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Reconciling the resource-based and competitive positioning perspectives on manufacturing flexibility

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Abstract

Purpose – The purpose of this paper is to reconcile two different perspectives on manufacturing flexibility found in the operations management literature.

Design/methodology/approach – Conceptual in nature, the paper examines manufacturing flexibility from the perspective of the resource-based view of the firm as a complement to the competitive positioning view of strategic management. It draws upon both these views to better understand the role of manufacturing flexibility in firms.

Findings – The paper emphasizes the proactive use of manufacturing flexibility, as a means to create opportunities, in addition to its reactive use in response to environmental uncertainties. The integration of the resource-based and competitive positioning views has implications for researchers in explaining inter-firm performance differences and for practitioners in incorporating the role of manufacturing flexibility in their strategic thinking.

Research limitations/implications – The integration of these two theories should be empirically tested to provide a better understanding of the conditions under which alternative use is more critical in explaining a firm's success.

Practical implications – Manufacturing has been traditionally viewed as a reactive tool to adjust to environmental uncertainties. The paper argues that this approach is too narrow and emphasizes the proactive role of manufacturing flexibility as a competitive weapon in strategy formulation.

Originality/value – The paper suggests that the integration of the resource-based and competitive positioning allows for a more complete picture of the role of manufacturing flexibility in creating a competitive advantage.

Keywords Competitive strategy, Flexible manufacturing systems, Manufacturing resource planning, Organizational performance

Paper type Conceptual paper

Introduction

Traditionally, manufacturing flexibility has been considered a means to react to the uncertainty in a firm's internal operations and external environment. This view of manufacturing flexibility as a reactive tool to environmental uncertainties stems from the widely accepted positioning theory of strategic management, whereby the firm chooses a competitive strategy that is most appropriate given surrounding industry and market conditions (Porter, 1980). In this context, manufacturing flexibility allows the firm to respond to changing market conditions.

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More recently, researchers (Gerwin, 1993; Sanchez, 1995; Chang *et al.*, 2003; Sawhney, 2006) have argued that this view is too limited, and that, by focusing only on the reactive side of manufacturing flexibility, companies may miss important opportunities. They maintain that manufacturing flexibility can also be a proactive tool, a means by which firms can create and sustain a competitive advantage. This change in perception parallels the emergence of the resource-based view (RBV) of the firm in the strategic management literature (Barney, 1991). The resource-based theory emphasizes internal resource use and capability development within the firm as a source of competitive advantage. Many of resources and capabilities on which competitive advantage is based reside in the operations function (Coates and McDermott, 2002). This paradigm shift from a market based to a RBV in strategic management has profound implications for operations strategy, as "it elevates the importance of the operations function" (Hayes and Pisano, 1996, p. 31).

The purpose of this article is to reconcile the divergent views of manufacturing flexibility that have appeared in the operations management literature by providing a context for the ongoing debate over the role of manufacturing flexibility in firms. Described as multi-dimensional, the concept of manufacturing flexibility has remained elusive and fragmented, and few studies have recognized its dual use. We argue that the RBV of the firm, as a complement to Porter's competitive positioning view, can enhance our understanding of manufacturing flexibility and its significance as a strategic weapon. To achieve this, we first draw upon the competitive positioning view of strategic management to explain the emergence of manufacturing flexibility in firms. We then identify shortcomings of the theory, and introduce critical features of the RBV that we rely on to propose a theoretically derived framework that sheds additional light on the elusive concept of manufacturing flexibility, its components, and its effect on competitive advantage. Finally, we conclude with implications for both practitioners and researchers, suggesting avenues for future research that recognize the need for integrating these two theories.

1. Manufacturing flexibility as a reactive tool

a. The competitive view of strategic management

For years, management strategists have strived to understand the factors that influence a firm's success in the marketplace. Among the different theories of strategic management, the dominant paradigm is the competitive view proposed by Porter (1980) in his seminal book *Competitive Strategy*. In this book, Porter's core idea is that "strategy is the act of aligning a company and its environment." Hence, a firm's success is based on both the attractiveness of the industry in which the firm competes and the firm's relative position in that industry. For a firm, the key to success lies in the identification of a profitable industry and, through deliberate actions, its positioning to become a dominant player in that particular industry. Porter identifies five sets of players (i.e. competitors, customers, suppliers, potential entrants, and substitute products), developing the so-called "five forces" framework, to assess the inherent attractiveness of industries. Once an attractive industry is found, a firm must then decide on the ways in which it might enter and/or position itself within this industry to gain a dominant position. After having identified the position to attain given the forces at play, the firm then engages in the activities necessary to fit the requirements of that position.

