Int. J. of Vehicle Design, Vol. 16, Nos 2/3, 1995 126

The dynamics of strategy and manufacturing technology relationship: a process framework

R. Parthasarthy* and S. Kotha†

*W. Paul Stillman School of Business, Seton Hall University, South Orange, NJ 07079, USA.

†Stern School of Business, NYU, Suite 7–10 Tisch Hall, 40W 4th Street, New York, NY 10012, USA.

Abstract: This paper proposes a framework that explains the causal role of flexible automation technology in business strategy formulation. By describing a firm's technology as an evolving competency system due to computer integration of tools and an external change in industry technology, the framework portrays it as an independent and strategic variable. By elaborating the foundations of strategy as both environmental and internal to a firm, the framework suggests that strategies can be deliberately planned based upon changes in manufacturing competencies or changes in the external environment. The emergent view of strategy is at the same time recognized. The paper offers an illustrative typology that can be used to examine whether different technologies are associated with different strategic orientations.

Keywords: automation technology, business strategy formulation, firms, operations management, strategic management.

Reference to this paper should be made as follows: Parthasarthy, R. and Kotha, S. (1995) 'The dynamics of strategy and manufacturing technology relationship: a process framework', *Int. J. of Vehicle Design*, Vol. 16, Nos 2/3, pp. 126–139.

1 Introduction

Manufacturing literature has consistently claimed an influential role for computerized manufacturing automation in business strategy formulation (e.g. see Dean and Susman, 1989; Jelinek and Goldhar, 1984; Kotha, 1991; Lei and Goldhar, 1990; Meredith, 1987a; Wheelwright, 1985). The new technology, popularly known as flexible automation or advanced manufacturing technology, comprises design and processing equipment such as Computer-Aided Design (CAD), Flexible Manufacturing Systems (FMS), robots, and transfer lines which are hierarchically integrated and supervised by a central computer. Programming capabilities of the new automation to produce variety economically and to change over from design to production rapidly are cited as the underlying reasons for its influential role in the selection of market choices and competitive methods. Precisely, the competencies of the new automation are suggested to demand a change in the rules by which firms would compete: from a cost- or quality-based approach to a cost-quality combination approach; from a standardized, mass production approach to a variety, innovation, and custom production approach (Bolwijn and Kumpe, 1990; Dean and Susman, 1989).

While case study evidence and anecdotal accounts of the strategic influence of the new automation are becoming plentiful (Ettlie, 1988; Goldhar and Jelinek, 1985; Gunn, 1987; Meredith, 1987a, b), large-scale empirical studies that would scientifically document this influence are absent. Investigating the impact of manufacturing technology over strategy requires as a first step a theoretical explanation of technology as an independent variable in the strategy formulation framework. Additionally, the basis for hypothesizing and testing the influence of technology over strategy has to be enunciated. Entrenched strategic management notions that describe strategy as essentially market-based (cf. Andrews, 1971; Porter, 1980) and those that view technology as primarily an implemental tool (cf. Wheelwright, 1985) are, however, stalling progress in this area. Besides, operations management has not yet emerged as a well-articulated research discipline offering a diverse set of manufacturing constructs that will demonstrate technology's causal influence over business strategy.

This paper reviews these issues and proposes a strategy framework that places a firm's technology as an independent variable, side by side with the external environment. By describing a firm's manufacturing technology as an evolving competency system due to an internal computer integration of tools (Groover, 1987; Gunn, 1987) and an external change in industry technology (Porter, 1988; Sahal, 1982), the framework suggests its influence over strategy formulation. By elaborating the foundations of strategy as both 'environmental' and 'internal' to a firm, the framework refines the intended strategy paradigm (Mintzberg and Waters, 1985) to suggest that strategies are *deliberately* planned either because of internal pressures from a changing manufacturing competency or because of external pressures from a changing socioeconomic demand. The emergent view (Mintzberg and Waters, 1985) of strategy is, at the same time, recognized by indicating that strategy can result when a firm incrementally (Quinn, 1980) adapts to the pressures posed by both internal and external issues. To operationalize the proposed framework, this paper offers an illustrative typology that can be used to examine whether different manufacturing technology competencies are associated with different strategic orientations of the firm. Finally, the paper notes the implications of the proposed framework for strategic management theory and practice.

2 Strategic management literature

2.1 *Paradigmatic problems*

The paradigm for theory development and research in business strategy centres around the notion that an alignment between the firm and the environment is a peremptory condition for achieving superior company performance (Andrews, 1971; Hofer and Schendel, 1978). Over the years, business policy researchers have sought to identify several correlates in the organization–environment relationship in order to develop various models of strategic fit (e.g. Anderson and Zeithaml, 1984; Buzzell and Gale, 1987; Porter, 1980). Such endeavours have invariably adhered to what Parthasarthy and Sethi (1992) describe as an 'outside-in and top-down approach': analysing the socioeconomic conditions of the environment and identifying the structural and technological attributes that match the market demands. The sequencing here is thus to understand the market uncertainties first and then to determine the internal requirements that would translate market knowledge into organizational success. That is, strategy formulation is a deliberately planned reaction to the changes in the market environment.

