

# 6

---

## Rival Interpretations of Balancing Exploration and Exploitation: Simultaneous or Sequential?

---

ERIC L. CHEN AND RIITTA KATILA

This research was supported by the National Science Foundation (Grant #0423646), Alfred P. Sloan Foundation Industry Studies Fellowship, and by Stanford Technology Ventures Program.

A long tradition of organizational literature has separated a firm's activities into two distinct realms of exploration and exploitation (March and Simon, 1958; Lawrence and Lorsch, 1967; Duncan, 1976; Mintzberg and McHugh, 1985). On the one hand, exploration encompasses behavior that increases the variance of organizational activity. As a result, its returns are often uncertain and distant in time. Exploration is 'the pursuit of knowledge, of things that might come to be known' (Levinthal and March, 1993, p. 105). On the other hand, exploitation encompasses behavior that increases the mean of organizational activity. As a result, its returns are more predictable and proximate in time (March, 1991). Exploitation is 'the use and development of things already known' (Levinthal and March, 1993, p. 105).<sup>1</sup>

Exploration and exploitation are particularly apt for describing different types of innovation activities, and their appropriate integration presents a consistent dilemma for innovating organizations (O'Reilly and Tushman, 2004). For instance, a typical product development strategy is likely to include exploratory projects that explore entirely new product categories as well as exploitative projects that target

<sup>1</sup>Consistent with the theoretical literature, the terms exploration and exploitation are used in this chapter to delineate specific types of *activities*. In empirical studies, exploration and exploitation are often described using outcome measures such as new product introductions or patents granted. In contrast, we focus on activities, in order to avoid tautological arguments and to enable *a priori* identification. For instance, exploitation versus exploration activities can be characterized as local versus nonlocal technology search behavior, and are not determined by the particular outcomes of search.

incremental improvements (Katila and Chen, 2006, 2008). Given the significance of these decisions for the entire organization and their long-term implications, an increasing stream of studies in the innovation literature has started to examine how to manage these two strategies effectively.

Several studies on technology and innovation have shown that innovative firms often use some combination of exploration and exploitation. Consequently, *balance of the two approaches* has emerged as one of the key concepts of organizational success (Tushman and O'Reilly, 1996; Katila and Ahuja, 2002; He and Wong, 2004; Laursen and Salter, 2006). Much research has argued that some degree of balance is necessary for firm survival and success: for example, scholars from a wide variety of theoretical perspectives including evolutionary (Katila and Ahuja, 2002; Laursen and Salter, 2006), organizational learning (Vermeulen and Barkema, 2001; He and Wong, 2004), organizational theory and structure (Tushman and O'Reilly, 1996), and resource-based views (Rao and Drazin, 2002); those studying product innovation, strategy, structural and human resource problems; and those using a varying set of labels such as old and new (Katila and Ahuja, 2002), stability and change (Baden-Fuller and Volberda, 1997), efficiency and flexibility (Adler, Goldoftas, and Levine, 1999), depth and breadth (Katila and Ahuja, 2002; Laursen and Salter, 2006), evolutionary and revolutionary (Tushman and O'Reilly, 1996), and exploitation and exploration (He and Wong, 2004).

Despite the significant insights regarding the importance of balancing exploration and exploitation, several rival interpretations exist on how to implement it. Our purpose in this chapter is to review these rival interpretations and synthesize previous empirical work from each approach. We also introduce an integrative framework that brings together the separate streams. By moving the discussion beyond just the elusive search for balance, the proposed framework also offers greater clarity on the strategic options that exist for firms. More specifically, it proposes that the appropriate innovation strategy for any particular firm depends on the characteristics of its environment. Firms competing in more stable environments benefit from sequentially switching between periods of exploration and exploitation while firms competing in more dynamic environments are required to explore and exploit simultaneously.

## RIVAL INTERPRETATIONS OF BALANCE

### *Background*

The scientific root of balancing exploration and exploitation lies in evolutionary biology, and is for example documented in Holland's (1975) work on complex adaptive systems. Models of adaptive systems reveal that they suffer from engaging in too much of one activity to the exclusion of the other. Exploration without exploitation results in experimentation costs without the benefits. Exploitation without exploration results in suboptimal stable equilibria. Viewing organizations as complex adaptive systems, March (1991) imports these concepts into the organizations field and argues that organizations have a similar detrimental tendency to lean towards either extreme. The subsequent proliferation of studies that have

drawn upon these themes continues to support their relevance, while stressing the importance of balance, in particular for innovation (e.g., Katila and Ahuja, 2002; He and Wong, 2004; Laursen and Salter, 2006).

However, finding the appropriate balance is often difficult for firms to achieve, let alone maintain. Studies have shown that firms more often tend to lean toward too much exploitation (Benner and Tushman, 2003; Rosenkopf and Almeida, 2003), and more infrequently toward too much exploration (Miller and Friesen, 1980; Nohria and Gulati, 1996). (See also incumbent technology firms such as Dell and IBM as examples of over-exploiters, and Amazon and Apple as examples of over-explorers, frequenting the business press.) Longitudinal studies from semiconductors and chemicals similarly showcase these extreme tendencies. Sorensen and Stuart (2000, p. 106) demonstrated that older semiconductor firms in particular are likely to over-exploit, and subsequently 'produce innovations that have a lesser impact on their technological communities than do those of young firms'. In contrast, and perhaps somewhat more rarely, Ahuja and Katila (2004) documented the dangers of over-exploration in chemicals firms' scientific research: 'At high levels, exploration tends to drive out exploitation altogether. An organization that excessively exposes potential innovators to science risks their losing sight of the ultimate goal of creating useful artifacts' (p. 891).