Early operations strategists espoused Porter's positioning view by asserting that alignment between the external environment and the firm's manufacturing strategy was

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critical to success (Skinner, 1969; Hayes and Wheelwright, 1984). From an operations standpoint, this translated into a set of structural (e.g. physical characteristics) and infrastructural (e.g. operating policies and management practices) decisions that best supported the firm's competitive strategy (Hayes and Pisano, 1996).

It is in this context that the concept of manufacturing flexibility emerged in the 1980s, a decade characterized by dramatic shifts in the competitive landscape. These shifts were due to the increased globalization of markets, further fragmentation of markets into smaller niches, and rapidly changing technologies (Beach *et al.*, 2000). With more non-US firms moving into the US market, product offerings proliferated while the total volume of sales slightly increased (Griffin, 1993)[1]. At the same time, customer preferences were shifting, with customers demanding higher product performance, more customization, and greater responsiveness – all at lower prices. With customer needs changing rapidly toward higher levels of sophistication, product life cycles were shrinking and product obsolescence was occurring more quickly than in the past. Further, diverse and rapidly changing technologies were fundamentally altering the character of the business and the nature of competition. Mass customization emerged in response to customers' requests for a greater variety of high-quality, low-cost goods and services (Pine, 1993). The advent of flexible technologies made the customization of product offerings to fairly narrow customer groups both feasible and economical (Sanchez, 1995; Sanderson and Uzumeri, 1995; Schilling and Hill, 1998)[2].

Recently, as consumers' tastes grow more complex and competition continues to intensify, firms are under pressure to meet these market-driven imperatives in a time- and cost-effective manner, and they are more concerned than ever before about the flexibility of their manufacturing processes. As Slack (2005, p. 1201) summarized, "flexibility has come to occupy a central position in how operations can be strategically developed to play an effective part in achieving competitive advantage."

b. The reactive use of flexibility

The reactive use of manufacturing flexibility has been the topic of numerous articles over the years, including several comprehensive reviews (Gupta and Goyal, 1989; Sethi and Sethi, 1990; De Toni and Tonchia, 1998; Koste and Malhotra, 1999; Beach *et al.*, 2000; D'Souza and Williams, 2000; Vokurka and O'Leary-Kelly, 2000). Rather than provide another review of the manufacturing flexibility literature, this paper attempts to reconcile the divergent views of manufacturing flexibility within their appropriate strategic management contexts.

In this view, definitions focus on manufacturing flexibility as a reaction to a range of environmental uncertainties. For instance, Cox (1989) defines it as "the quickness and ease with which plants can respond to market conditions." Similarly, for Gupta and Goyal (1989), manufacturing flexibility is "the ability of a manufacturing system to cope with changing circumstances or instability caused by the environment," and Sethi and Sethi (1990) refer to a system's flexibility as "its adaptability to a wide range of possible environments that it may encounter." More recently, Vokurka and O'Leary-Kelly (2000) define manufacturing flexibility as "the ability of firms to respond to changes in their customers' needs, as well as unanticipated changes stemming from competitive pressures." Finally, for D'Souza and Williams (2000), it refers to "the ability of the manufacturing function to make adjustments needed to react to environmental changes without significant sacrifices to firm performance."

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As is evident, there are strong similarities among these definitions, for they are all based on the premise that the firm develops flexibility to cope with the uncertainties of the environment in which it operates. The sources of these uncertainties can be both internal and external to the firm. Internal disturbances include, among others, machine/equipment breakdowns, workforce absenteeism, variability in task times, queuing delays, and variations in output quality (D'Souza, 2002; Sawhney, 2006). Most uncertainties originate, however, from external forces. Changes in demand (e.g. product/service mix and volume), changes in supply (e.g. availability of quality resources), and introduction of new initiatives (e.g. new process technologies, new product introductions, and new managerial approaches) typically arise from competitors' actions, changing consumer preferences, technological innovations, new laws and regulations, or combinations of any of these aforementioned factors (Kara and Kayis, 2004; Beckman, 1990). While there exist various ways in which a firm confronts environmental uncertainty (e.g. long-term contracts with suppliers, promotions and incentives for customers, finished goods inventory), the focus in operations management has been on the development of flexible processes by firms, either through the adoption of flexible technologies, the reduction of setup and cycle times, the implementation of worker cross-training, and/or the development of capacity cushion (Boyle, 2006; Anand and Ward, 2004; Beckman and Rosenfield, 2008).

