Strategic Management Journal
Strat. Mgmt. J., **24**: 997–1010 (2003)
Published online in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/smj.332

THE DYNAMIC RESOURCE-BASED VIEW: CAPABILITY LIFECYCLES

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This article introduces the concept of the capability lifecycle (CLC), which articulates general patterns and paths in the evolution of organizational capabilities over time. The capability lifecycle provides a structure for a more comprehensive approach to dynamic resource-based theory. The analysis incorporates the founding, development, and maturity of capabilities in a manner that helps to explain the sources of heterogeneity in organizational capabilities. In addition, the analysis includes the 'branching' of an original capability into several possible altered forms. Copyright © 2003 John Wiley & Sons, Ltd.

INTRODUCTION

The resource-based view provides an explanation of competitive heterogeneity based on the premise that close competitors differ in their resources and capabilities in important and durable ways. These differences in turn affect competitive advantage and disadvantage. Nothing in this premise necessarily implies a static approach to the resource-based view, notwithstanding some controversy in this regard (see, for example, Priem and Butler, 2001). Indeed, recent research on the evolution of organizational capabilities suggests the promise of dynamic resource-based theory (Helfat, 2000). The concept of dynamic capabilities (Teece, Pisano, and Shuen, 1997), for example, has attracted increasing attention (Zollo and Winter, 2002; Zott, 2002). By definition, dynamic capabilities involve adaptation and change, because they build, integrate, or reconfigure other resources and capabilities. We go even further to include all organizational capabilities, 'dynamic' or otherwise, in a dynamic resource-based view. In this article, we introduce a new concept that underpins a more comprehensive approach to dynamic resource-based theory: the *capability lifecycle (CLC)*.

Heterogeneity of capabilities and resources in a population of firms is one of the cornerstones of resource-based theory (Peteraf, 1993; Hoopes, Madsen, and Walker, 2003). Within the resource-based view, however, we lack a clear conceptual model that includes an explanation of how this heterogeneity arises. Absent an understanding of where heterogeneity in resources and capabilities comes from, it is difficult for researchers to fully explain how firms use resources and capabilities to create competitive advantage. This gap in our understanding makes it more difficult to offer prescriptive advice to managers as well. As one of its contributions, the capability lifecycle helps to explain the fundamental sources of firm heterogeneity.

Key words: resource-based view; dynamic capabilities; capability lifecycles; organizational evolution; diversification
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The capability lifecycle provides a common language and way of thinking about the evolution of capabilities, as well as a more fully dynamic approach to resource-based theory. In what follows, we outline the main elements of the capability lifecycle and explain the supporting logic. We begin by explaining the general approach taken in the analysis. We then define the term 'organizational capability,' provide an overview of the capability lifecycle, and explain each individual stage of the lifecycle in greater detail. An important part of the analysis includes the 'branching' of an original capability into several possible altered forms. A concluding section discusses implications for future research on the dynamic resource-based view of the firm.

DYNAMIC RESOURCE-BASED THEORY AND THE CLC

Competitive advantage and disadvantage comes about over a period of time and also may shift over time. Therefore, in order to explain competitive advantage, the resource-based view must incorporate the evolution over time of the resources and capabilities that form the basis of competitive advantage. The capability lifecycle helps to make resource-based theory dynamic by providing a framework for understanding the evolution of capabilities over time.

To date, research has relied heavily on the concept of dynamic capabilities to analyze change in organizational capabilities. Teece *et al*. (1997: 516) define dynamic capabilities as 'the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments.' In this conception, nondynamic capabilities change through the action of dynamic capabilities. We argue here that while some capabilities may deal specifically with adaptation, learning, and change processes, all capabilities have the potential to accommodate change. Learning, change, and adaptation do not necessarily require the intervention of 'dynamic' capabilities as intermediaries.

There are a number of ways to make these arguments, as suggested by Porter's (1991) defense of the positioning paradigm and Peteraf's (1993) description of incremental resource expansion along an upwardly sloping supply curve. We take an approach derived from evolutionary economics (Nelson and Winter, 1982) and describe the evolutionary trajectories of capabilities in general (Helfat, 1994).[1] The analysis focuses on the regularities among these trajectories and describes both patterns and paths of capability evolution. This approach links together the various strands of resource-based theory (Wernerfelt, 1984; Rumelt, 1984; Teece *et al*. 1997), including 'routine-based' (Nelson and Winter, 1982) and 'knowledge-based' (Kogut and Zander, 1992; Winter, 1987; Grant, 1996) theories. Moreover, it illustrates why resource-based theory as a whole must be understood in dynamic terms.

The concept of the capability lifecycle flows naturally from Wernerfelt's (1984) observation that products and resources are two sides of the same coin. Just as products have development paths that follow recognizable patterns, known as product lifecycles, so do capabilities. Like the product lifecycle, the capability lifecycle describes recognizable stages, such as growth, maturity, and decline.

Some key elements differ between the capability and the product lifecycle, however. Along their evolutionary paths, capabilities may support a sequence of products or multiple products simultaneously (Helfat and Raubitschek, 2000). Thus, a product lifecycle and the lifecycle of the core capabilities from which the product springs do not have a one-to-one correspondence. In addition, because resources and capabilities are fungible across products, the lifecycle of a typical capability may extend beyond that of a typical product. A capability also may pass through multiple stages of transformation before it faces an ultimate decline. For this reason, the lifecycle of a capability may extend beyond that of the firm and the industry in which it originated. This is a paradoxical implication of the CLC, given the emphasis that all variants of resource-based theory place on the firm specificity and immobility of resources and capabilities.