A body of the strategy literature (Burgelman, 1983; Quinn, 1980) suggests firm–environment alignment from a 'bottom-up and inside-out' perspective. Strategy formulation in this approach occurs in an incremental manner based upon a confluence of internal decisions and external events. That is, environmental assessments and internal arrangements are made in an adaptive and overlapping manner leading to the 'emergence' (Mintzberg, 1978) of a firm–environment fit. A critical implication of this approach is that a firm's existing administrative and technical arrangements will have a significant impact over the selection of future product-market and competitive strategy choices. However, research that would test this implication thus far has been sparse and studies have only dealt with the impact of structure on strategy (Bower, 1970, 1974; Burgelman, 1983). Also, both structure and technology have generally been viewed more as constraints than as influential agents in strategy formulation (see e.g. Hrebiniak and Joyce, 1984).

Whether it is deliberate or adaptive, current thinking on strategy formulation and consequent firm–environment fit is that it is essentially driven by market imperatives. The former assumes strategy formulation as deliberately planned to *deal with* the environment whereas the latter assumes it as an evolutionary process of *changing with* the environment (Chaffee, 1985). Besides, both models conceptualize fit as a successive selection (or adaptation) of administrative and technical mechanisms that are designed to meet the demands of the market choice in an essentially implemental capacity. Precisely, the market environment is the referent and starting point for strategy formulation frameworks that follow the coalignment tradition (*cf.* Hayes, 1985).

A market-based view of strategy is obviously inappropriate for investigating the strategic role of a firm's manufacturing automation. It would require a broader description that views strategy as the result of a *deliberate plan to meet either the market or the internal resource imperatives and, at the same time, as one that can emerge due to the firm's adaptive exercises*.

2.2 *Perceptual problems*

A central theme in strategy conceptualizations is the notion of change. Change impacts an organization by providing it with new growth opportunities or by bringing in threats to its existing business. Understanding change and acquiring the means to deal with it are therefore considered essential for company performance (Andrews, 1971; Hofer and Schendel, 1978). The emphasis here is upon the 'exclusive' competencies that a firm should possess to identify and exploit change so as to create a competitive differential advantage. In other words, anything that is universally held by all firms does not provide a competitive advantage.

For strategy scholars and practitioners, social and economic conditions of the macro-environment have been the critical sources of change. Rapid shifts in consumer lifestyle and capital market uncertainty during the post-War decades have made marketing and financial expertise critical to the survival of the firm. Most competitive strategy frameworks currently in vogue are thus of a marketing and finance base (Biggadike, 1981; Jemison; 1981; Porter, 1981) in which the role of a top manager is described as surveying markets and allocating funds based upon survey results.

In contrast, manufacturing has not been a source of change or uncertainty in business decisions. Developments in mechanics and automation had made manufacturing activities controllable, thereby eliminating threats from them for planned operations. As a result, manufacturing automation has been viewed as staid and any change in its attributes is perceived as only an increase in its capacity to produce more of the existing product. Further, introduction of standardized techniques in work methods and coordination had made the manufacturing function highly predictable. A predictable tool or task cannot be a basis for competitive strategy. But it is a constant around which other less predictable tasks could be built. In line with this thinking, manufacturing automation has often been viewed by strategy scholars and practitioners as 'neutral' (*cf.* Wheelwright and Hayes, 1985) to product/market and business strategy choices.

Investigating technology's role in business strategy requires describing it as a strategic variable. In addition, a theoretical basis that supports this claim has to be articulated. Next, the specific ways by which the variations in a firm's technology influence business strategy choices have to be explained.

3 Operations management literature

3.1 *Lack of integrative research*

Operations management literature is still in its nascency. It is not fully grown conceptually as yet to be likened to the stature of business strategy literature. As Adam and Swamidass (1989) lament, there are no common themes or paradigms as such that would bind the different streams of thinking within this subject (see also Kotha, 1993). Frameworks that would integrate various sub-functions within operations (e.g. purchasing, design, production) or operations and strategic planning are slow to come by and those that have been proposed (e.g. Kotha and Orne, 1989) are yet to be tested empirically.