To summarize the development of manufacturing flexibility as a reactive mechanism in organizations has paralleled the adoption of competitive strategies designed in light of increased environmental uncertainties. Environmental uncertainty influences the firm's strategy, and the level of manufacturing flexibility exhibited supports the competitive strategy pursued by the firm[3]. This finding is supported by earlier empirical work by Swamidass and Newell (1987), which found a positive relationship between environmental uncertainty, manufacturing flexibility, and firm performance. Thus, it is within the context of Porter's positioning view that the concept of manufacturing flexibility, and the emphasis on its reactive use, became prevalent in the operations management literature.

2. Manufacturing flexibility as a proactive tool

Some scholars have recently contended that viewing manufacturing flexibility solely as a reactive mechanism against environmental uncertainty is too narrow an approach (Chang *et al.*, 2003; Sawhney, 2006). These critics have relied on evidence that the competitive positioning view, with its over-emphasis on external industry characteristics, has failed to explain many successes and failures (e.g. Southwest Airlines), as well as observed performance differences between firms. Firms, such as Honda, IBM, Xerox, and GE, have employed the flexibility in their production systems to create and maintain a competitive advantage in "tough" industries. For example, while Honda's line of smaller, fuel-efficient vehicles is critical to its success, it is, however, its superior ability to switch production among different plants and to produce different models efficiently in the same plant that enables it to compete successfully (Linebaugh, 2008). Critics have also argued that the competitive positioning approach is not only too narrowly focused, but also static in nature. It does not allow for the possibility of learning and adaptation over time, nor does it recognize that decisions made by the firm to support a given strategy at one point in time may induce the development of resources and capabilities that could be exploited to compete in different ways later on

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(Hayes *et al.*, 2005). In sum, Porter's theory, static in nature, does not acknowledge that firm decisions might shape the forces of the industry in which a firm competes; instead it takes these forces as given. In this context, manufacturing flexibility can only be a reactive tool. Yet, some companies have shown that the flexibility of their manufacturing processes could be used, not only to respond to environmental uncertainties, but also to change their competitive positions and, in some instances, even transform the nature of their industries (Hayes and Pisano, 1996). It has thus become evident that focusing solely on the reactive side of manufacturing flexibility and ignoring its proactive side can lead firms to miss important opportunities (for themselves) and misjudge competitive threats (from others) in their environment.

a. The proactive use of flexibility

Few studies have investigated the dual use of manufacturing flexibility (Gerwin, 1993; Sawhney, 2006). An early proponent of manufacturing flexibility as a proactive tool, Upton (1994, p. 73) defined flexibility as "the ability to change or react with little penalty in time, effort, cost or performance". This definition introduced a new proactive dimension – the ability to change – in addition to the ability to adapt. The ability to change is, in Upton's view, "the ability to instigate change rather than react to it" (i.e. proactive use), while the ability to react refers to the ability to maintain the status quo (or to continue to perform well) despite changes in the environment (i.e. reactive use) (Upton, 1994).

Similarly, Gerwin (1993) stated that a firm may choose to use flexibility to either "defensively adjust to uncertainty or proactively control it." In other words, a firm can be a "passive reactor to environmental cues," but it can also choose to "seize the initiative and try to bend the environment to its will" (Gerwin, 1993, p. 396). Gerwin (1993) identified four different strategies:

(1) adaptation;

(2) redefinition;

(3) banking; and

(4) reduction.

Adaptation, a defensive approach to adjust to the changing needs of customers, relates to the traditional use of manufacturing flexibility. But, as Gerwin (1993) also points out, flexibility can also be used to redefine uncertainties or be banked for future purposes. Redefinition is the process by which the firm proactively alters market uncertainties to change the competitive landscape. For example, improved performance through superior manufacturing flexibility raises customers' expectations about the industry, thereby creating uncertainties for rivals. Banking, by contrast, refers to the ability to reserve flexibility for future needs. Through banking, a firm can either adapt to unexpected changes in the market or proactively redefine market uncertainties. Finally, reduction is a proactive approach that reduces the need for flexibility. For example, product designs that promote modularity reduce uncertainty in many ways. Similarly, the sharing of information in supply networks, by diminishing the bullwhip effect, reduces the time and cost needed to face market uncertainties (Schmenner and Tatikonda, 2005). Whether manufacturing flexibility is deployed proactively or reactively depends on the situation facing the firm (Gerwin, 1993).