Over time, a natural organizational tendency exists towards exploitation, making the balance point unstable. There are several reasons for this tendency. Evolutionary theory posits that organizations often become grounded in a series of common routines that favor local search behavior (Stinchcombe, 1965; Helfat, 1994; Stuart and Podolny, 1996). In addition, the rise of process management practices over the past several decades, such as programs aimed at improving quality and efficiency metrics, have often come at the cost of exploratory practices (Benner and Tushman, 2003). Similarly, the common emphasis on short-term financial performance, in particular in public firms, commonly leads to over-exploitation (Davis and Stout, 1992; Leonard-Barton, 1992; Christensen, 1997). For all these reasons, students of organizations and strategy have continued efforts to increase understanding of the dynamics of exploration and exploitation with the hope that they will lead to improved strategies for balancing the two strategies.

A review of the empirical literature that follows reveals two distinctly different conceptual approaches to balance. One approach is based on the notion that exploration and exploitation occur simultaneously within organizations. This stream stands aligned with the idea that successful complex adaptive systems must be able to balance both activities at once. A second approach argues that simultaneous balance is difficult, unnatural, and inefficient. Instead, this stream offers a sequential interpretation and posits that the tradeoff between exploration and exploitation is best overcome by periodically switching attention between them. The theoretical foundations of this approach can be traced back to studies on paradigm shifts (Kuhn, 1970; Dosi, 1982) and to the punctuated equilibrium model (Tushman and Romanelli, 1985), as well as to evolutionary processes of variation, selection, and retention (Campbell, 1969). The two approaches will be discussed next, followed by their integration.

### *The sequential approach*

Exploration and exploitation are fundamentally conflicting activities. In fact, several researchers have questioned whether it is possible for one organization to pursue both activities simultaneously (Abernathy, 1978; Porter, 1985; Ghemawat and Costa, 1993). For example, exploration is an inefficient process – the expectation is that increased variance will not necessarily lead to any positive returns. In contrast, exploitation is fundamentally efficient. Given these incompatibilities, it is easily conceivable that an organization that tries to do both at once will succeed in neither. In response to this conflict, a set of scholars proposes that organizations should engage in the two activities *sequentially* rather than simultaneously in order to maintain a level of internal consistency. That is, the organization's innovation strategy at any point in time should focus either on increasing variety or increasing efficiency, but not on both. This interpretation of balance is temporal: periods of exploration should be moderated with periods of exploitation, and vice versa.

Early studies on the sequential approach to innovation can be traced back to the evolution of scientific paradigms (Kuhn, 1970) and technological trajectories (Dosi, 1982; Utterback, 1994). Subsequent evidence of technology S-curves (Foster, 1986; Christensen, 1992) can also be conceptualized as sequential periods of exploration and exploitation. At the beginning of the curve, significant effort and investment is required to establish a new technology or dominant design (exploration period). After this period, a dramatic increase in production and efficiency results as the innovation diffuses (exploitation period). A second inflection point in the S-curve marks the beginning of the end for that particular paradigm, at which point a new S-curve often arises, initiating a new period of exploration (Tushman and O'Reilly, 1997).

Ideas on technological paradigm shifts can also be translated into an evolutionary framework that supports the prudence of a sequential approach. In particular, Tushman and Anderson's (1986) examination of technological discontinuities offers descriptive reasons for why it may not be necessary or wise for firms to engage continuously in both exploration and exploitation. By examining patterns of technological change in multiple industries, the authors demonstrate that industries evolve through 'periods of incremental change punctuated by technological breakthroughs' (Tushman and Anderson, 1986, p. 439). In other words, industries go through periods dominated by exploitation that are interrupted by shorter periods of exploration. Similarly, Tyre and Orlikowski (1993) showed that technology evolution is characterized by natural windows of opportunity for significant change that are separated by periods of minor adjustments, and that the most innovative firms are those that take advantage of both phases: they explore significantly during windows of opportunity and exploit unceasingly during subsequent periods of minor adjustment.

Sequential models are also closely related to the processes of variation, selection, and retention (Campbell, 1969; Nelson and Winter, 1982). Indeed, the variation-selection-retention cycle mirrors that of exploration-exploitation. Exploration serves the functions of increasing variation and probing the environment to select a dominant design. Once selected, the design is retained, as well as disseminated and improved, through exploitation.

Several empirical studies also confirm the sequential interpretation of balance. For instance, Winter and Szulanski (2001) examined sequential balance in their study of business model innovation and its replication, i.e., the business process exemplified by McDonalds in which a large number of similar outlets are created for delivering a product or service. Although replication itself is a process of exploitation, Winter and Szulanski showed that an exploratory process precedes replication. This exploration phase involves experimentation leading to the discovery of a successful business model as well as an understanding of which components of the model are necessary to replicate. The success of replication strategies is evidenced by the profits achieved by the number of large corporations that employ them. Another successful example of a sequential approach is a two-stage product development model of Pixar Animation Studios. Pixar typically first explores the new technical features of a movie separately (e.g., through short films, such as *Gerl's Game*) and then proceeds to exploit the successful ideas from the experiments in full feature-length films (e.g., *A Bug's Life*).