The capability lifecycle rests upon a large volume of research that spans strategic management, economics, and organization theory. The capability lifecycle reflects what we know, and what theory suggests, about capabilities, firms, and their evolution. We believe that the underlying research has reached the point where it supports the concept

[1] Bromiley and Fleming (2002) also advocate the more explicit use of evolutionary economics to enhance the resource-based view.

of a capability lifecycle. Because the underlying research also contains many unanswered questions, however, future work may add to or alter some elements of the CLC.

ORGANIZATIONAL RESOURCES AND CAPABILITIES

As work on the resource-based view has progressed, it has become clear that the resource-based view extends not only to the assets of an organization but also to its capabilities (see, for example, Henderson and Cockburn, 1994). For purposes of this analysis, we define organizational resources and capabilities as follows. A resource refers to an asset or input to production (tangible or intangible) that an organization owns, controls, or has access to on a semi-permanent basis. An organizational capability refers to the ability of an organization to perform a coordinated set of tasks, utilizing organizational resources, for the purpose of achieving a particular end result.

Both resources and capabilities may evolve and change over time in important ways. This analysis focuses on the evolution of capabilities, deferring an analysis of resource evolution to another time and place. We also classify capabilities as either 'operational' or 'dynamic,' while recognizing that other categories may prove useful in future analyses.

Winter (2000: 983) defines an operational capability as 'a high-level routine (or collection of routines) that, together with its implementing input flows, confers upon an organization's management a set of decision options for producing significant outputs of a particular type.' In this definition, the term routine refers to a 'repetitive pattern of activity' (Nelson and Winter, 1982: 97). An operational capability generally involves performing an activity, such as manufacturing a particular product, using a collection of routines to execute and coordinate the variety of tasks required to perform the activity.

Dynamic capabilities, as defined by Teece *et al.* (1997), do not involve production of a good or provision of a marketable service. Instead, as noted above, dynamic capabilities build, integrate, or reconfigure operational capabilities. Dynamic capabilities do not directly affect output for the firm in which they reside,[2] but indirectly contribute to the output of the firm through an impact on operational capabilities. Zollo and Winter (2002) also note that, like operational capabilities, dynamic capabilities consist of routines. For example, a dynamic capability such as post-acquisition integration is composed of a set of routines that integrates the resources and capabilities of the merged firms (Zollo, 1998; Capron and Mitchell, 1998).

The concept of a capability as a set of routines implies that in order for the performance of an activity to constitute a capability, the capability must have reached some threshold level of practiced or routine activity. At a minimum, in order for something to qualify as a capability, it must work in a reliable manner. Taking a first cut at an activity does not constitute a capability.

Simply because a capability may have reached a threshold level of reliability, however, does not imply that the capability has attained the highest possible level of functionality. Organizations may differ in the efficiency or effectiveness of a particular type of capability. To say that an organization has a capability means only that it has reached some minimum level of functionality that permits repeated, reliable performance of an activity. Some versions of a capability are better than others. For example, among the mass automobile producers, Toyota manufactures better cars. In retailing, Wal-Mart has superior logistics. Even though other companies have copied aspects of Toyota's and Wal-Mart's capabilities, we know that Toyota and Wal-Mart remain superior.

Capabilities, whether operational or dynamic, include two sorts of routines: those to perform individual tasks and those that coordinate the individual tasks. The need to coordinate tasks implies that a capability involves coordinated effort by individuals—teams, in other words. Therefore, the capability lifecycle depicts the evolution of an organizational capability that resides within a team.

[2] Note that some firms may sell services that build, reconfigure, or integrate resources and capabilities of the purchasers. Examples include consulting firms that provide organizational development and change management services. The firms that sell these services, however, have their own operational capabilities that underlie the sale of these services.

THE CAPABILITY LIFECYCLE: OVERVIEW

The capability lifecycle depicts a general pattern and set of possible paths that characterize the evolution of an organizational capability. The framework is sufficiently general to incorporate the emergence, development, and progression of virtually any type of capability in any type of organizational setting, ranging from small start-ups to large diversified firms. The capability lifecycle also applies to the development paths of capabilities that reach across firm boundaries, such as those involving strategic alliances or supply chains.[3]

A framework of this generality cannot explain the details of how any one capability will evolve in a particular setting. Instead, the capability lifecycle provides an outline of the main features of capability evolution that can serve to guide future research, much as the product lifecycle helped to structure thinking regarding the evolution of products and markets (Kotler, 1980; Grant, 2002; Klepper, 1997). To accommodate this level of generality, we present a stylized analysis that focuses on the overall pattern of the capability lifecycle. This analysis provides a frame within which subsequent research can examine the processes that shape the CLC in greater detail.