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b. The RBV of the firm

This change in perception of the role of manufacturing flexibility in organizations has paralleled the emergence of the RBV of the firm in strategic management. Building on the seminal work of Penrose (1959), the theory maintains that competitive advantage is grounded within the firm, in its unique resources, that enable it to perform particular tasks effectively. It builds on the assumptions that resources are heterogeneously distributed among firms and that they are imperfectly mobile across firms (Wernerfelt, 1984; Barney, 1991). As a result, differences in firm resource endowments can both exist and endure over time, thereby allowing for differences in performance among firms (Barney, 1991; Peteraf, 1993). To achieve a competitive advantage, these resources must be valuable (i.e. they allow the firm to exploit opportunities or neutralize threats relative to competitors) and rare (i.e. in relatively short supply). For this advantage to be sustainable, the firm's resources must also be imperfectly imitable (i.e. difficult to replicate because of causal ambiguity, social complexity, and/or specific historical circumstances), and non-substitutable (Barney, 1991; Dierickx and Cool, 1989).

As early critics pointed out, resources are not productive by themselves. It is not the "mere possession" of resources, but their exploitation – the effective and innovative utilization of these resources towards clearly defined ends – that creates superior economic value (Mahoney and Pandian, 1992). In addition to simply possessing valuable resources, firms also need to be organized in such a way that these resources can be expressed to their full potential (Barney, 1997). Thus, the capabilities, derived from the firm's ability to coordinate, deploy, and/or reconfigure resources, are crucial in achieving superior performance. This shift from static firm-specific assets to the dynamic process of developing capabilities was further developed by the influential work of Teece *et al.* (1997).

The emergence of this resource-based paradigm has profound implications for operations strategy (Hayes and Pisano, 1996; Lowson, 2003). As Coates and McDermott (2002, p. 437) remark, "many of the resources and capabilities upon which competitive advantages are formed have their basis in the operations area." Anand and Ward (2004, p. 371) further note that:

> [. . .] the success of the Toyota production system and JIT helped bring about a change in the approach to dynamic environments, popularizing the idea of incorporating flexibility in manufacturing systems without sacrificing efficiency. [. . .] As a result, the strategic approach of manufacturing firms has changed, with a new focus on building capabilities to effectively deal with dynamic environments instead of simply trying to avoid uncertainties.

As Hayes and Upton (1998) summarized, the role of the operations function goes beyond just "that of an implementer of strategy." The RBV approach has raised the significance of the operations function, in general, and of manufacturing flexibility, more specifically. The operations function has come to occupy a central position in the firm's quest for a competitive advantage, and manufacturing flexibility is now viewed as an important capability embedded within the operations function (Hayes and Pisano, 1996; Upton, 2005; Coates and McDermott, 2002; Sawhney, 2006; Beckman and Rosenfield, 2008).

Relying on the work by Beckman and Rosenfield (2008, p. 9), we refer to capability in this context as:

> [. . .] the processes, activities, or functions performed within a system that reflect the ability of an organization to perform a coordinated set of tasks, utilizing organizational resources, for the purpose of achieving a particular end result.

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The resource-based logic supports the view of resource use and capability development as dynamic and difficult to imitate: such capabilities are developed through a firm's experience and effort over time and thus cannot be developed quickly or bought off-the-shelf. They are causally ambiguous, as it is not always transparent to competitors what combinations of internal resources and capabilities led to competitive advantage and how these combinations were developed (Hayes and Upton, 1998). Moreover, because these bundles of resources and capabilities were developed within the firm's own organizational structure and are embedded within the firm's idiosyncratic processes and routines, they are not always visible and socially complex (i.e. they involve large number of employees). As a result, competitors have difficulties uncovering them and replicating them within their own organizations, making the firm's operations-based competitive advantage longer lasting.