Although the exploration-to-exploitation periods and transitions are carefully crafted in the examples described above, there are also situations in which the same process occurs less as a result of strategic agency and more as a result of institutional factors. For instance, in a longitudinal study of Hollywood studio heads, Miller and Shamsie (2001) examined the relationships between exploration, exploitation, and executive tenure, and deconstructed the CEO life cycle into three distinct periods. The earliest period of the life cycle, the learning stage, is marked by a high level of product line experimentation and relatively modest financial performance. The second period, the harvest stage, is characterized by decreased experimentation and high financial performance. The final period, the decline stage, reveals even lower experimentation and a decline in financial performance. In terms of organizational learning, these CEOs begin their tenures by exploring different genres, talent, and procedures followed by exploiting the methods that are successful to the point where they become stale and outdated. Once they are replaced, the life cycle repeats itself, and over time a sequential pattern develops.

Another example that illustrates the sequential model in the context of organic growth is the Intel Corporation. The rise of Intel to its status as the world's dominant semiconductor manufacturer corresponded with the tenure of Andy Grove and his singular focus that led to coevolutionary lock-in with the personal computer market segment (Burgelman, 2002). Burgelman conceptualized this focus as strategic exploitation that originated at the top of the organizational hierarchy. The mantra 'copy exactly' coupled with countless incremental improvements to develop more efficient production were key characteristics of this strategy. However, as the growth of the PC market slowed and the development of the Internet expanded, Intel found itself in need of a transition to more exploration – one of the reasons it selected Craig Barrett as the next CEO. Grove had successfully led the firm through a period of exploitation, and Barrett was expected to transition the company into a new period of exploration. This temporal pattern is characteristic of the sequential interpretation of balance.

Empirical studies on inter-organizational resource acquisition such as acquisitions and alliances also provide support for the sequential model. Vermeulen and

TABLE 6.1 Selected papers on technology and innovation: sequential approach to balance.

<i>Study</i>	<i>Sample</i>	<i>Exploration terms</i>	<i>Exploitation terms</i>	<i>Key findings and implications for exploration and exploitation</i>
Organic resource development				
Tushman and Anderson (1986)	US cement, airline, and minicomputer firms, from inception to 1980	Competence-destroying	Competence-enhancing	Technological change within a product class is characterized by long periods of incremental change punctuated by discontinuities. Competence-destroying discontinuities are introduced by new firms, and competence-enhancing discontinuities by incumbents.
Winter and Szulanski (2001)	Banc One, 1970–1995	Experimentation, discovery	Replication	Firms must first engage in exploration to find a successful business model and then exploit it through replication of the model.
Burgelman (2002)	Intel Corporation, 1987–1998	Autonomous strategy (bottom-up)	Induced strategy (top-down)	Intel's success in semiconductors was a result of Grove's induced strategy towards incremental improvement. The necessity to explore more led to management turnover and a more autonomous strategy.

Author(s)	Acquisition	Greenfield (newly formed subsidiary of a firm)	Firms strike a temporal balance between the use of greenfields and acquisitions that is clearly patterned – the more a firm expands through acquisitions, the more likely it is to use greenfields, and vice versa.
Vermeulen and Barkema (2001)	25 largest nonfinancial companies on the Amsterdam Stock Exchange, 1993; and a computer simulation		
Rodanmel and Deeds (2004)	325 global biotech firms in 2565 alliances, 1973–1997	Exploitation alliances (downstream activities)	Biotechnology ventures that use a sequential alliance strategy (first upstream then downstream alliances) introduce more products in development and on the market.
Puranam, Singh, and Zollo (2006)	207 acquisitions of small US technology firms by large established firms, 1988–1998	Autonomy	Successful post-acquisition integration that improves innovation performance is characterized by a sequential approach to balance. Autonomy (exploration) is more important than coordination (exploitation) immediately following the acquisition, and vice versa later.

Barkema (2001) contrasted greenfields, i.e., newly formed affiliates of a firm, with acquisitions. The authors argued that when firms create greenfields they are inclined to impose existing organizational routines and habits on the new subsidiary (that is, they engage in exploitation). In contrast, the integration of an acquired firm can lead to organizational conflict that may break the buyer out of its inertial state (that is, enable exploration). Both simulation and archival analysis revealed that once a firm has used acquisitions as a dominant method of expansion for some time, it becomes increasingly likely to use greenfields for its next expansion. Once the switch to greenfield expansions has been made, the firm will continue to utilize them for a period until it switches back to acquisitions. Over time, a clear pattern forms that follows the sequential approach. Similarly, Puranam *et al.* (2006) showed how successful buyers used a sequential model that clearly separated periods of exploration from periods of exploitation when they integrated acquisitions.

Empirical studies on alliances also confirm the sequential pattern. In a longitudinal study of strategic alliances in biotechnology, Rothaermel and Deeds (2004) modeled a product development path that proceeds from exploration to exploitation. They found that research alliances dominate early parts of the product life cycle (exploration phase) whereas commercialization alliances are more common later in the life cycle (exploitation phase). A key finding was that new ventures that followed a sequential exploration-exploitation alliance strategy introduced more products than those following other types of strategies.