The field of operations management as it stands today is an offshoot of Taylor's (1947) scientific management. Achieving efficiency by using engineering principles underscored the Taylorean approach to operations management. The unit of analysis was the individual worker and the focus of inquiry was the physical operation relevant to the performance of a task. Subsequent inquiries broadened the scope of investigation by including issues in the input–output transformation process. Nonetheless, research in this field still dwells within the narrow confines of production operations such as materials planning and work scheduling whereas global issues that would relate manufacturing options and respective competencies to various competitive criteria remain untouched. No attempt has been made to understand the likely implications of man–machine interactions on product development and processing across various social settings. Studies that would investigate and explain the reasons for differences in the performance of firms, operating within the same industry group and using similar tools and equipment, are rare. As a result, theoretical models that would relate manufacturing technology or function to the strategic decisions of the firm are missing.

In sum, operations management literature has not yet provided a groundwork, theoretical or normative, on which the business strategy researchers could postulate a technology–strategy relationship. There is a need for terminology and conceptual schemes which can be readily borrowed and used in business strategy research.

4 The framework

This paper proposes a framework that explains the causal role of a firm's manufacturing technology in strategy formulation, side by side with the external environment. The framework is shown in Figure 1. The framework makes the following assumptions:

1 Strategy formulation involves creating a fit between the organization and its environment (Hofer and Schendel, 1978). Since organizational capabilities and environmental characteristics change, fit may be internally or externally induced or emerge by chance.

2 Externally induced fit arises when the socioeconomic factors of a firm's environment change, producing a mismatch between the firm's competitive endeavours and market demands. A firm *deliberately* chooses a strategy that fits its external environment and implements it with a technology that meets the task demands of strategy (Andrews, 1971).

3 Internally induced fit arises when a firm's manufacturing technology competencies change due to changes occurring in the industry technology (David, 1987; Porter, 1988; Rosenberg, 1982; Sahal, 1981) and due to the fact that firms integrate diverse manufacturing tools and activities in stages (Groover, 1987; Gunn, 1987). Such changes and integrative approaches alter the strategy–technology balance requiring the firm to restore the balance by *deliberately* modifying its strategy to suit the competencies of the new technology.

4 Strategy for a firm also emerges due to a confluence of external and internal changes in market demands and firms' competencies.

4.1 Elements of the framework

Socioeconomic Environment (SE). This construct, external to the organization, consists of macro-level conditions such as social, economic, cultural, and political forces that change and consequently define as well as constrain product/market and competitive opportunities for a firm.

Industry's Technological Environment (ITE). This construct, external to the organization, refers to the industry trends in new technical knowledge and tool development and eventual adoption by firms to achieve competitive capabilities in the areas of product design, processing, testing, packaging, storage, and retrieval of inventory. The extent of change in this variable depends, among others, on the extent of R&D activities occurring in the industry and the ability of constituent firms to absorb new technologies for linking the design–manufacturing–distribution sequence. In some industries (e.g. computing, health care), changes in this variable are suggested to occur rapidly and more frequently (Sahal, 1981). Under those conditions, ITE should be construed to be a more dominant exogenous variable than SE.

Manufacturing Technology. For the purposes of this framework, manufacturing technology refers to automated technology only. The essence of automation is integration of machines and activities, but machines have to be first controlled before integration can occur. Controls on machines can be set to perform single operations repeatedly (e.g. cutting or boring) to maximize volume and efficiency. To achieve machine integration