3. Manufacturing flexibility as a capability within the operations function

Looking at manufacturing flexibility as such a capability through the RBV lens can help, we argue, enhance our understanding of its role as a competitive weapon. Manufacturing flexibility has long been recognized as a complex, multi-dimensional concept, with limited consensus on its constituents, enablers, and measurements. Several researchers have proposed classifications and taxonomies to reflect its dimensions (Browne *et al.*, 1984; Sethi and Sethi, 1990; Koste and Malhotra, 1999; Beach *et al.*, 2000). Unfortunately, these efforts have led to the creation of a plethora of terms with different meanings depending on individual authors' interpretations. Some definitions overlap while some terms are aggregates of others, making it difficult to distinguish between different types of flexibility and difficult to disentangle the interrelationships that exist between them (Sawhney, 2006). As Upton (1994, p. 72) observes, "the term [flexibility] has come to be used for many different purposes." Gerwin (1993, p. 398) insightfully remarks that "most treatments of flexibility assume that it is a multi-dimensional concept, but provide *no theoretical basis* for finding its relevant dimensions (italics added)[4]."

Several authors have recognized the need for different levels of analysis, alluding to a hierarchical structure of the flexibility concept. For example, Browne *et al.* (1984) offer an early discussion of the relationships that exist between flexibility types. Sethi and Sethi (1990), in their extensive review of the flexibility literature, expand on the linkages between the various flexibility types, organizing them into three levels: component (or basic), systems, and aggregate flexibilities. More recently, Koste and Malhotra (1999), based on a review of studies that discuss relationships between flexibility types, propose a more complex cone-shaped structure, describing the lower tier types as more tactical and the higher tier ones as more strategic. These authors typically depict flexibility as moving in one direction from the lowest individual resource level to the highest aggregate level, and with flexibility types at higher levels being supported by flexibility types at lower levels (Sethi and Sethi, 1990; Koste and Malhotra, 1999; De Treville *et al.*, 2007; Sawhney, 2006).

We contend that looking at manufacturing flexibility as a capability through the resource-based lens provides the theoretical foundation that has been lacking in the operations management literature to motivate its hierarchical structure (Gerwin, 1993). More specifically, we rely on four previously defined capability dimensions, which, in the context of the RBV logic, can be thought of as increasingly difficult to imitate,

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to organize flexibility types (Hayes and Upton, 1998; Lowson, 2002; Beckman and Rosenfield, 2008). In addition to its theoretical foundation, our proposed framework expands upon other published frameworks, in that it goes beyond the boundaries of the single firm to include supply chain partners both upstream and downstream. Adopting the definitions provided by Koste and Malhotra (1999) and adapting those by Duclos *et al.* (2003), we categorize, in Table I, commonly accepted flexibility types along the four capability dimensions, each of which we discuss below:

(1) Process-based capabilities relate to the advantage a firm can derive from performing more effectively (typically on cost and quality outcomes) the basic activities involved in transforming inputs, such as materials or information into products and services (Hayes and Upton, 1998; Beckman and Rosenfield, 2008). For example, McDonald's procedures have supported the delivery of low cost, highly consistent fast food throughout the world. Similarly, fidelity investments' state-of-the-art technology has allowed it to record customer transactions quickly and accurately (Hayes and Upton, 1998). In the context of manufacturing flexibility, process-based capabilities are linked to machine flexibility, material handling flexibility, and labor flexibility. The number and variety of operations (or tasks) a machine can perform, the number and variety of operations (or tasks) that a worker can perform, and the number of existing pathways between processing centers and the variety of materials that can be transported along those pathways, without incurring high transition penalties or large changes in performance outcomes, would, at the most basic level, give the firm a competitive advantage. These capabilities are derived from the characteristics of the resources themselves.

(2) Systems (or coordination)-based capabilities are derived from a firm's ability to execute multiple activities and integrate them across the entire operations system to achieve a competitive advantage. This means delivering high-quality customer experiences, short lead times, a broad range of products or services, or customization on demand (Hayes and Upton, 1998; Beckman and Rosenfield, 2008). For example, Allegheny Ludlum Steel Corporation's ability to rethink the steps involved in its steel-making process to efficiently produce small batches of customized products allowed it to emerge as a profitable player at a difficult juncture in this industry (Beckman and Rosenfield, 2008). In this context, system-based capabilities would include routing flexibility, operations (or sequencing) flexibility, volume flexibility, and mix flexibility. The ability to use alternate machines (or machine locations) to perform the processing for a given sequence of operations (due to machine overloads and/or breakdowns), the ability to change the actual sequence of operations performed (made possible because of the product's design), the ability to adjust to changes in aggregate demand levels and individual demand level (within the current production system without considering major setups or facility modifications) require that activities be coordinated and integrated across the firm.