Taken together, several empirical studies that have focused on a wide range of organic and inter-firm resource development activities support a sequential balance of exploration and exploitation. Early development of a new technology, business, or product is often characterized by a phase of significant exploration, followed by a focused period of exploitation. In addition, multiple mechanisms influence the transition between the two phases. Executive tenure and control can lead the firm through distinct phases, for example. In addition to these descriptive findings, normative findings demonstrate that some firms are successful precisely because they sequentially switch attention between exploration and exploitation. Table 6.1 summarizes several recent studies that have documented a sequential pattern.

### *The simultaneous approach*

Despite the significant advances in understanding the sequential approach, another stream of literature provides equally strong support for a *simultaneous* model of balancing exploration and exploitation. In line with adaptive systems research, this stream of studies has approached exploration and exploitation as activities that reinforce each other and so must occur simultaneously. The concept of mutual learning, in which both the individual beliefs and the organizational code converge over time, is one of the fundamental features of the March (1991) model. March finds that achieving optimal organizational learning requires an appropriate balance of mutual learning rates.

Several studies on product innovation have similarly provided support for the simultaneous balance between exploration and exploitation (e.g., Katila and Ahuja, 2002; Laur sen and Salter, 2006). For instance, in a longitudinal study of new product



development in 124 robotics firms, Katila and Ahuja (2002) found a significant interaction effect between deep exploitation and wide exploration of technologies, indicating that at least some firms were able to engage in both approaches at the same time. Their results also provided evidence that firms that simultaneously pursue both approaches, rather than those that engage in either approach alone, are more innovative. That is, robotics firms that introduce the most new products do so by leveraging a combination of new and existing technology resources, rather than relying on new resources alone. Similarly, a recent study of corporate venture units showed that those following a simultaneous approach, which gave dual importance to both using existing capabilities and to building new capabilities, innovated more (Hill and Birkinshaw, 2006).

Danneels (2002) also looked at the dynamics of product innovation to better understand the roles of exploration and exploitation. This study defined the development of new products that draw on existing competencies as exploitation and those that require competencies that the firm does not yet have as exploration. Using field study results, he developed a  $2 \times 2$  typology that further delineated exploration and exploitation by examining competencies both in terms of technology and customers. Pure exploration takes place when both technological and customer competencies are new to the firm, pure exploitation when both already exist in the firm. Case studies of high-tech B2B firms revealed that much new product development takes place in the remaining two quadrants outside of either pure form. In each of these quadrants, either technological or customer competence for the new product already exists in the firm but the other does not. These cases result in the firm leveraging the existing competence and combining it with the new competence. More simply stated, the firm is simultaneously exploiting its existing technologies (or customers) to explore a new customer market (or technology). This process closely resembles the recombinatory process that takes place in 'technology brokering', in which old knowledge is applied to new uses to create superior designs (Hargadon and Sutton, 1997).

The above papers on simultaneous balance all emphasize organic development of resources. Other work has also demonstrated the significance of the model in the context of inter-organizational resource acquisition. Research on acquisitions, for example, has been particularly influential. Karim and Mitchell (2000) focused on acquisitions in the medical sector as a vehicle to extend existing resources and to obtain new ones. They suggested two contrasting roles for acquisitions: acquisitions can deepen existing resource bases (path-dependent change, i.e., exploitation) and they can move the firm to new areas that require substantially different resources (path-breaking change, i.e., exploration). Their data support both types of change: acquiring firms deepen existing resources by retaining target firm product lines that are similar to their own, while, at the same time, extend into new areas by retaining target firm medical categories that are distinct from their own. Ahuja and Katila (2001) similarly showed that successful buyers in the chemicals industry balance exploration and exploitation by acquiring target firms that are somewhat related but not too similar. Finally, in line with March's (1991) model, Karim and Mitchell (2000) suggested that in successful acquisitions both the buyer and the target learn from each other, thus supporting the simultaneous interpretation of balance.

TABLE 6.2 Selected papers on technology and innovation: simultaneous approach to balance.

<i>Study</i>	<i>Sample</i>	<i>Exploration terms</i>	<i>Exploitation terms</i>	<i>Key findings and implications for exploration and exploitation</i>
<b>Organic resource development</b>				
Tushman and O'Reilly (1996, 1997)	Multiple case studies of mainly US-based firms	Revolutionary change	Evolutionary change	Successful technology firms manage dual strategies where they support exploitation in mature divisions and exploration in divisions that need to be revitalized.
Katila and Ahuja (2002)	124 robotics companies in Europe, Japan, and North America, 1985–1996	Search scope	Search depth	Firms that balance their efforts on two fronts by simultaneously both reusing their existing knowledge (search depth) and exploring new knowledge (search scope) introduce new products more frequently.
He and Wong (2004)	206 manufacturing firms in Singapore and Malaysia, 1999–2000	Exploratory innovation strategy	Exploitative innovation strategy	Firms that explore and exploit simultaneously, and invest in both strategies at equal levels, grow faster (but do not have significantly higher product innovation).
Katila and Chen (2006)	71 industrial automation companies in Japan, Europe, and the US, 1984–1998	Early-mover	Late-mover	Firms create the most innovative product portfolios when they move early in some technology areas while simultaneously moving late in others.