The analysis begins with the simplest possible case of a new-to-the-world organization that has no relevant organizational pre-history that might influence capability development. The analysis initially focuses on an organization seeking to supply a single product and geographic market. Wal-Mart's establishment as a discount store retailer in Bentonville, Arkansas, provides one example of such a new-to-the-world organization serving a single geographic market (within driving distance of Bentonville) and supplying essentially a single 'product' (retail sale of discounted consumer products). While many organizational capabilities do not emerge in such stark circumstances, analysis of the simplest case provides the critical historical path necessary for understanding the subsequent evolution of a capability.

The capability lifecycle includes several stages. The lifecycle of a new capability in a new-to-the-world organization begins with the *founding stage*, which lays the basis for subsequent development of the capability. A *development stage* follows this initial stage, marked by gradual building of the capability. Eventually, capability building ceases and the capability reaches the *maturity stage*.

Once the capability reaches the maturity stage, or even before then, a variety of events may influence the future evolution of the capability. The capability then may branch into one of at least six additional stages of the capability lifecycle: *retirement (death), retrenchment, renewal, replication, redeployment*, and *recombination*. These six stages may follow one another in a variety of possible patterns over time. Some of these branching stages also may take place simultaneously. Importantly, in each branch of the capability lifecycle, historical antecedents in the form of capability evolution prior to branching influence the subsequent evolution of the capability.

STAGES OF AN INITIAL CAPABILITY LIFECYCLE

The founding stage

The lifecycle of a capability begins with the founding stage. In this stylized example, the founding stage begins when a group of individuals organizes around an objective requiring or centrally involving the creation of a capability. The founding stage has two general requirements: (1) an organized group or team, having some type of leadership and capable of joint action; (2) a central objective, the achievement of which entails the creation of a new capability. Though new to the organization, the capability need not be new to the world.

Although our stylized analysis characterizes the founding stage as devoid of organizational and capability pre-history, this does not imply a blank slate (Helfat and Lieberman, 2002). The newly formed team begins with a set of endowments (Levinthal and Myatt, 1994). For example, each of the individuals in the founding team has human capital (knowledge, skills, and experience), social capital (social ties within and outside of the team), and cognition (see Adner and Helfat, 2003). Moreover, as a group these individuals may possess team-specific human capital if they have worked together previously in another setting (Bainbridge, 2002). Team members may have complementary abilities or they may interact in

[3] The partnership formed by Intel and Sharp for the explicit purpose of creating mutual capabilities in flash memories presents an example of this (Collis and Noda, 1993).

ways that detract from the functioning of the team. In addition, teams with a history of interaction may have pre-existing routines for interaction.

Among the team members, particular individuals may play a key role. Even at the outset, self-organization requires some leadership and mechanisms to govern the team. This type of endowment may derive from the characteristics of the team leader. In addition, the decisions of the team leader going forward affect the capability development path.

Finally, a new team requires other inputs and resources besides those of the team members in order to build capabilities. For a new team without prior history, however, access to some resources such as financing or new technology may depend on the ability of individual team members to obtain these resources (Burton, Sorensen, and Beckman, 2002). Thus, the social capital and external ties that individual team members bring with them may constitute important endowments of the founding team.

An interesting historical example illustrates many of the foregoing points (Goranson, 1999).[4] In the whaling industry centered in New England during the 1800s, a whaling expedition to the Pacific and Indian oceans required financial partners, a crew including skilled craftsmen, and a captain. For each new expedition, a ship's owner configured a new set of these individuals from a base of local people. The external ties and social capital of the ship owner, the financial partners, and the skilled craftsmen provided access to key skills and resources needed for the expedition. In addition, the individuals involved in each expedition had skills and human capital that complemented one another. The individuals also were used to interacting in a similar sort of team for a similar purpose. As the leader of the voyage itself, the captain held particular importance as the organizer who could help meld the capabilities of individuals into an organizational capability that involved transporting a versatile team to an area quickly to work as a unit. The captain also played a pivotal role as the person able to understand prior captains' logs, which contained valuable information regarding whale locations halfway around the world.

[4] We thank Dick Rumelt for directing us to this example.

As just described, the endowments present at founding set the stage for further capability development by preconditioning the emergence of a capability. The endowments at founding also provide initial sources of heterogeneity among capabilities. This heterogeneity occurs in the attributes of the individuals, the teams, their leadership, and the available inputs.[5]

The development stage

The development stage begins after the team has organized itself around the objective of developing a particular capability. During this stage, the capability develops through search by the team for viable alternatives for capability development, combined with accumulation of experience over time. In this context, an alternative is 'an *ex ante* plausible way of *attempting* to accomplish the end result at which a capability aims' (Winter, 2000: 984). Alternatives may differ in the types of inputs, the nature of the tasks needed to perform the activity, the sorts of coordination required among the various tasks, and the intended scale of output or activity. Some alternatives may involve somewhat codified routines and capabilities and other alternatives may involve tacit and perhaps new-to-the-world processes.

The choice of which alternatives to pursue will depend on the conditions at founding. Teams that have the same objective may choose different alternatives if the teams have different initial configurations of human capital, social capital, and cognition. For example, a team comprised of individuals with a predisposition to adopt new technologies early may choose to develop a new-to-the-world technology, whereas a team comprised of risk-averse individuals may choose a more established approach. Or a team of individuals with mathematical training may choose a mechanical or engineering-based production process, whereas a team of artists may choose a more craft-based approach.