(3) Organization-based capabilities are derived from superior organization-wide skills developed through learning and knowledge management in adopting and mastering new processes, new technologies, and new product designs across the entire organization (Hayes and Upton, 1998; Beckman and Rosenfield, 2008). For example, Boise Cascade's ability to bring its newly built paper plants to be

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Capability dimensions	Flexibility types	Flexibility definition
Process-based	Machine/equipment	The number and heterogeneity (variety) of operations a machine can execute without incurring high transition penalties or large changes in performance outcomes
	Labor	The number and heterogeneity (variety) of tasks/operations a worker can execute without incurring high transition penalties or large changes in performance outcomes
	Material handling	The number of existing paths between processing centers and the heterogeneity (variety) of material which can be transported along those paths without incurring high transition penalties or large changes in performance outcomes
System-based	Routing	The number of products which have alternate routes and the extent of variation among the routes used without incurring high transition penalties or large changes in performance outcomes
	Operation	The number of products which have alternate sequencing plans and the heterogeneity (variety) of the plans used without incurring high transition penalties or large changes in performance outcomes
	Volume	The extent of the change and the degree of fluctuation in aggregate output level which the system can accommodate without incurring high transition penalties or large changes in performance outcomes
	Mix	The number and heterogeneity (variety) of products which can be produced without incurring high transition penalties or large changes in performance outcomes
Organization-based	Expansion	The number and heterogeneity (variety) of expansions which can be accommodated without incurring high transition penalties or large changes in performance outcomes
	New product	The number and heterogeneity (variety) of new products which are introduced into production without incurring high transition penalties or large changes in performance outcomes
	Modification	The number and heterogeneity (variety) of product modifications which are accomplished without incurring high transition penalties or large changes in performance outcomes
Network-based	Supply chain	The ease with which the supply chain (in terms of number and types of relationships) can be reconfigured without incurring high transition penalties or large changes in performance outcomes
	Logistics	The extent of the supply and customer changes that the existing supply chain configuration can accommodate without incurring high transition penalties or large changes in performance outcomes

Table I.
Capability dimensions and flexibility types

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fully operational faster than its competitors provided it with a competitive edge when demand for paper products soared in the early 1990s (Hayes *et al.*, 2005). Organization-based capabilities include, for example, expansion, modification, and new product flexibility. The ability to incorporate new resources smoothly to augment capacity, the ability to modify product lines, or the ability to introduce entirely new products all depend on the quality of information technology and knowledge management techniques. These capabilities, embedded in the firm's routines and practices, engage large numbers of employees. Causally ambiguous and socially complex, they are particularly difficult to imitate.

(4) Network-based capabilities refer to the capabilities that are derived from a firm's ability to transcend its formal boundaries and reach out to the other players in the value (or supply) chain to improve the efficiency of the value (or supply) chain overall. Network-based capabilities include supply network flexibility and logistics flexibility. For example, Dell's ability to integrate product design with suppliers and to coordinate internal assembly operations with sales information enables it to efficiently design, assemble, and deliver customized computers. Similarly, for Spanish clothier Zara, superior performance has been linked to a revolutionary, highly responsive supply chain achieved through centralized warehousing, efficient transportation networks, and tight information integration across supply chain levels (Beckman and Rosenfield, 2008; Ferdows *et al.*, 2004).

In sum, by looking at flexibility as a capability along these dimensions, the RBV provides a theoretical foundation for organizing flexibility types, understanding the nature of the interrelationships that exist between them, and comprehending how they can contribute to creating and sustaining a competitive advantage.

4. Implications for future research and concluding remarks

This article sheds additional light on the concept of manufacturing flexibility. By drawing on the RBV of the firm, as a complement to the competitive positioning view of strategic management, we recognize both the proactive and reactive facets of manufacturing flexibility. We provide an appropriate theoretical context to discuss the ways in which manufacturing flexibility can be used to create opportunities and address uncertainties, allowing us to reconcile the divergent views of manufacturing flexibility that can be found in the operations management literature. We conclude by suggesting that the lack of success and even failed performance of flexible systems that have puzzled flexibility advocates might be better explained by integrating these two theories. It appears that firm performance, and thus, differences in inter-firm performance, depend on the fit between the firm's resource (and capability) position and the external environmental conditions it faces. This integration has significant implication for practitioners, as they rethink the role of the operations function in general and of manufacturing flexibility in particular, in their approach to strategy formulation. This integration also has major implications for researchers, as it provides a theoretical basis for future work on manufacturing flexibility and performance.