Inter-organizational resource acquisition		Exploration (turnover)	Exploitation (socialization)	Organizations with hiring strategies that balance short-term exploitation (old, mean-seeking activity) with long-term exploration (new, variance-seeking activity) live longer and perform better.
March (1991)	Simulation model of impact of employee socialization and turnover rates on organizational knowledge			
Rao and Drazin (2002)	Recruitment of portfolio Novices managers in 588 US mutual funds, 1986–1994	Novices	Veterans	Firms that introduce new products more frequently, balance exploration and exploitation in recruiting. New firms recruit industry veterans to gain industry experience and old firms recruit novices to gain new ideas.
Karim and Mitchell (2004)	Johnson & Johnson; 88 medical sector business units (incl. 54 acquired), 1975–1997	Boundary-redefinition	Routines	Innovation stems from maintaining a deep understanding of organizationally-embedded routines (exploitation) while undertaking redefinition of unit and firm boundaries (exploration).

Taken together, several empirical studies reviewed above, both from organic and inter-organizational perspectives, provide significant support for a simultaneous model of balance. The authors show that a simultaneous balance of exploration and exploitation may be difficult to implement, but often produces beneficial results. For example, the findings showed that some firms are able to explore and exploit simultaneously, and those that did so introduced new products more frequently, adapted to rapidly changing environments more swiftly, and created more value through acquisitions. The main insight of this set of studies is that exploration and exploitation need not always be competing activities, but can and should be complementary. Table 6.2 summarizes recent studies that document a simultaneous pattern.

### TOWARD AN INTEGRATIVE FRAMEWORK

Balancing the dual processes of exploration and exploitation is a constant struggle for firms and their managers. As a result, innovation researchers across a wide variety of theoretical disciplines and empirical focuses have offered insights on the subject. The above review of the current literature shows that these interpretations can be categorized into two approaches: simultaneous and sequential. Given these rival interpretations, several new questions arise. One is how to reconcile the two approaches, which are based on fundamentally different theoretical perspectives on balance. Another question is how to resolve empirical findings that offer support for both interpretations and show that both approaches can support and stimulate innovation. Third, it is unclear which types of challenges underlie the successful implementation of each approach. Simultaneous and sequential approaches demonstrate different prescriptions for stimulating innovation, and are likely to present distinct managerial challenges as well. In this section, we propose a framework that begins to integrate the two approaches.

#### *Integrated model of balance*

One approach to resolving an apparent contradiction between simultaneous and sequential approaches is to take into account that organizations face a spectrum of different competitive environments. Since early contingency theory, scholars have pointed out that successful organizations create a fit with their environmental conditions (Lawrence and Lorsch, 1967; Thompson, 1967). For example, the strategies needed to succeed in 'high-velocity' markets (Brown and Eisenhardt, 1998) differ from those required in more stable environments. Although several environmental characteristics are likely to be significant for balance, in this chapter we differentiate between two types of environments, stable and dynamic, because of their significance for innovation activities. More stable environments have lengthy production cycles and follow clear technological trends whereas demands for successful innovation are likely to change rapidly and in more unpredictable ways in dynamic environments.

First, several arguments support the idea that the simultaneous approach is more appropriate in dynamic environments. In landscapes where conditions are

constantly changing, it is vital that firms simultaneously explore and exploit. One major implication of managing under these conditions is that careful, long-term strategic planning is less effective. Instead, firms must continually explore for new opportunities, and be prepared to exploit them as they arise. Firms competing in more dynamic markets do not have time to switch from exploration to exploitation mode because the window of opportunity is often very short. Thus, the best strategy for firms facing highly dynamic environments is to engage in simultaneous exploration and exploitation.

Comparatively, in more stable, established environments, firms are afforded the luxury of sequential switching. Industries such as cement and airlines analyzed by Tushman and Anderson (1986) are characterized by significant periods of stability before being punctuated by major change. Given these features, firms are able to predict more accurately environmental conditions and their evolution, and can concentrate on either exploration or exploitation depending on the environmental state.

Our analysis of empirical studies described above and summarized in Tables 6.1 and 6.2 provide support for this integrative model. Studies that emphasized the simultaneous approach typically include firms in more dynamic, technology-based industries. Firms analyzed by Brown and Eisenhardt (1997), Katila and Ahuja (2002), and Danneels (2002) competed in information technology, robotics, and B2B products, respectively. Similarly, Karim and Mitchell (2000) focused on medical sector product lines in which new, competing devices were steadily being generated by a wide array of firms. In contrast, studies that provided support for a more sequential approach focused on more stable industries such as cement, airlines, and minicomputers (Tushman and Anderson, 1986). Each of these industries is characterized by long and predictable product technology life cycles, and by conditions that are relatively stable with the rare exception of disruption events. Other industries that offer support for a sequential approach range from semiconductors (Burgelman, 2002) to feature films (Miller and Shamsie, 2001). In each case, firms engage in lengthy periods of exploitation equated with high performance, and only shift to an exploration phase when the industry is in search of a new dominant design. For example, Intel made famous the predictable speed of technological advance in semiconductors (Moore's Law).

