proposition 8: Increases in the extent of process management activities will speed organizational responsiveness during eras of incremental technological change.

Adaptation in turbulent environments

Conversely, the ability to rapidly develop new technological capabilities is especially critical in environments characterized by rapid innovation and change (Tushman & Anderson, 1986; Brown & Eisenhardt, 1997; Teece et al., 1997). Periods of technological ferment are characterized by substantial product variation and market uncertainty. Responding to environmental uncertainty and variation requires similar variety within the firm (Daft & Weick, 1984). A reduction in variance-increasing activity within the firm prevents it from registering and/or responding to environmental uncertainty (Burgelman, 1994). The variation reducing focus of process management restricts the development of alternatives to respond to environmental changes. For example, Sitkin and Stickel (1996) found that TQM efforts in R&D settings not only bred distrust and dissension across the firms, but they also drove out variability in R&D.

Organizational outcomes are affected by delayed or inadequate responses to environmental turbulence (Meyer, Brooks & Goes, 1990; Henderson, 1993). For example, IBM's relatively slow response to personal computers resulted in the successful entry of other less-inertial competitors that fundamentally changed the nature of the computer industry (Mitchell, 1989). Slow or incompetent responses to environmental shifts prevented incumbents from retaining their leadership positions in the disk drive (Christensen & Bower, 1996), photolithographic equipment (Henderson & Clark, 1990), and watch industries (Glassmeier, 1991), among others (Tushman & O'Reilly, 1997). Similarly, TQM practices have been associated with lower performance in the dynamic computer industry environment (Ittner & Larcker, 1997; Sitkin et al., 1994).

Proposition 9: Increases in the extent of process management activities will lead to lower performance in eras of technological ferment.

The same practices that help an organization learn and achieve efficiency more quickly can also impede an organization's adaptation to major technological transitions (Levinthal, 1991, 1997a). Over time, as process management activities permeate an organization, the increasingly stable, tightly-linked, and efficient routines that span an organization make anything more than incremental organizational change difficult (Hannan & Freeman, 1984). Organizations that have honed their skills in making incremental changes in processes and products develop momentum that works to impede major change (Miller & Friesen, 1980), or transforms core competencies into rigidities (Leonard-Barton, 1992).

Case studies of process management efforts and simulation studies of problem solving dynamics provide evidence of this tendency for increased resistance to change resulting from process management activities. Following successful implementation of a process improvement program, Analog Devices' financial performance fell far below the industry average. The company subsequently underwent a major reorganization, including a reorientation of its product development efforts away from its core business and into emerging markets (Sternan et al., 1997: 505). While process improvement efforts were underway, internally generated innovations necessary for successful performance in a changed environment were not executed. Extending this work, Repping (1999) argued that over time process improvement activities trigger cycles of increased managerial control and bureaucratic procedures, which undermine initial gains. Similarly, Alcoa's CEO's frustration with the slow pace of continuous improvement might also be explained by the increased inertia associated with practices focused on incremental change and improvement (Kolesar, 1993). Finally, Levinthal's (1997b) modeling of adaptation dynamics finds that tightly coupled organizations are subjected to heightened inertia and high failure rates in changing environments. Because organizational inertia is so strong, successful firms moved through environmental change by initiating reorientations.

Thus, the influence of process management techniques on integrating and coordinating processes can drive rapid exploitation and efficiency, but also longer-term momentum and resistance to change. While tightly coordinated and streamlined processes in product development and manufacturing may allow for rapid response with extensions and enhancements of current capabilities, the associated inertia is likely to make such an organization slower to respond to subsystem, linking, or radical technological change.

Proposition 10: Increases in the extent of process management activities will slow organizational responsiveness during eras of technological ferment.

Moderating effects of ambidextrous organizational forms

To maximize short-term performance and survive in periods of incremental technology change, firms need to accentuate incremental change, momentum, and inertia associated with process activities. Multiple functions and activities must be seamlessly linked throughout the organization to efficiently deliver to and satisfy existing customers. Without this concerted refinement of capabilities, firms may not survive long enough to be faced with or initiate technological change. But process intensity also stunts incumbents' ability to take advantage of internally generated opportunities for discontinuous change (Cooper & Smith, 1992; Foster, 1986). For example, even though Swiss producers invented the quartz movement, it was American and Japanese firms that actually introduced this technological discontinuity (Glassmeier, 1991). Thus, process management provides only one side of the dynamic capabilities story. Firms that achieve success with process management are likely to increase their commitment to process intensity and broaden its influence to ever more processes. Yet, firms must be capable of forgetting their past, breaking rules and traditions, and increasing variation in the service of architectural and/or radical innovation or in meeting the needs of new customer segments (Hedberg et al., 1976; Weick, 1995).

As competencies are hard to develop and the rates of environmental change are substantial, dynamic capabilities are not rooted in sequential attention or rhythmic pacing (e.g. Brown & Eisenhardt, 1998), but rather in exploiting and exploring simultaneously (Sutcliffe et al., 2000; Tushman & O'Reilly, 1997).