In pursuing its initial alternatives, a team may elect to imitate a capability that exists in another organization or the team may develop a capability from scratch. Both cases require organizational

[5] Environmental conditions also may lead to heterogeneity of capabilities at the founding stage. We abstract from this source of heterogeneity in order to focus on the internal development of capabilities.

learning, since the team has never performed the activity before. More generally, capability development entails improvement over time in carrying out the activity as a team. As we argue next, these improvements are likely to stem from a number of factors, including but not limited to learning-by-doing.

Most research on organizational learning has focused on learning-by-doing. Relatively little empirical research, however, has confirmed or refuted the many theories of organizational learning, both in general and with regard to the development of organizational capabilities in particular. (See also the discussion in Huber, 1991, and Nelson and Winter, 2002.) Much of the empirical research that has implications for organizational (as opposed to individual) learning derives from statistical estimates of the experience curve in organizations. Therefore, we use these studies to draw implications for capability development.

Studies have documented sustained productivity improvements over time, especially for manufactured products in early stages of production (for a review, see Argote, 1999). These studies frequently invoke learning-by-doing as the likely explanation for the productivity improvements. Research that examines the underlying sources of productivity improvement, however, shows that factors not associated with organizational level learning-by-doing can explain a substantial portion of the productivity increases in particular industries and firms. These factors include worker–management relations and individual worker experience (Lazonick and Brush, 1985), improvements in operations management and task coordination (Mishina, 1999), capital investment (Thompson, 2001), and research and development on manufacturing processes (Sinclair, Klepper, and Cohen, 2000). In addition to these various factors, some direct but more limited evidence points to learning-by-doing by a team. Cohen and Bacdayan (1994) found that two-person teams of card players improved their ability to configure the cards in a specified manner as they repeatedly played the game.

Putting the foregoing evidence together leads to the following conjecture regarding the development of a new capability. Improvements in the functioning of a capability derive from a complex set of factors that include learning-by-doing of individual team members and of the team as a whole, deliberate attempts at process improvement and problem-solving, as well as investment over time. Moreover, development of a new capability may proceed via an iterative process, where 'online' trials of techniques alternate with additional search for alternatives, as the team reflects on what it has learned from the trials (Winter, 2000; Edmondson, Bohmer, and Pisano, 2001). This process may not proceed smoothly. Initial alternatives may prove fruitless. Feedback from trials may be ambiguous. Coordination between tasks may prove complicated. Nevertheless, the basic path of capability development reflects a process of capability improvement, though perhaps somewhat fitful.

At some point capability development ceases and the capability enters the maturity stage of its lifecycle. Almost all estimates of the experience curve suggest that the curve eventually becomes flat as gains to experience taper off and finally cease. Capability development may end simply because capabilities may have inherent limits to what any team could achieve with available technologies, inputs, workers, and state of managerial practice. Teams also may satisfice and cease capability development at some level of skillfulness which the team perceives as good enough (Winter, 2000). The team leaders (managers) may make the final decision to cease capability development.

The analysis thus far contains a built-in heterogeneity between teams pursuing the same objective in the extent of capability development that they achieve. As noted earlier, teams may choose different alternatives that put them on different trajectories for capability development and therefore lead to different end points. Additionally, even when teams choose the same alternatives, they may meet with greater or less success. Differences in the human capital, social capital, and cognition of team members may affect the abilities of teams to perform various tasks and to learn from experience.

Teams that choose the same alternatives also may differ in the extent of capability development if they satisfice and cease capability improvement at different levels of skillfulness prior to reaching the full technical limits of capability development. Differences between teams in the cognitive attributes of their members, for example, may lead to differences in satisficing choices. Clearly, the external environment places limits on heterogeneity between teams in the extent to which they satisfice when ceasing capability development. At the very least, a team must cover its costs in order to survive in the marketplace. But the market may

allow higher-cost or lower-quality firms to survive at lower levels of profitability than firms that have superior capabilities. Additionally, in some environments, firms may be able to compensate for lower skillfulness in one capability (e.g., manufacturing) with greater skillfulness in another capability (e.g., marketing) (see Peteraf and Bergen, 2003).

The heterogeneity just described reflects a strongly path-dependent process of capability evolution. Capability development depends on the prior experience that the team brings with it, on the initial path chosen, on the success of the initial alternative, on new alternatives that appear reasonable based on the initial development path (reflecting local search), and on choices made within the limited set of alternatives. As a result, the specific pattern of the capability lifecycle through the development stage, such as length of time prior to maturity and extent of capability development reached, will differ from team to team.

The maturity stage

The maturity stage entails capability maintenance. This involves exercising the capability, which refreshes the organizational memory. If exercised regularly, the capability becomes more deeply embedded in the memory structure of the organization. Routines may become more habitual, requiring less and less conscious thought. Over time, the ability of the team to recall the development path may fade and the capability may become more tacit in nature.

This shift to reliance on 'softer' forms of organizational memory does not imply any change in the level of capability. Evidence from experience curves shows that under conditions of continuous production, productivity declines do not set in (Thompson, 2002). Interruptions in production, however, do lead to organizational forgetting and declines in productivity (Thompson, 2002). By implication, how well the capability is maintained depends on how often and how consistently the team exercises the capability.