Although the studies reviewed above show clear support for the environmental contingency model, several recent studies have also proposed an alternative approach to integrate the simultaneous and sequential approaches. Rather than posit the two approaches as competing alternatives, these studies argue for an 'open source' model where firms do not need to make a choice between exploration and exploitation, but can pursue both simultaneously, mainly by 'outsourcing' exploration (e.g., Laursen and Salter, 2006). For example Katila (2002) demonstrated how new product innovators explore externally created knowledge while simultaneously exploiting their internal knowledge. In this view, firms can explore and exploit sequentially, as long as the organization is able to effectively use others' 'simultaneous' exploration. Other authors have proposed similar solutions where exploration and exploitation occur simultaneously but are structurally (rather than temporally) separated or where the organizational context is simultaneously

supportive for both exploration and exploitation (Gibson and Birkinshaw, 2004). These integrative models provide intriguing avenues for future work, and further emphasize the importance of integrating the two approaches.

### *Implementation challenges*

In addition to new solutions to resolving the tension between exploration and exploitation, several open questions also remain about implementation. The sequential approach has emphasized the processes of variation, selection, and retention that enable organizations to evolve into an efficient form. Furthering the biological analogy, those firms that are unable to evolve or adapt are naturally-selected out. However, the same adaptive mechanisms that increase environmental fit put high performing incumbents at risk when faced with sudden changes in the landscape (Christensen, 1997). In related terms, adaptive processes refine exploitation faster than exploration (March, 1991). This imbalance is further magnified in more stable environments where firms face greater inertial pressures that result from the establishment of organizational routines (Stinchcombe, 1965) and institutionalization (Meyer and Rowan, 1977). Thus, due to this skew towards exploitation, the fundamental source of imbalance in the sequential approach is maladaptation. As a result, most innovation studies have focused on examining how to increase exploratory activity and improve its outcomes (e.g., Leonard-Barton, 1992; Ahuja and Lampert, 2001; Rosenkopf and Nerkar, 2001).

In contrast, the simultaneous approach to balance is subject to being at a dissipative equilibrium (Brown and Eisenhardt, 1998). Therefore, the fundamental source of imbalance for firms is a tendency to slip either into too much exploration or too much exploitation. But with some exceptions (Gersick, 1991; Brown and Eisenhardt, 1998; Ahuja and Katila, 2004), few empirical studies have discussed the case of over-exploration. Instead, the majority of proposed solutions are part of the same research stream that treats too much exploitation as the main problem and increased exploration as the lofty goal.

To summarize, the sequential approach tends to adapt towards too much exploitation while the simultaneous approach is subject to dissipative equilibrium that can easily destabilize in either direction. However, the majority of the innovation studies have focused on only one side of the solution – namely, improving mechanisms for exploration – even though under-exploitation may provide equally important challenges.

## DISCUSSION

Early work on organizations established the fundamental organizational tendencies towards path-dependent behavior. Our subsequent understanding of the tradeoffs between exploration and exploitation highlighted the dangers of such path-dependent tendencies and the desirability of balancing the two activities, especially in the context of innovation. This chapter reviewed the current innovation literature on exploration–exploitation balance. Although both concepts are heavily cited in the literature, the meaning of their balance is often ambiguous and

multifaceted. In trying to uncover the concept, we reviewed in detail the modes of activity being considered, the types of knowledge that are created and utilized, and the methods of managerial behavior employed. Our review revealed rival interpretations of balance and called for an integrative framework that is more specific about the terms and activities being discussed.

Our review illustrated empirical studies supporting both a simultaneous and a sequential approach to balancing exploration and exploitation. The simultaneous approach, following a complexity theory foundation, advocates organizations engaging in both activities at the same time. Although subject to unstable equilibrium, a balance that enables complementarities between exploration and exploitation has proven beneficial. The sequential approach, following an evolutionary theory foundation, advocates organizations alternating between each activity in turn. In this approach the challenge is to avoid the pitfall of a stable but unbalanced equilibrium towards too much exploitation. Based on features of environmental turbulence, a framework was proposed to reconcile these two interpretations in which the simultaneous approach performs better in dynamic environments and the sequential approach in stable environments.

Our review of the balance literature also reveals two main avenues for future research. First, studies of innovation have almost uniformly made the assumption that more exploration is better. Few empirical investigations have been directed at the problem of over-exploration, and, even fewer, to better understanding effective exploitation. However, our discussion on the dissipative equilibrium that characterizes simultaneous balance indicates that firms are just as likely to err in one direction as in the other. More empirical studies of entrepreneurial firms in emerging industries and more studies on effective exploitation by incumbent firms are fruitful directions for future work.

Second, we need to better understand the relationship between the simultaneous and sequential approaches. The first integrative framework proposed in this paper couples each approach with a particular type of environment. However, there is an opportunity to conceptualize environments in a more realistic manner, as continuous rather than as binary states, and to determine the point at which one approach outperforms the other. In addition, our framework mirrors current organization theory in that it assumes for the most part that environments are exogenous and unchanging. In reality, organizations do not compete under constant conditions, and do impact their environments. In fact, they are likely to consciously attempt to change the competitive landscape in their favor, and to interact across increasingly permeable organizational boundaries (e.g., Katila and Chen, 2006, 2008; Laursen and Salter, 2006). One hypothesis is that leading firms in emergent industries attempt to manage the uncertainty by making the environment more stable as it matures (Thompson, 1967). As a result, they are also able to move from a simultaneous approach to a sequential one that may be easier to manage because it demands focus on only one activity at a time and avoidance of maladaptation in only one direction. A related issue that could be examined in more detail in future work is the effects of different types of environments, such as how environmental complexity and munificence affect the choice of innovation strategies (e.g., Katila and Shane, 2005).