Over time, process management crowds out exploratory innovation. A decrease in exploratory behaviors stunts an organization's ability to adapt in environments characterized by technological ferment and uncertainty. Ambidextrous organizational forms isolate process management activities in subunits where reducing variation and increasing control is strategically vital. An ambidextrous organizational design allows for uncoupling the variance-decreasing units and activities from those units where variation is strategically vital. For example at CibaVision, a single senior team created highly differentiated subunits where one subunit pursued low cost lenses even as another subunit developed a substitute (disposable) lens. Similarly at Ciba's Crop Protection Division, a single general manager built multiple internally inconsistent subunits in order to drive an innovation stream to keep plants healthy. One unit based in Switzerland focused on the efficient development of chemical based fungicides. Anchored in molecular biology, another unit based in the United States, was focused on the development of a seed that would grow plants that would not need fungicides. If this latter unit were successful, it would cannibalize the chemical based unit in Switzerland (Tushman and O'Reilly, 1997). These experimental, variance-creating units provide the options from which a firm's senior managers can select to shape an evolving innovation stream. These ideas suggest modifications in propositions 7 and 8.

Proposition 11: In the context of an ambidextrous organizational form, increases in process management will be positively associated with responsiveness and performance in eras of incremental technological change, but will have less effect on responsiveness or performance in eras of technological ferment.

DISCUSSION

Twenty years after Abernathy's admonition about the productivity dilemma, the ideology of process management has ever increased its influence on organizations. Over the past two decades, there have been substantial institutional pressures for firms to adopt TQM, QFD, BPR, get ISO 9000 certified, or compete for the Baldrige or Deming awards. While the symbolic importance of process management may be important, its substantive benefits are much less clear. Our review suggests that inconsistent outcomes of process management practices can be reconciled with attention to the context in which these practices are employed. Process management activities are positively associated with organizational effectiveness in a limited set of conditions: during periods of stability or incremental change, and for incremental innovation or existing customers. In contrast, in a much wider set of conditions, during eras of ferment, in turbulent environments, for new customer segments, and for architectural, modular and radical innovation, process management activities are less conducive to organizational effectiveness. Under these frequently occurring conditions, process management activities build resistance to change, momentum, and in turn, inhibit organizational variability. These inertial outcomes of process management activities stunt a firm's ability to adapt.

But organizations must outcompete rivals both in the short and long run. Organizations that must meet current customer requirements and new customer demands do not have the luxury of choice—they must deal with the inconsistent demands of both exploitation and exploration. Process management capabilities speed exploitation and efficiency and may allow organizations to survive in the short run, but simultaneously dampen the exploration required for longer-term adaptation. Ambidextrous organizational forms reconcile these paradoxical demands by building internally

inconsistent architectures within a single organization. These contrasting architectures retain the benefits of experimentation and variability along with the benefits of exploitation and process control. These tightly coupled, internally inconsistent architectures must be tactically uncoupled. However, to drive streams of innovation, these inconsistent units must be strategically integrated by the senior team. It may be that heterogeneous senior team capabilities coupled with complex organizational architectures are at the root of dynamic organizational capabilities.

Implications for future research

Our model provides a starting point for future research on how process management practices affect firm dynamic capabilities. We advance testable propositions about the effects of these institutionally mandated practices on both technological innovation and adaptation. Moreover, our propositions provide a base for understanding how the effects of process management practices unfold over time in an organization. Future empirical work to test and modify these propositions will benefit from incorporating a longitudinal perspective and assessing how increases in such activity affect organizations, rather than comparing differences associated with nominal adoption of quality programs across firms.

While our ideas may be relevant for all types and sizes of firms, they apply most readily to firms whose strategies include both exploitative and exploratory innovation. Our discussion concerns the effects of increased process management intensity for such firms already challenged with balancing such activities. Our propositions are less relevant for firms whose strategies focus either solely on exploitation or exploratory innovation. In addition, these ideas may not apply to small startups in their initial phases, not yet challenged with balancing exploitation of their initial project with the exploratory development of subsequent products. Finally, these ideas may not apply to service organizations. Future research could further test the boundaries of our propositions.

Our review also suggests that to more fully understand the relations between process activities and organizational outcomes, research and theory in process management, organizations, and strategy need to be more explicitly coupled. There is much to be gained by integrating these perspectives on the phenomena and by taking a contingency approach to process activities and organizational outcomes. Technological, environmental, and structural conditions clearly moderate the relations between process activities and organizational outcomes. If dynamic capabilities require exploitation as well as exploration, more complex organizational forms are required which, in turn, demand more complex senior team capabilities. This review, then, indicates the potential in exploring more deeply the relations between organizational architectures, senior team behaviors, innovation streams, and process management.