The initial capability lifecycle from founding to maturity

Figure 1 depicts the general form of the initial capability lifecycle from founding to maturity. The horizontal axis represents the cumulative amount of activity toward which the capability is directed and the vertical axis represents the 'level' of capability per unit of activity. To simplify the exposition, a unit of activity corresponds to a particular scale of activity, such as manufacturing a certain number of cars or performing a certain number of post-acquisition integrations.

The level of capability on the vertical axis reflects the overall skillfulness of the team in executing the particular activity. A capability can be characterized along multiple dimensions of skillfulness. As noted earlier, capabilities consist of multiple routines for individual tasks and for task coordination. Figure 1 collapses the many attributes of a capability into one dimension in order to convey the idea that some versions of a capability are simply better than others. This approach does not preclude the possibility that some versions of a capability with different constellations of attributes may have the same overall level of capability.

For the founding and development stages, the nature of the capability lifecycle makes it difficult to specify the transition point from one stage to the next with precision. The founding stage could occur solely at the starting point of the graph or it could occupy the first part of the graph. Huber (1991), for example, describes a form of 'congenital learning' that involves the gathering and inventorying of knowledge that conditions further learning. Thus, Figure 1 does not delineate an exact point of transition between founding and development. The figure also depicts the maturity stage as a straight line, consistent with a steady-state level of capability maintenance at a roughly similar level of task performance over time.

Figure 1 depicts the shape of the capability development path as one similar to an experience

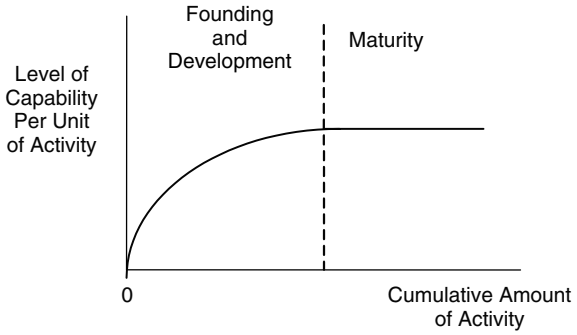

Figure 1. Stages of the initial capability lifecycle

curve, based on the evidence discussed earlier. The exact shape of the curve might differ from this. For example, the curve might take the shape of an 'S', reflecting increasing and then diminishing returns to learning through time. Short of definitive empirical evidence regarding the exact shape of the capability lifecycle during the founding and development stages, however, we rely on the experience curve as a reasonable starting point.

Capability transformation and dynamic capabilities

The initial capability lifecycle indicates the potential for development of a capability over time. Not all capabilities may reach the maturity stage if selection events external to the capability intervene. Selection events may affect the evolutionary path of capabilities in the maturity stage as well. The next portion of the analysis examines how various selection events lead to the branching of the capability lifecycle along several possible paths.

Most branches of the capability lifecycle analyzed next deal with some form of transformation of the original capability. Heretofore, conceptual analyses of the process by which capabilities change over time have often relied on the idea that dynamic capabilities must act upon other (operational) capabilities in order to change them. The following analysis explains, where possible, which branches of the capability lifecycle may proceed more smoothly if the organization also has dynamic capabilities to facilitate the transformation.

It is important to bear in mind, however, that capability building and change do not require dynamic capabilities, either in the initial lifecycle or in subsequent branching. In the preceding analysis of a new capability in a new-to-the-world organization, dynamic capabilities do not enter as a factor determining the evolutionary path. Indeed, they cannot, since a new organization has no dynamic capabilities. In the founding and development stages of the capability lifecycle, a capability (including a dynamic one) evolves and changes over time without the action of any dynamic capabilities upon it. Moreover, the entire capability lifecycle applies to dynamic as well as operational capabilities. Dynamic capabilities follow the same general pattern of founding, development, and maturity, and may branch in new directions as well.

In what follows, to reflect the expanded scope of the analysis, the term 'organization' replaces 'team.' An organization also may have more than one capability, each of which has entered at least the development stage of the lifecycle, but none of which has reached a branching stage. The inclusion of more than one capability enables the analysis to incorporate the interaction among capabilities, dynamic or otherwise, that may occur as capabilities and firms evolve over time.

BRANCHING AND CAPABILITY TRANSFORMATION

Capability branching occurs when factors external to the capability have a strong enough impact to alter the current development trajectory of the capability. These factors may derive from within or outside of the organization in which the capability resides, termed the 'internal' and 'external' selection environment, respectively. Important factors in the internal selection environment include managerial decisions. Factors in the external selection environment include changes in demand, science and technology, availability of raw materials, and government policy.

The impact on organizations of many external selection effects depends on internal firm reactions, especially of managers. For example, while a large increase in input prices may create large losses for the firm, managers still must make choices about how to react. The choices include whether to declare bankruptcy, sell the firm, make cost-reducing investments, or borrow money and see if input prices fall in the future. As an example, consider the impact of fuel oil prices on airline companies. The cost of fuel oil has a major impact on airline profitability. When faced with rising oil prices, airline company executives have used a variety of approaches. These have included carrying less reserve fuel on board planes to reduce weight and fuel consumption, reducing other costs such as wages, buying new, more fuel-efficient planes, merging with another airline, extending lines of credit, and declaring bankruptcy. Unless the external selection environment is so constraining that it limits managers to only one possible option, different managers in different firms may make different choices (Adner and Helfat, 2003; Peteraf and Reed, 2003).