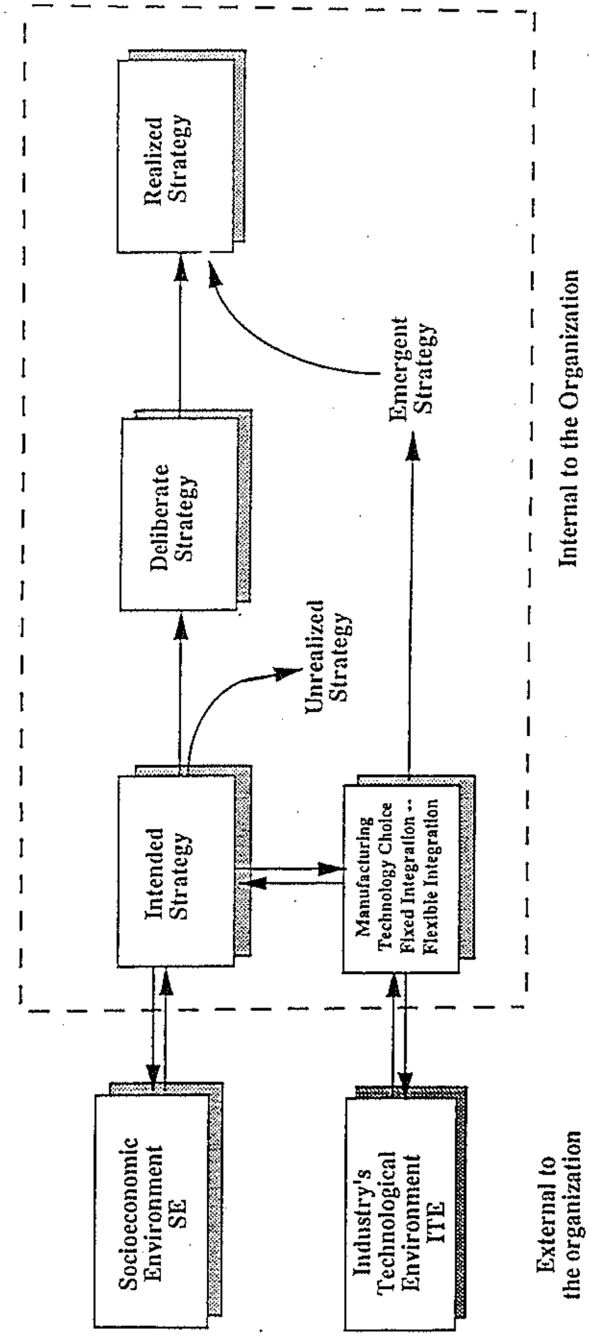

Figure 1 Mintzberg's strategy framework modified.

here, the product has to be first designed and the processing sequence planned accordingly. As a result, automation becomes sequential (or fixed) and processing remains dedicated to the needs of a designed product. In contrast, controls on machines can also be set to perform the specific operation needed by an incoming product to maximize process flexibility (i.e. producing variety). To achieve machine integration here, each machine has to be first programmed to perform several operations and the transfer of operations among machines must be controlled by a central computer. As a result, automation becomes flexible and processing makes the demands that product design remain fluid to exploit the versatility in processing.

Logically, flexible processing automation should realize its full potential when activities that precede processing (e.g. product engineering, design) and those that succeed it (e.g. packaging, storage) are also programmed for flexibility and integrated with processing. Such an integration permits real time communication between processing and design on the one hand and processing and marketing on the other. As a result, processing can involve itself in design decisions and enhance design quality or product producibility. It also can involve itself in marketing decisions and rapidly adjust for fluctuations in current markets or create products for new markets. Integration of diverse operational activities is thus a critical variable in flexible automation. The higher the level of integration in the design–processing–marketing sequence, the higher is the strategic capability of flexible automation.

The type of automation (i.e. fixed or flexible) for a firm would depend upon SE and ITE imperatives but within flexible automation, the level of operational integration (i.e. linking design with processing, etc.) for a firm would depend upon both the ITE imperatives and the firm's technical and financial capabilities. The level of operational integration for a firm can be measured by using a semantic differential scale similar to the one proposed by Parthasarthy and Sethi (1992). This scale surveys the extent of integration that has occurred in the design and processing activities only. By adding items to this scale on testing, storage, and the level of overall integration achieved by a firm, a comprehensive scale can be developed.

4.2 *Linking the elements*

The traditional description of strategy formulation indicates the external environment as a reservoir of business opportunities and competitive threats (Andrews, 1971; Hofer and Schendel, 1978; Porter, 1980). Following this environment-based description of strategy, the framework suggests that the socioeconomic forces change and offer new product, market, and competitive opportunities to a firm or introduce threats to its existing business. A firm analyses its external environment to understand these issues, determines its strategic decision to deal with them, and implements it with a manufacturing technology that befits strategy. In other words, strategy is a deliberate reaction to environmental changes and manufacturing technology is specifically designed to carry out its task demands.

The industry's technological environment (ITE) also evolves continuously (Porter, 1988; Rosenberg, 1982; Sahal, 1981), causing the firm to modify its manufacturing technology. Such modifications are not caused by a change in the firm's business strategy but by a need to prevent the ossification of the firm's technology and to maintain its technological competitiveness within the industry (For example, see Schroeder, 1990; Schroeder, Congden and Gopinath, 1988). Such modifications, however, alter the firm's processing capabilities and its equation with business strategy as a result. Restoring strategy–technology balance requires adjustments in the firm's strategy that are complementary to the evolving processing competencies.

More importantly, automation has been occurring, until recently, in three distinct areas in a more or less disjointed fashion (Kaplinsky, 1983; Kotha, 1991): (1) product design, (2) processing, and (3) coordination of administrative activities (e.g. process planning, materials planning). Developments in computer automation have now enabled the linking of both planning and operation into an integrated system (Gunn, 1987). Higher levels of such integration increase manufacturing automation's flexibility that can be sustained only when upstream and downstream activities (i.e. product planning, marketing, and distribution) are also made flexible. Consequently, a firm makes adjustments to its strategy that are congruent with the demands of its manufacturing technology. In other words, strategy is a deliberate plan corresponding to the needs of manufacturing technology.