Implications for managerial practice

Finally, our review has implications for practice. The powerful institutional pressures to adopt process management practices have cut across industries and firms, regardless of age or size. Despite the coercive pressure and promise of legitimacy, managers need to exercise great care in when and where to adopt these practices. While in stable, technologically certain settings these practices may be productive, in uncertain or technologically complex contexts, these practices may be quite counterproductive. Indeed, the utility of process management practices may be much more constrained than the popular literature suggests. Process management and its associated technologies and philosophies are conservative and resistant to anything but incremental or competence-enhancing innovation. This variance-hostile focus on incremental change and existing customers, from the senior team to lower levels of the firm, severely stunts a firm's dynamic capabilities. It is the promise of ambidextrous organizational forms and heterogeneous senior teams that provide the possibility of building organizations capable of both celebrating process activities as well as limiting their damage.

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FIGURE 1 – PROCESS MANAGEMENT’S EFFECTS ON TECHNOLOGICAL INNOVATION AND ADAPTATION

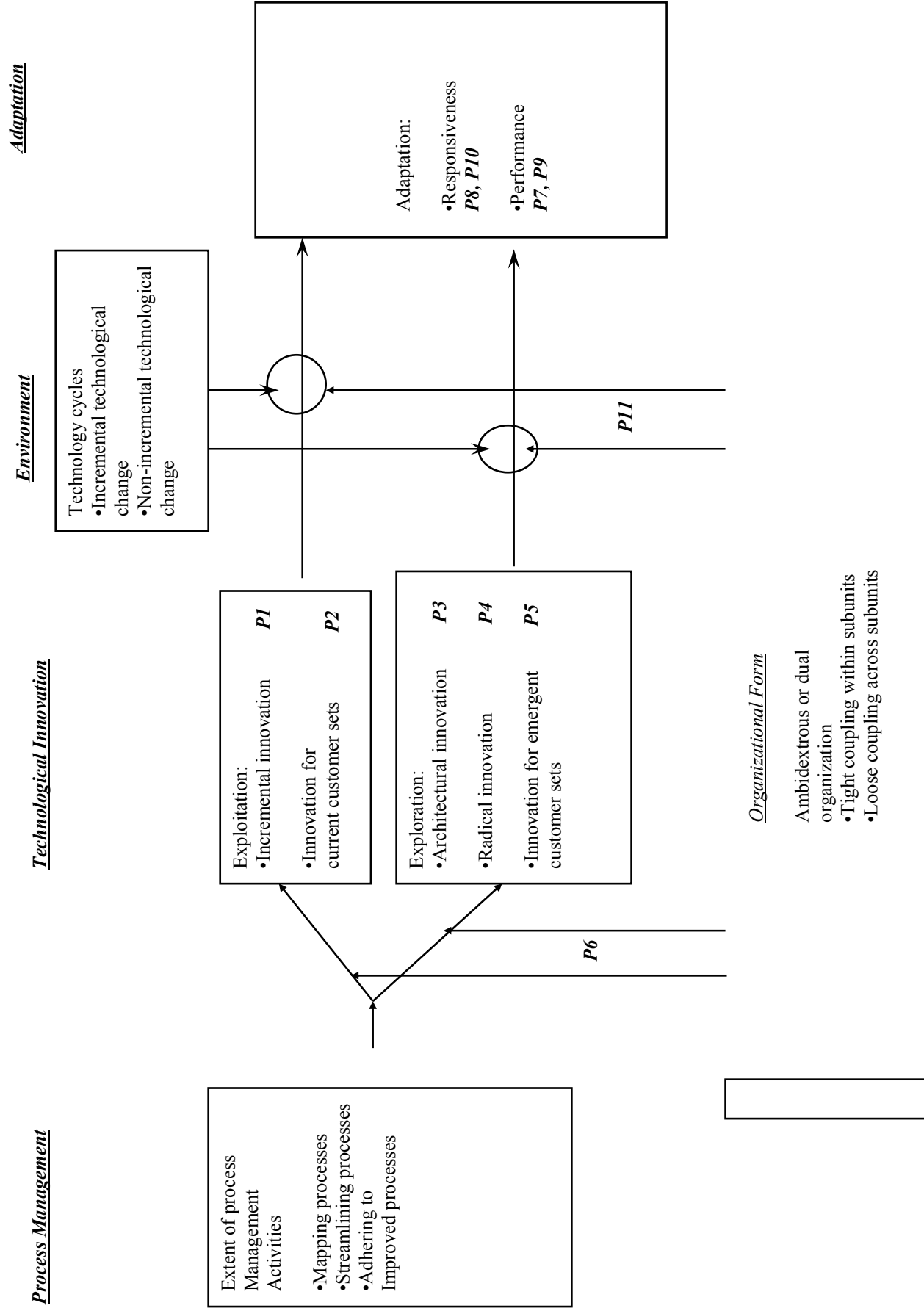


FIGURE 2
 Ambidextrous Organizational Form: Exploitation and Exploration Within Business Units