In contrast to external selection effects, internal selection effects stem primarily from within the organization. For example, managers may see an opportunity to diversify into another market as the organization becomes more efficient over time, even when no change has occurred in the external environment.

Some selection effects may reinforce the current trajectory of a capability along its lifecycle rather than lead to branching. For example, an increase in demand during the development stage of the lifecycle provides a further inducement for an organization to continue developing the particular capability to meet this demand. Other selection effects, however, may shift the trajectory of a capability lifecycle, as next explained.

Lifecycle branches: six Rs of capability transformation

Figure 2 depicts six branches of the capability lifecycle. While these may not represent all possible branches, they include a large range of capability transformations that correspond to many regularities identified in large-sample and case study empirical analyses of business strategies. Not all capabilities have access to all of the branches. Instead, the branches represent a general set of potential paths, the choice of which depends in part on the particular capability and its stage of development. Although branching may occur during the development stage of the capability lifecycle, in order to simplify the exposition the following analysis of branching deals with a capability that has reached the maturity stage and has exhausted the technical limits of development.[6] Figure 2 provides one example of the potential branches in this situation. The exact shape and placement of these branches for any particular capability may differ from that in Figure 2.

The branches of the capability lifecycle are as follows: retirement (death), retrenchment, renewal, replication, redeployment, and recombination. These branches—the six Rs of capability transformation[7]—occur when a selection event intervenes, as shown in Figure 2. The figure also depicts the renewal, redeployment, and recombination branches using the same curve, because the three stages

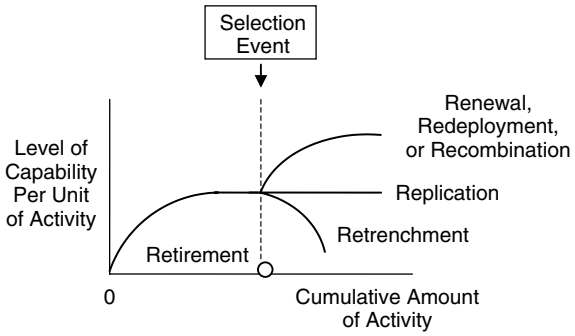

Figure 2. Branches of the capability lifecycle

have a similar trajectory even though the underlying mechanisms differ.

The branches of the capability lifecycle reflect the impact of two sorts of selection effects: those that threaten to make a capability obsolete, and those that provide new opportunities for capability growth or change. All six branches of the capability lifecycle may pertain to threats to a capability. New opportunities, however, generally do not involve retirement or retrenchment of a capability. In addition, the branches of replication and redeployment (and often recombination) involve transfer of the capability to a different market. Presumably such transfer has a cost. As a first approximation, we consider the cost as fixed rather than as affecting the level of capability. Due to this cost, the firm will not transfer the capability to another market unless faced with new opportunities or threats.

Capability threats

First consider threats to a capability. Some extreme situations may force a firm to *retire* a capability entirely, meaning that the capability dies. If the government prohibits sale of a chemical (e.g., DDT) that a firm produces, the managers of the firm may shut down its plant and retire the capabilities that go with it. In a less severe situation, such as when demand for a product falls, a firm may be able to curtail output and still make a profit. Empirical evidence suggests that interruptions in production lead to declines in productivity (Thompson, 2002). By analogy, we might expect that reduced utilization of a capability would degrade the level of capability. Figure 2 depicts *retrenchment* as a gradual decline in the level of capability, but in

[6] In order to branch during the development stage, the performance of an activity must qualify as a capability in the sense that it has reached at least a minimum threshold of functionality.

[7] We tip our hat to Sid Winter (1996) and the 4 Rs of profitability.

some cases retrenchment might proceed in discrete steps.

As alternatives to capability retrenchment or retirement, a firm might attempt to improve or *renew* the capability in some way. Winter (2000) notes that a crisis may raise aspirations and motivate the organization to improve the level of capability. For example, if faced with a sharp rise in input prices, a firm may search for ways to improve the capability in order to raise efficiency.[8] Renewal of a capability involves a new development stage as the firm searches for and develops new alternatives. Capability renewal may involve major as well as minor modifications to a capability. In Figure 2, the renewal of the capability lifecycle begins at the same (or lower) level of capability than in the previous stage.

In some situations, firms can also respond to a threat to a capability in one market by transferring the capability to another market. Such a transfer does not make economic sense unless the benefits of transfer exceed the costs. If this condition holds, the capability may branch to replication or redeployment. To return to the example of restrictions on chemical production, instead of retiring the capability, the managers of a firm may respond by transferring the capability to a different country with different governmental rules. Such *replication* of a capability entails reproducing the same capability in another geographic market (Winter and Szulanski, 2001).

Figure 2 depicts replication as a straight line, representative of the ideal of highly accurate replication with no drop in the level of a capability. Barriers to replication are often high, however (Szulanski, 1996). Less complete replication may involve an initial drop in the functioning of the capability, followed by additional development to raise the level of capability back to its pre-replication level. In addition, firms may replicate only a portion of a capability.