## REFERENCES

- Abernathy, W.J. (1978). *The productivity dilemma: roadblock to innovation in the automobile industry*. Baltimore, MA: Johns Hopkins University Press.
- Adler, P.S., Goldoftas, B., and Levine, D.I. (1999). Flexibility versus efficiency? A case study of model changeovers in the Toyota Production System. *Organization Science*, 10(1), 43–68.
- Ahuja, G., and Katila, R. (2001). Technological acquisitions and the innovation performance of acquiring firms: a longitudinal study. *Strategic Management Journal*, 22, 197–220.
- Ahuja, G., and Katila, R. (2004). Where do resources come from? The role of idiosyncratic situations. *Strategic Management Journal*, 25(8/9), 887–907.
- Ahuja, G., and Lampert, C.M. (2001). Entrepreneurship in the large corporation: A longitudinal study of how established firms create breakthrough inventions. *Strategic Management Journal*, 22, 521–43.
- Baden-Fuller, C., and Volberda, H.W. (1997). Strategic renewal. *International Studies of Management and Organization*, 27(2), 95–120.
- Benner, M., and Tushman, M.L. (2003). Exploitation, exploration, and process management: the productivity dilemma revisited. *Academy of Management Review*, 28(2), 238–56.
- Brown, S.L., and Eisenhardt, K.M. (1997). The art of continuous change: linking complexity theory and time-paced evolution in relentlessly shifting organizations. *Administrative Science Quarterly*, 42, 1–34.
- Brown, S.L., and Eisenhardt, K. (1998). *Competing on the edge—strategy as structured chaos*. Boston, MA: Harvard Business School Press.
- Burgelman, R.A. (2002). Strategy as vector and the inertia of co-evolutionary lock-in. *Administrative Science Quarterly*, 47, 325–57.
- Campbell, D.T. (1969). Variation and selective retention in socio-cultural environments. *General Systems*, 14, 69–85.
- Christensen, C.M. (1992). The limits of the technology S-curve. Parts I and II. *Production and Operations Management*, 1, 334–66.
- Christensen, C.M. (1997). *The innovator's dilemma: when new technologies cause great firms to fail*. Boston, MA: Harvard Business School Press.
- Danneels, E. (2002). The dynamics of product innovation and firm competencies. *Strategic Management Journal*, 23(12), 1095.
- Davis, G.F., and Stout, S.K. (1992). Organization theory and the market for corporate control: a dynamic analysis of the characteristics of large takeover targets, 1980–1990. *Administrative Science Quarterly*, 37(4), 605–33.
- Dosi, G. (1982). Technological paradigms and technological trajectories. *Research Policy*, 11, 147–62.
- Duncan, R.B. (1976). The ambidextrous organization: designing dual structures for innovation. In R.H. Kilmann, L.R. Pondy, and D. Slevin (eds), *The Management of Organization*, New York: North-Holland, vol. 1, 167–88.
- Foster, R. (1986). The S-curve: a new forecasting tool. *Innovation. The attacker's advantage*. New York: Summit Books, Simon and Schuster.
- Gersick, C. (1991). Revolutionary change theories: a multi-level exploration of the punctuated equilibrium paradigm. *Academy of Management Review*, 16, 10–36.
- Ghemawat, P., and Costa, J. (1993). The organizational tension between static and dynamic efficiency. *Strategic Management Journal*, 14(8), 59–73.
- Gibson, C.B., and Birkinshaw, J. (2004). The antecedents, consequences, and mediating role of organizational ambidexterity. *Academy of Management Journal*, 47(2), 209–26.
- Hargadon, A., and Sutton, R.I. (1997). Technology brokering and innovation in a product development firm. *Administrative Science Quarterly*, 42, 716–49.