The strategy–environment fit in the latter-mentioned situation occurs proactively: by altering the rules of competition in the industry. The changing nature of competition in the automotive industry due to changes in the technological competencies of auto manufacturers is a good empirical example here. (For some other examples, see Meredith, 1987.)

The framework recognizes the thinking that a fit between the firm and its environment can also emerge serendipitously (Mintzberg and Waters, 1985). An unplanned action by the firm taken in response to an unforeseen contingency can create the strategic fit.

4.3 *Operationalizing the framework*

Operationalizing the framework proposed here requires describing when strategy formulation will be based upon manufacturing technology competencies and when it will be a function of market influences. In other words, contingencies regarding when fit will be internally induced and when it will be externally induced have to be specified. Ideally, under a rapidly changing ITE condition, technology may demand predominance in strategy selection since competitive advantages in the industry are created on the basis of the firm's technical competencies in design and processing. These are described as the technologically pioneering environments where radical product reorientations are considered critical for competitive survival (Bahrami and Evans, 1987; Prahlad and Hamel, 1990). Additionally, under conditions where a firm's operational activities (e.g., design, manufacturing, distribution) are computer integrated, a manufacturing-based strategy formulation is in order to exploit manufacturing's ability to involve itself, in almost real time, in upstream and downstream functions (Parthasarthy and Sethi, 1992). The multiple proficiencies that manufacturing is capable of (e.g. cost, quality, flexibility) under such circumstances would demand that competitive strategy be based upon the exact composition of such proficiencies.

On the other hand, under a dynamic socioeconomic condition that results in atomized markets, market research and market intelligence may hold the key to strategy formulation since competitive advantages are created on the basis of an effective market segmentation and market positioning. A firm would thus make a deliberate selection of strategic choices that are congruent with the demands of the chosen market segment. In other words, under conditions where the industry technology is dynamic and a firm's manufacturing competency is diverse, the fit will be internally induced. By contrast, under a highly dynamic socioeconomic condition, the fit will be externally induced.

Operationalizing the framework also requires identification of specific strategy constructs that are environment-based or internal technology-based. A traditional method with strategy scholars attempting to develop strategy classification is taxonomic research which is often recommended because of its parsimony in capturing systematic relationships (Kotha, 1993) and because of its power to yield comprehensive empirical patterns or *gestalts* (Miller, 1986). A taxonomy thus refers to a pattern of relationships identified through empirical analysis and is different from a typology that refers to theory-based patterns (e.g. Porter's generic strategy framework; see Hambrick, 1984). Taxonomies identified by using the environment as the unit of analysis are now well documented in the strategy literature. For example, researchers have used the market and industry life cycle stages to identify business strategy taxons appropriate for different stages (Anderson and Zeithaml, 1984; Hambrick and Lei, 1985; Hofer, 1975). Others have used market contexts such as market growth rate *vis-à-vis* the market share of the firm for the same purpose (Hedley, 1977; Hofer, 1977). For a firm that must achieve an externally induced fit, a deliberate selection of any of these strategies depending upon the market and industry contexts may be appropriate.

In recent years, attempts have been made to develop manufacturing technology-based strategy constructs (Hayes and Wheelwright, 1984; Kotha, 1991; Parthasarthy and Sethi, 1992; Skinner, 1985). The binding theme in these attempts is the competency associated with manufacturing. However, empirical existence of a relationship between manufacturing competency and business strategy choices, either in the case of individual firms or of strategic groups in an industry (Hatten and Schendel, 1977), is yet to be demonstrated. Taxonomic research that would empirically verify competitive orientations that are based on manufacturing technology competencies is necessary for operationalizing the framework proposed in this article. There is a need to understand whether different computer automation types (e.g. CAD, CAM, etc.) and the different activity levels at which they are integrated (e.g. processing with design only or with design, testing, and storage) are associated with different environmental contexts, competitive strategies, and organizational variables in terms of company performance. To achieve this purpose, Table 1 provides a description of various technologies forming part of computer automation, their benefits to the manufacturing function, and how these benefits are related to various competitive methods. Table 2 uses this information to propose a typology that illustrates environmental strategic, and organizational contingencies appropriate for two of the five configurational systems proposed by Mintzberg (1990): machine organization and innovative organization. Table 2 is a starting point for testing the validity of the claims relating to the influence of manufacturing technologies on business strategy and for the identification of manufacturing based strategy taxons. A large scale analysis of the users of computer automation technologies in different industry groups with regard to their competitive choices and economic performance should satisfy these twin objectives.

Table 1 Manufacturing technologies, their benefits to the manufacturing function, and their contribution to competitive methods.