As an alternative to replication, a firm may seek to *redeploy* its capability to a different product-market. Unlike replication, which applies to a different geographic market for the same product or service, redeployment involves a market for a different but closely related product or service.[9] This sort of transfer often requires some alteration of the capability in order to serve the new market, and therefore some additional development of the capability in new directions (Helfat and Raubitschek, 2000). The capability therefore would enter a new development stage as part of redeployment.

Capability redeployment may take one of two forms. The first involves the sharing of a capability between the old and the new market. Many instances of related diversification fall into this category. For example, faced with difficult economic conditions in the steel industry, U.S. Steel purchased Marathon Oil. U.S. Steel had capabilities in complex manufacturing and sale of commodity products that it could apply in the more profitable oil industry. A second form of redeployment involves intertemporal transfer of capabilities from one market to another, where a firm exits a market (often a declining one) and redeploys the capabilities in a new market (Helfat and Eisenhardt, 2002). To return to the whaling example, when demand for sperm oil plummeted after the first drilling of petroleum in Pennsylvania in 1859, the whaling teams shifted their activities. They adapted their processes and plans in order to move from hunting sperm whales in tropical waters to hunting baleen whales in the Arctic. This also involved a product-market shift from whale oil to whale teeth used in products such as corsets, buggy coaches, and umbrellas (Goranson, 1999).

When transferring a capability to serve a different but related market, rather than replicate or redeploy the existing capability, the firm may *recombine* the original capability with another capability. In addition, the recombination of capabilities can provide an alternate approach to capability renewal in the current product-market. This idea of capability recombination draws on the concept of knowledge recombination in innovation (Kogut and Zander, 1992). For example, a firm may combine a capability in using information technology with an existing manufacturing capability in order to improve its level of manufacturing capability. As this example suggests, recombination

[8] Winter's (2000) analysis uses a satisficing framework in which firms do not necessarily operate at the lowest possible production cost.

[9] Clearly, how narrowly or broadly one defines a capability in terms of the type of activity (e.g., producing any type of motorized vehicle vs. producing a luxury car) will affect whether the transfer to another market constitutes replication or redeployment. The main point is that both sorts of branches are possible. This applies to dynamic capabilities as well. Many dynamic capabilities such as new product development, process R&D, and even post-acquisition integration are tailored to a particular product-market and require alteration in order to be applied in another product-market.

requires additional development of the capabilities and a new trajectory for the capability lifecycle. In Figure 2, recombination or redeployment of a capability involves a new development stage that begins at or below the previous level of capability.

Capability opportunities

Thus far, the analysis has focused on threats to capabilities. In addition, new opportunities may arise. Many of the branches in Figure 2 provide options for the firm to respond to opportunities. The branch (or branches) that the firm pursues will tend to depend on the nature of the opportunity. The whalers in the middle 1800s provide yet another example, in this case, of intertemporal redeployment in response to market opportunity. Attracted by the California Gold Rush, some whaling teams became teams of gold miners. This switch exploited an organizational capability to form and transport versatile teams to an area quickly (Goranson, 1999).

In addition to redeployment, firms may use renewal or replication to respond to opportunities. For example, a technological innovation that raises the technical limits to development of a capability may cause a firm to enter the renewal stage of the lifecycle. The opportunity to enter a different geographic market, perhaps due to the lifting of prior governmental restrictions on entry, may cause the firm to replicate an existing capability in that market.

In the preceding examples, new opportunities arise from factors external to the firm. Other opportunities for capability branching may stem from internal factors. The productivity improvements documented by the experience curve may produce slack capabilities, particularly for indivisible ones such as management. The firm therefore may search for additional markets in which to redeploy or recombine the unused portion of the capability (Penrose, 1995).

Even without slack resources, a firm may choose to replicate or redeploy or recombine an existing capability in another market if this would increase revenues from the prior investment in capability development. Wal-Mart, for example, has reaped consistently high profits by systematically expanding into new geographic markets based on a strategy of capability and resource replication. This replication includes a logistics capability that involves standardized procedures for warehouse handling and inventory management, in combination with standardized resource configurations that cluster stores around company distribution centers.

Dynamic capabilities

The analysis of capability branching applies to dynamic and operational capabilities alike. For example, a dynamic capability in the form of research and development may enter the renewal stage as new techniques for conducting R&D become available. A firm also may redeploy an R&D capability from one market to another market that requires a similar knowledge base when conducting R&D. In the U.S. oil industry, many petroleum companies undertook R&D on synthetic fuels because it allowed them to redeploy an R&D capability in oil refining, which utilized similar processing technologies (Helfat, 1997). Firms also can replicate or recombine dynamic capabilities, which may face retrenchment or retirement as well.

The analysis thus far of capability branching and transformation contains no special role for dynamic capabilities in the transformation process. Instead, the branches reflect the same sort of capability development process as in the founding, development, and maturity stages of the initial portions of the capability lifecycle. Some branches of the capability lifecycle, however, may benefit from the action of certain dynamic capabilities in some instances.

Acquisitions provide one example where a dynamic capability in the form of post-acquisition integration can aid capability branching. Replication may proceed by acquisition, where the acquirer replicates its capability within the acquired company, often replacing a prior capability of the acquired company (Szulanski, 2000; Baum *et al.*, 2001). Acquiring companies frequently redeploy and recombine their capabilities with those of target firms as well (Capron and Mitchell, 1998). A well-developed capability for post-acquisition integration may smooth the replication, redeployment, and recombination processes (Zollo, 1998). Companies that diversify using internal growth rather than acquisition also may have developed dynamic capabilities for redeploying existing capabilities in additional markets. Such 'redeployment capabilities' can make the redeployment branching process proceed more quickly and effectively for the

capabilities upon which the redeployment capabilities act.