- He, Z.-L., and Wong, P.-K. (2004). Exploration vs. exploitation: an empirical test of the ambidexterity hypothesis. *Organization Science*, 15(4), 481–94.
- Helfat, C.E. (1994). Evolutionary trajectories in petroleum firm R&D. *Management Science*, 40, 1720–47.
- Hill, S., and Birkinshaw, J. (2006). Ambidexterity in corporate venturing: simultaneously using existing and building new capabilities. *Academy of Management Proceedings*, C1–C6.
- Holland, J.H. (1975). *Adaptation in natural and artificial systems: an introductory analysis with applications to biology, control and artificial intelligence*. Ann Arbor, MA: University of Michigan Press.
- Karim, S., and Mitchell, W. (2000). Path-dependent and path-breaking change: reconfiguring business resources following acquisitions in the U.S. medical sector, 1978–1995. *Strategic Management Journal*, 21(11), 1061–81.
- Karim, S., and Mitchell, W. (2004). Innovating through acquisition and internal development. *Long Range Planning*, 37(6), 525–47.
- Katila, R. (2002). New product search over time: past ideas in their prime? *Academy of Management Journal*, 5, 995–1010.
- Katila, R., and Ahuja, G. (2002). Something old, something new: a longitudinal study of search behavior and new product introduction. *Academy of Management Journal*, 45(6), 1183–94.
- Katila, R., and Chen, E. (2006). Never too early, never too late: effects of search timing on product innovation. *Academy of Management Best Paper Proceedings*, Atlanta: Academy of Management: OMT: O1–O6.
- Katila, R., and Chen, E. (2008). Effects of search timing on product innovation: the value of not being in sync. *Administrative Science Quarterly*, in press.
- Katila, R., and Shane, S. (2005). When does lack of resources make new firms innovative? *Academy of Management Journal*, 48(5), 814–29.
- Kuhn, T. (1970). *The structure of scientific revolutions*. Chicago, IL: University of Chicago Press.
- Laursen, K., and Salter, A. (2006). Open for innovation: the role of openness in explaining innovation performance among U.K. manufacturing firms. *Strategic Management Journal*, 27(2), 131–50.
- Lawrence, P.R., and Lorsch, J.W. (1967). *Organization and environment: managing differentiation and integration*. Boston, MA: Harvard University Press.
- Leonard-Barton, D. (1992). Core capabilities and core rigidities: a paradox in managing new product development. *Strategic Management Journal*, 13, 111–25.
- Levinthal, D.A., and March, J.G. (1993). The myopia of learning. *Strategic Management Journal*, 14, 95–112.
- March, J.G. (1991). Exploration and exploitation in organizational learning. *Organization Science*, 2(1), 71–87.
- March, J., and Simon, H. (1958). *Organizations*. New York: John Wiley & Sons, Inc.
- Meyer, J.W., and Rowan, B. (1977). Institutionalized organizations: formal structure as myth and ceremony. *American Journal of Sociology*, 83, 340–63.
- Miller, D., and Friesen, P.H. (1980). Momentum and revolution in organizational adaptation. *Academy of Management Journal*, 23(4), 591–614.
- Miller, D., and Shamsie, J. (2001). Learning across the life cycle: experimentation and performance among the Hollywood studio heads. *Strategic Management Journal*, 22, 725–45.
- Mintzberg, H., and McHugh, A. (1985). Strategy formation in an adhocracy. *Administrative Science Quarterly*, 30, 160–97.
- Nelson, R.R., and Winter, S.G. (1982). *An evolutionary theory of economic change*. Cambridge, MA: Belknap – Harvard University Press.
- Nohria, N., and Gulati, R. (1996). Is slack good or bad for innovation? *Academy of Management Journal*, 39(5), 1245–64.

- O'Reilly, C.A., III, and Tushman, M.L. (2004). The ambidextrous organization. *Harvard Business Review*, 82(4), 74–81.
- Porter, M.E. (1985). *Competitive advantage*. Boston, MA: Free Press.
- Puranam, P., Singh, H., and Zollo, M. (2006). Organizing for innovation: managing the coordination-autonomy dilemma in technology acquisitions. *Academy of Management Journal*, 49(2), 263–80.
- Rao, H., and Drazin, R. (2002). Overcoming resource constraints on product innovation by recruiting talent from rivals: a study of the mutual fund industry, 1986–94. *Academy of Management Journal*, 45(3), 491–507.
- Rosenkopf, L., and Almeida, P. (2003). Overcoming local search through alliances and mobility. *Management Science*, 49(6), 751–66.
- Rosenkopf, L., and Nerkar, A. (2001). Beyond local search: boundary-spanning, exploration and impact in the optical disc industry. *Strategic Management Journal*, 22, 287–306.
- Rothaermel, F.T., and Deeds, D.L. (2004). Exploration and exploitation alliances in biotechnology: a system of new product development. *Strategic Management Journal*, 25, 287–306.
- Sorensen, J.B., and Stuart, T.E. (2000). Aging, obsolescence and organizational innovation. *Administrative Science Quarterly*, 45(1), 81–112.
- Stinchcombe, A.L. (1965). Social structure and organizations. In J.G. March (ed.), *Handbook of Organizations*, 142–93. Chicago, IL: Rand McNally and Company.
- Stuart, T., and Podolny, J. (1996). Local search and evolution of technological capabilities. *Strategic Management Journal*, 17, 21–38.
- Thompson, J.D. (1967). *Organizations in action*. New York: McGraw-Hill.
- Tushman, M.L., and Anderson, P. (1986). Technological discontinuities and organizational environments. *Administrative Science Quarterly*, 31, 439–65.
- Tushman, M.L., and O'Reilly, C.A., III. (1996). Ambidextrous organizations: managing evolutionary and revolutionary change. *California Management Review*, 38(4), 8–30.
- Tushman, M.L., and O'Reilly, C.A., III. (1997). *Winning through innovation: a practical guide to leading organizational change and renewal*. Boston, MA: Harvard Business School Press.
- Tushman, M., and Romanelli, E. (1985). Organizational evolution: a metamorphosis model of convergence and reorientation. In L.L. Cummings, and B.M. Staw (eds), *Research in Organizational Behavior*, Vol. 7, 171–222. Greenwich, CT: JAI Press.
- Tyre, M., and Orlikowski, W. (1993). Exploiting opportunities for technological improvement. *Sloan Management Review*, 35(1), 13–26.
- Utterback, J. (1994). *Mastering the dynamics of innovation*. Boston, MA: Harvard Business School Press.
- Vermeulen, F., and Barkema, H.G. (2001). Learning through acquisitions. *Academy of Management Journal*, 44(3), 457–76.
- Winter, S., and Szulanski, G. (2001). Replication as strategy. *Organization Science*, 12(6), 730–43.