Technology	Benefits to manufacturing	Contribution to competition
Computer-Aided Design (CAD). Develops designs, displays them, and stores them for future reference or modification.	• Reduces the time lag between product idea and actual design • Enables preparation of many designs speedily and cost efficiently • Enhances design quality • Enhances product producibility • Saves on labour costs	• Frequent product design changes • Custom design at no extra cost • Product quality • Offering products in a variety of packages • Institutional image
Computer-Aided Engineering (CAE). Tests product design graphically.	• Saves on expensive prototypes • Saves on lead time in product testing	• Speedy new product introductions • Product performance reliability • Institutional image
Computer-Aided Manufacturing (CAM). Translates CAD information, prepares route sheets, and controls robots and machine tools to achieve production according to plan.	• Enables economical production of variety • Facilities the optimal use of machines • Minimizes machine downtime	• Product mix flexibility • Volume mix flexibility • Product quality • Fast/timely delivery • Institutional image
Automated Storage and Retrieval Systems (AS/RS). Delivers a batch of parts to a location or picks up a manufactured part for storage.	• Saves on storage costs • Keeps track of in-process or finished inventory	• Fast/timely delivery • Institutional image
Computer-Aided Design and Computer-Aided Manufacturing System (CAD/CAM). A system in which both CAD and CAM are integrated by a supervisory computer thereby providing for a common database.	• Reduces the time lag between product design and processing • Reduces the work-in-process inventory • Enhances product producibility	• Frequent new product introductions • Fast response on customer orders • Volume/design changes to accommodate customers' requests • Institutional image

Table 2 Strategy–structure–environment–technology typology using two of Mintzberg's configurations.

Organizational/ environment choices	Machine organization	Innovative organization
Strategy process	Planning process and strategic programming predominate. Resistance to strategic change. Long periods of stability interrupted by occasional bursts of strategic revolution.	Planned and emergent approaches predominate. Change in strategy emerges but deliberately shaped by top management. Cycles of convergence and divergence in strategic focus.
Structure	Mechanistic with centralized bureaucracy.	Organic, fluid and selectively decentralized.
Context	Simple and stable environment. Common in large, mature organizations.	Complex, dynamic environments. Common in entrepreneurial and technology-based organizations.
Issues	Efficiency, reliability, and consistency valued. Bureaucratic control. Highly proficient in process innovations.	Effectiveness is critical but efficiency is not overlooked. Self/clan control. Highly proficient in product innovations.
Manufacturing	Low cost and acceptable product quality. Command and control philosophy. Cost-driven strategy deliberately planned. Focus is on static optimization where competitive choices are viewed as trade-offs.	Product variety, uniqueness, and high value added. Autonomous, participatory, and creative philosophy. Cost and product innovation strategy deliberate or emergent. Focus is on dynamic optimization where competitive choices are viewed as complementary.
Productive unit focus	Process issues tend to dominate due to design standardization and stable environment.	Product issues tend to dominate due to design flexibility and dynamic environment.
MRP systems	High emphasis due to the command and control mentality.	Moderate emphasis on the use of such systems.
CAD systems	Relatively low-medium emphasis. Usage focuses on improving product design /quality (replicability).	Moderate-to-high emphasis. Usage focuses on generating product variety /custom designs.
CAM systems	Fixed integration of machines to achieve dedication to planned product. Maximize volume to minimize cost on a standard product.	Flexible integration of machines to achieve volume/design variety. Maximize variety to spread costs on several products.
CAD-CAM	Low integration between product design and processing systems. Such integration is viewed as unnecessary due to a standardized product environment.	High integration between product design and processing systems. Such integration is viewed as essential due to an innovative product environment.
AS/RS	High emphasis due to savings in storage costs and need to track in-process/finished inventory for timely delivery.	Low-to-moderate emphasis due to frequent design changes.

5 Implications for theory and practice

A growing body of literature in the operations management area has made various claims on the causal influence of computerized manufacturing automation on business strategy formulation. These claims are significant for business strategy research and practice especially when US manufacturing competitiveness is reported to be suffering from serious malaise (Hayes and Abernathy, 1980). However, a problem with these claims is their lack of scientific validity. The strategy literature on its part lacks a conceptual basis for methodically investigating these claims. A market-based paradigm and a mechanistic view of manufacturing automation have characterized the strategy formulation frameworks.

This paper presents a new strategy-making framework that explains the influence of manufacturing automation over business strategy, side by side with the external environment. It elaborates upon a currently popular description of the strategy process, known as the deliberate–emergent paradigm (Mintzberg and McHugh, 1985; Mintzberg and Waters, 1985), to make the argument that strategies can be deliberately planned to exploit a firm's evolving manufacturing competencies just as they are deliberately planned to exploit external market opportunities. This elaboration, while contributing to theoretical clarity, has become necessary especially when organizations are reported to be achieving success by intentionally building and exploiting core competencies (Prahalad and Hamel, 1990). To understand what specific strategic choices are appropriate with different manufacturing technology types, this paper suggests taxonomic research and presents a typology to be tested.