This idea that dynamic capabilities can facilitate the branching of other capabilities, while informative, has clear limits. One type of dynamic capability (e.g., a redeployment capability) may act upon another type of dynamic capability (e.g., an R&D capability), but a dynamic capability generally cannot act upon itself to transform itself. Furthermore, capabilities can develop and branch along the lifecycle without the action of dynamic capabilities.

Sequencing of branches and capability survival

As a capability evolves, a capability may go through several different branching stages. For example, Maritan and Brush (2003) show that accurate *replication* of a portion of a manufacturing process to another plant within a firm provided the basis for subsequent adaptation and *renewal* of the capability within the recipient plant. Szulanski *et al*. (2002) find that completely accurate replication of a capability followed by adaptation to local conditions results in better performance than adaptation prior to attempted replication.

A firm also may redeploy or recombine a capability and then replicate it. Nucor's entry into thin-slab casting provides an example of this (Ghemawat and Stander, 1993). Moreover, a firm may renew and then redeploy, recombine, or replicate a capability. Redeployment may also follow retrenchment if a firm finds new uses for a capability before it becomes necessary to retire it. Furthermore, retrenchment may contain the seeds of renewal if the same events that cause the initial retrenchment also raise aspirations to renew the capability (see Winter, 2000). In addition, a firm may simultaneously pursue two branches, such as replication of a capability in a different geographic market and redeployment in a different product market.

Three of the branches—renewal, redeployment, and recombination—may lead to substantial alteration in the original capability. If a capability undergoes multiple episodes of branching along different renewal, redeployment, and recombination paths, a capability theoretically could end up far removed from its origin.

The capability lifecycle also contains the implication that capabilities can live on and branch even when the firm in which they originated ceases to exist as a legal entity (Winter, 1990). Acquisition of a company in which a capability resides does not imply that the acquiring firm necessarily retires the capability. To the contrary, one firm often acquires another in order to gain access to, and sometimes to transform, the capabilities of the acquired firm (Capron and Mitchell, 1998). In some industries such as nursing homes (Banaszak-Holl, 1995) and airlines, firm deaths often occur as a result of acquisitions rather than bankruptcy. Even in the event of bankruptcy, firms frequently reorganize. Many of the capabilities survive, perhaps branching along the retrenchment path.

Like death of a firm, death of a product does not necessarily spell the death of a capability. Consider Intel's introduction of a new generation of microprocessors every few years. When Intel introduces a new chip with faster processing speed and other improvements, demand for the prior generation chip tends to dry up. Intel does not, however, retire its manufacturing capability simply because demand for the old chip falls sharply. Instead, Intel redeploys its manufacturing capability in order to produce the new microprocessor.

Death of an industry, like death of a product or firm, need not result in capability death. Firms may combine exit from one product-market with entry into another via capability redeployment or recombination, thus obtaining intertemporal economies of scope (Helfat and Eisenhardt, 2002). More generally, analysis of firm births and deaths, industry evolution, and product lifecycles without reference to capability evolution may provide misleading inferences regarding a host of factors, including market entry and exit, firm scale and scope, as well as firm and industry survival, success, and failure.

CONCLUSION

The capability lifecycle provides a foundational framework for the dynamic resource-based view of the firm. By definition, the dynamic RBV deals with resources and capabilities over time. The dynamic RBV therefore must include, as one of its prime components, an understanding of the evolution of resources and capabilities. Otherwise, the dynamic resource-based view cannot go on to effectively answer questions about competitive advantage and disadvantage over time based on capabilities and resources.

The capability lifecycle identifies three initial stages of a capability lifecycle—founding, development, maturity—followed by possible branching into six additional stages. These branches, the six Rs of capability transformation, reflect the reality that the lifecycles of capabilities may extend beyond that of the firms and industries in which they originated, and beyond the products to which they originally applied. The entire capability lifecycle also provides an explanation for the emergence and sustained heterogeneity of capabilities. By implication, the capability lifecycle helps to explain the sources of heterogeneity for the firms in which the capabilities reside.

In providing a foundation for future research, the capability lifecycle suggests a number of promising directions. More empirical research regarding each of the stages of the capability lifecycle is high on the research agenda. Capabilities are not products or firms or industries, and the evolution of capabilities must be investigated as a separate empirical undertaking.

The evolution of organizational resources, from both an analytical and an empirical perspective, merits additional research as well. Like the evolution of capabilities, the evolution of organizational resources is a key component of the dynamic RBV. A more complete understanding of the joint evolution of resources and capabilities also merits further research. Only then we can more fully understand evolution and change of competitive advantage and disadvantage of firms over time.

ACKNOWLEDGEMENTS

This paper benefited greatly from discussions with and comments of Sid Winter, Ron Adner, Jerker Denrell, David Hoopes, Tammy Madsen, Steve Postrel, Dick Rumelt, Peter Thompson, and participants at the SMU conference on the resource-based view. Summer support from the Tuck School of Business is gratefully acknowledged.

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