Operations strategists (Skinner, 1969; Hayes and Wheelwright, 1984) have long recognized the need for alignment between manufacturing strategy and the external environment. Along those lines, the necessity of fit between manufacturing strategy

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and external environment has been supported by empirical research (Swamidass and Newell, 1987; Berry and Cooper, 1999; Ward and Duray, 2000). However, research on the relationship between manufacturing flexibility and firm performance has remained scarce (Swamidass and Newell, 1987; Pagell and Krause, 1999, 2004; Anand and Ward, 2004). Early empirical work by Swamidass and Newell (1987) finds support for the impact of manufacturing flexibility and its interaction with environmental uncertainty on manufacturing performance. Vokurka and O'Leary-Kelly (2000) further propose that, for firms with an appropriate fit between internal organizational attributes and external environmental factors, higher flexibility in manufacturing technology is associated with higher levels of performance. Based on an empirical study of 101 manufacturing firms, Anand and Ward (2004) also argue for a better fit between the type of environmental dynamism and type of flexibility pursued to predict business performance. Pagell and Krause (1999, 2004), on the other hand, question the evidence that connects flexibility with an environmental imperative by showing that manufacturing flexibility is "always" present in high performing firms regardless of the environment in which they evolve. Finally, manufacturing strategy research has failed to recognize the effects of competition on this relationship (Schroeder *et al.*, 2002). To the best of our knowledge, no studies have looked at the impact of manufacturing flexibility on performance through the RBV lens (Newbert, 2007).

This highlights the need for empirical studies that investigate the various aspects of the relationship between manufacturing flexibility and performance and opens many avenues for future research. The RBV, as a complement to the competitive positioning view, provides a theoretical basis on which one could base empirically testable propositions that link a firm's flexibility portfolio to the development of a sustainable competitive advantage and thus to superior performance. One could, for example, start with longitudinal studies of the evolution of a firm's flexibility portfolio along the capability dimensions previously discussed for a variety of external environmental contexts (or industries). Moreover, it would be useful to understand the factors that affect this evolution over time and how they relate to the external environmental conditions that the firm faces. It would also be of interest to see, as the firm moves towards higher levels of flexibility portfolios, whether this change in flexibility capabilities is associated with higher levels of performance. One could also, for example, investigate how firm strategies are linked to different flexibility profiles. Similarly, the extent to which, if any, different flexibility portfolios have led to changes in firm strategies would constitute evidence supporting the necessity to incorporate the proactive use of manufacturing flexibility in strategy formulation. Finally, one would expect that, given similar external environmental conditions (say, the same industry), firms pursuing similar strategies would exhibit higher levels of performance for higher levels of flexibility-based capability.

To conclude, this article places the discussion of the role of manufacturing flexibility within the larger strategic debate about sources of performance differences between firms as it seems reasonable to expect both internal (e.g. resources and capabilities) and external (e.g. competitors and uncertainty) factors to affect performance. The challenge, of great interest to both practitioners and researchers, is to identify the conditions under which one set of forces becomes more prominent in shaping the impact of manufacturing flexibility in firms.

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Notes

1. In the automobile industry of the mid-1960s, the largest selling car in the USA was the Chevrolet Impala. The platform on which it was based sold approximately 1.5 million units. In the early 1990s, the largest selling car in the USA, the Honda Accord, sold about 400,000 units. Thus, in a market much larger than in 1965, the volume per model declined over about 15 years by a factor of four (Schilling and Hill, 1998).
2. The Sony Corporation, which introduced its first Walkman in the early 1980s, had launched more than 160 SONY Walkman in the US market by 1990 (Sanderson and Uzumeri, 1995).
3. An early example is the product-process matrix developed by Hayes and Wheelwright (1979), which illustrates how strategic choices about the breadth and volume of products to be offered influence the needs for manufacturing flexibility in organizations.
4. Note that there is some consensus, however, on the four basic components that describe these flexibility types: range number, range heterogeneity, mobility, and uniformity. Range number refers to the number of different positions that can be achieved for a given flexibility dimension, whereas range-heterogeneity captures the differences between possible options. Mobility refers to the ease (in terms of both costs and time) with which the firm moves from one state to another, whereas uniformity is the ability to maintain performance outcomes as the firm switches among products within the range (Upton, 1994; Koste and Malhotra, 1999, 2004; Beach *et al.*, 2000).

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