Theoretical implications of the framework proposed here are toward a reformulation of the strategic management paradigm. Current description of this paradigm is that organizational opportunities arise either due to environmental munificence or are identified through systematic analysis. This paper suggests products and markets can be deliberately created by a firm based upon its technological competencies (Prahalad and Hamel, 1990). In today's environment, where markets and economies are highly volatile, an environment-based approach to strategy development can prove to be disastrous. Focusing on the firm's internal competencies should provide for a more reliable foundation. Besides, an internal orientation in strategy-making can explain the within-industry differences in performances of firms even though they use the same tools and equipment.

For management practice, the framework emphasizes the importance of involving manufacturing technology in strategic decisions. This would mean that top management personnel have an informed understanding of computerized manufacturing technologies, their competencies, and how such competencies influence product, market, and competitive choices. A technically knowledgeable top management personnel (Ettlie, 1990) and a creative approach in strategy formulation are necessary for successfully managing a computerized automation firm.

References

Adam, E.E. and Swamidass, P.M. (1989) 'Assessing operations management from a strategic perspective', *Journal of Management*, **15**, pp.181–203.

Anderson, C.R. and Zeithaml, C.P. (1984) 'Stages of the product life cycle, business strategy, and business performance', *Academy of Management Journal*, **27**, pp.5–24.

Andrews, K.R. (1971) *The Concept of Corporate Strategy*, Homewood, IL: Dow Jones Irwin.

Bahrami, H. and Evans, S. (1987) 'Stratocracy in high-technology firms', *California Management Review*, **30**, 1, pp.51–66.

Biggadike, E.R. (1981) 'The contributions of marketing to strategic management', *Academy of Management Review*, **6**, pp.621–632.

Bolwijn, P.T. and Kumpe, T.T. (1990) 'Manufacturing in the 1990s - productivity, flexibility, and innovation', *Long Range Planning*, **23**, pp.45–57.

Bower, J.L. (1970) *Managing and Resource Allocation Process*. Boston, MA: Graduate School of Business Administration, Harvard University.

Bower, J.L. (1974) 'Planning and control: bottom-up or top-down', *Journal of General Management*, **1**, pp.20–31.

Burgelman, R.A. (1983) 'A process model of internal corporate venturing in the diversified major firm', *Administrative Science Quarterly*, **28**, pp.223–244.

Buzzell, R.D. and Gale, B.T. (1987) *The PIMS Principles: Linking Strategy to Performance*, NY: Free Press.

Chaffee, E.E. (1985) 'Three models of strategy', *Academy of Management Review*, **10**, 1, pp.89–98.

David, P. (1987) 'Some new standards for the economics of standardization in the information age', In P. Dasgupta and P. Stoneman (eds), *Economic Policy and Technological Performance*, pp.206–239, Cambridge University Press.

Dean, J.W. and Susman, G.I. (1989) 'Strategic responses to global competition', in C. Snow (ed.), *Strategy, Organization Design, and Human Resource Management*, Greenwich, CT: JAI Press, pp.297–331.

Ettlie, J.E. (1988) *Taking Charge of Manufacturing*, San Francisco: Jossey-Bass.

Ettlie, J.E. (1990) 'What makes a manufacturing firm innovative?, *The Executive*, **4**, 4, pp.7–20.

Goldhar, J.D. and Jelinek, M. (1985) 'Computer integrated flexible manufacturing: organizational, economic, and strategic implications', *Interfaces*, **15**, 3, pp.94–105.

Groover, M.P. (1987) *Automation, Production Systems, and CIM*, New Jersey: Prentice Hall.

Gunn, T.G. (1987) *Manufacturing for Competitive Advantage*, Cambridge, MA: Ballinger.

Hambrick, D. and Lei, D. (1985) 'Towards an empirical prioritization of contingency variables for business strategy', *Academy of Management Journal*, **28**, pp.763–788.

Hatten, K.J. and Schendel, D.E. (1977) ' Heterogeneity within an industry: firm conduct in US brewing industry, 1952–71, *Journal of Industrial Economics*, **26**, pp.97–113.

Hayes, R.H. (1985) 'Strategic planning: forward in reverse?', *Harvard Business Review*, **65**, 6, pp. 111–119.

Hayes, R.H. and Abernathy, W.J. (1980) 'Managing our way to economic decline', *Harvard Business Review*, **58**, 4, pp.67–77.

Hayes, R.H. and Wheelwright, S.C. (1984) *Restoring Our Competitive Advantage: Competing Through Manufacturing*, NY: Wiley.

Hedley, B. (1977) 'Strategy and business portfolio', *Long Range Planning*, **10**, 1, 9–15.

Hofer, C.W. (1975) 'Toward a contingency theory of business strategy', *Academy of Management Journal*, **18**, pp.784–810.

Hofer, C.W. (1977) *Conceptual Constructs for Formulating Corporate and Business Strategies*, Boston, MA: Intercollegiate Clearing House, 9–378–754.

Hofer, C.W. and Schendel, D.E. (1978) *Strategy Formulation: Analytical Concepts*, St. Paul, MN: West Publishing.

Hrebiniak, L.G. and Joyce, W.F. (1984) *Implementing Strategy*, NY: Macmillan.

Jelinek, M. and Goldhar, J.D. (1984) 'The strategic implications of the factory of the future', *Sloan Management Review*, **25**, pp.29–37.

Jemison, D.B. (1981) 'The importance of an integrative approach to strategic management', *Academy of Management Review*, **4**, pp.601–608.

Kotha, S. (1991) 'Strategy, manufacturing structure, and advanced manufacturing technologies – a proposed framework, *Academy of Management Best Paper Proceedings*, pp.293–297.

Kotha, S. (1993) 'Manufacturing strategy research approaches: issues and implications for global manufacturing', in Berg, D. and Wallace, W. (eds) (1993) *Global Manufacturing Technological Economical Opportunities and Research Issues. Advances in Applied Business Strategy*, pp. 189–210, JAI Press, Greenwich.

Kotha, S. and Orne, D. (1989) 'Generic business strategies and manufacturing structures: a conceptual framework', *Strategic Management Journal*, **10**, 3, pp.211–231.

Lei, D. and Goldhar, J.D. (1990) 'Multiple niche competition: the strategic use of CIM technology', *Manufacturing Review*, **3**, 3, pp.195–206.

Meredith, J.R. (1987a) 'The strategic advantage of the factory of the future, *California Management Review*, **29**, pp.27–41.

Meredith, J.R. (1987b) 'The strategic advantages of new manufacturing technologies for small firms', *Strategic Management Journal*, **8** (3), pp.249–258.

Mintzberg, H. (1978) 'Patterns in strategy formulation', *Management Science*, **24**, pp.934–948.

Mintzberg, H. and McHugh, A. (1985) 'Strategy formation in an adhocracy', *Administrative Science Quarterly*, **30** (2), pp.160–197.

Mintzberg, H. and Waters, J.A. (1985) 'Of strategies, deliberate and emergent', *Strategic Management Journal*, **6**, 3, pp.257–272.

Parthasarthy, R. and Sethi, S.P. (1992) 'The impact of flexible automation on business strategy and organizational structure', *The Academy of Management Review*, **17**, 1, pp.86–111.

Porter, M.E. (1980) *Competitive Strategy: Techniques for Analyzing Industries and Competitors*, NY: Free Press.

Porter, M.E. (1981) 'The contributions of industrial organization to strategic management', *Academy of Management Review*, **6**, pp.609–620.

Porter, M.E. (1988) 'The technological dimensions of corporate strategy, in R.A. Burgelman and M.A. Maidique (eds), *Strategic Management of Technology and Innovation*, Homewood, IL: Irwin, pp.211–233.

Prahalad, C.K. and Hamel, G. (1990) 'The core competence of the corporation', *Harvard Business Review*, **68**, 3, pp.79–91.

Quinn, J.B. (1980) *Strategies for Change: Logical Incrementalism*, Homewood, IL: Irwin.

Rosenberg, N. (1982) *Inside the Black Box: Technology and Economics*, CUP.

Sahal, D. (1981) *Patterns of Technological Innovation*, Reading, MA: Addison Wesley.

Schroeder, D.M. (1990) 'A dynamic perspective on the impact of process innovation upon competitive strategies, *Strategic Management Journal*, **11**, pp.25–41.

Schroeder, D.M., Congden, S.W., and Gopinath, C. (1988) 'Competitive strategy, process technology, and small manufacturers in mature industries', *Academy of Management Best Paper Proceedings*.

Skinner, W. (1985) *Manufacturing: The Formidable Competitive Weapon*, NY: John Wiley.

Taylor, F.W. (1947) *The Principles of Scientific Management*, NY: Harper & Row.

Wheelwright, S.C. (1985) 'Restoring competitiveness in US manufacturing', *California Management Review*, **27**, 3, pp.26–42.

Wheelwright, S.C. and Hayes, R.H. (1985) 'Competing through manufacturing', *Harvard Business Review*, **63**, 1, pp.99–109.