Evolving forms of manufacturing strategy development: Evidence and implications

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Introduction

Some companies have a manufacturing strategy development process that is biased towards the top-down planning paradigm originally proposed by Skinner (1969, 1974). Yet, many companies that we studied recently do not use such a process. Upon closer investigation, while a top-down process may be absent, they use one or more successful alternatives. Thus, there appears to be no single universal process for manufacturing strategy development. The purpose of this paper is to capture and document the alternative to top-down planning for manufacturing strategy. Our method, which is illustrated in-depth by a UK case unearths successful alternatives to the top-down planning process.

This paper is not structured in the conventional manner. First, we present case nuggets from three different US companies to illustrate the successful useof alternative forms of manufacturing strategy development process in manufacturing firms. Next, we discuss the four alternative methods of manufacturing strategy development based on the cases we have investigated. The discussion is presented in the context of existing literature.

In the next section, using the case of manufacturing in the UK, we describe in detail the evolution of manufacturing strategy within the company. A process mapping method is employed to display in a two-dimensional chart the evolution of manufacturing strategy within this company. Process-mapping proves to be a powerful tool for studying the complex phenomenon of manufacturing strategy evolution over time. Finally, the paper ends with our conclusions. The conclusions are meant to guide future research and practitioners in the industry.

Methodology

The method used here to study and unearth newly-evolving alternatives to manufacturing strategy development is difficult to explain without the help of a detailed case. Therefore, in a later section: “An in-depth case of a UK company”, the method of process mapping used here for investigation is illustrated in detail. In effect, the in-depth case described later may be viewed as an extension of this section on methodology.

To organize and display the data about the manufacturing strategy development processes at several US companies, including the three cases summarized at the start of the paper, a “process mapping” approach was used. Darlow (1999), Swamidass et al. (1999), and Darlow and Baines (2000) describe this approach in detail. Data for the four companies were gathered during plant visits in semi-structured interviews of several senior managers in 1998. Two of the authors were present in each interview session in the USA. A majority of theinterview sessions were tape-recorded. One of the authors interviewed managers from four UK companies.

There are several ways of using case studies for investigation (General Accounting Office, 1990; Yin, 1994):

- illustrative;
- exploratory;
- critical instance;
- implementation;
- program effects; and
- cumulative.

In this paper, case studies are used as illustrative cases, which “primarily describe what is happening and why, in one or two instances …” (General Accounting Office, 1990).

Manufacturing strategy development literature

While the literature on the content of manufacturing strategy, the same is not true for the literature on manufacturing strategy development (Adam and Swamidass, 1989). Marucheck et al. (1990) have done a good exploration of themanufacturing strategy development process in practice. The traditional approach to manufacturing strategy development evident in the literature is founded on the idea of matching manufacturing structure and infrastructure with business strategy through a formal planning process (Skinner, 1969). This approach is the essence of the top-down approach to developing manufacturing strategy in which the manufacturing function is devoted to performing specified manufacturing tasks that derive from business strategy and/or corporate strategy. In the business strategy literature, it is recognized that a company's strategy may not be always completely planned but may consist of planned and emergent components (Mintzberg, 1978). Mintzberg provides some measure of motivation for this study to investigate the emergent component of manufacturing strategy.

The top-down approach

The top-down approach has universal and intuitive appeal, and has formed the basis for many observations, recommendations and refinements in the literature of how to develop manufacturing strategy (for example, Hill, 1985; Fine and Hax, 1985; Mills et al., 1996; Schroeder and Lahr, 1990; Swamidass, 1986, 2000a; Swamidass and Newell, 1987; Kotha and Swamidass, 2000). A step-wise process that captures the essence of the traditional manufacturing strategy-planning approach is illustrated in Figure 1. The stages of this top-down process are:

1. (1) Define corporate objectives. Corporate objectives may include items such as frequent introduction of new products, low costs, or product customization, which have profound implications for manufacturing.
2. (2) Select product families. Group products by the similarity in their competitive requirements and establish strategic manufacturing priorities in terms of differentiation, cost, quality, delivery and flexibility.
3. (3) Audit of external conditions. This audit addresses market requirements and competition for each group. This stage uses input from the marketing function of the company. Benchmarking may assist in understanding competitors and the nature of competition.
4. (4) Audit of internal capabilities. Evaluate the manufacturing capability of the firm in the context of the manufacturing strategy priorities established in Stage 2 above. This stage assesses the state of the current manufacturing facilities, technology and infrastructure with respect to the priorities.
5. (5) The gap between actual and desired performance (gap analysis). Evaluate the manufacturing capabilities of the firm in the context of the strategic manufacturing priorities.
6. (6) Prioritize and set objectives for manufacturing. Use the results of the gap analysis to address the shortcomings of the manufacturing system through a set of tangible objectives.
7. (7) Choose manufacturing strategies. The objectives from the previous stage are translated into specific action plans.

The planning approach described above is an elegant process. But, in our studies, we do not see it being used extensively.

Evolving methods

We present three mini-cases to illustrate new alternatives to the top-down planning approach described above.

Company A

A material handling equipment manufacturer with about 950 employees has a reputation for producing high-quality specialized, heavy-duty equipment for material handling. The manufacturing practices at this plant compare with industry norms. The company invests in manufacturing improvement programs to keep up with industry practices. The most recent initiative, which began in late 1998, is to invest in an ERP implementation program with the help of consultants at a cost of $3 million spread over a five-year period. This is the single biggest investment in manufacturing process improvement in the company's history. This improvement program is the result of the

initiative of mid- to lower-level manufacturing managers. There is no formal top-down manufacturing strategy development process in this company. Yet, it is an above-average performer.

Company B

This low-cost, mass producer of engines with about 750 employees, uses manufacturing flexibility as a core competence, which is not easily replicable by competitors or by sister plants of the firm. The plant is aggressive in seeking economy of scope through flexibility in manufacturing, and the corporate office uses the increased flexibility in emerging corporate product strategy.

Formal, periodic top-down manufacturing strategy development is not evident here, but investments in sustaining the core competence flow freely as and when needed. The drive to maintain manufacturing core competence ensures investments in manufacturing. There are both top-down and bottom-up initiatives that strengthen the core competence. Large investments in manufacturing occur rapidly as this market leader exploits every reasonable opportunity. This company performs well and is dominant in the industry.

Company C

This manufacturer of agricultural equipment runs an old manufacturing facility with 850 employees. The products have a stable market. Changes in manufacturing are incremental, the most recent being the slow introduction of six welding robots over a three-year period. The initiative, which is heavily bottom-up, is intended to reduce the dependence on skilled welders, who are in short supply. No formal manufacturing strategy development process is in evidence. This established manufacturer is performing well.

The three mini-cases above show that, while top-down manufacturing strategy planning is not evident, the following alternative processes are being used

(1) a coherent and incremental pattern of actions;
(2) manufacturing/process improvement programs; or
(3) core manufacturing capability development programs.

The various manufacturing strategy processes have their merits, which are summarized in Table I. In the following paragraphs we discuss the three new alternative approaches illustrated by the three mini-cases.

1. An incremental pattern of actions.

One view of strategy development is that strategy may not be what is written in the planning documents of the company, but it is constituted by the actual patterns of decisions and actions over a period of time. Mintzberg (1978, 1987) proposed that emergent, almost accidental strategies together with proactive plans form the overall strategic direction of the company (Table II). Thus, manufacturing strategy can evolve incrementally, while it may not be a part of formal planning documents. Company C exemplifies this form of manufacturing strategy development through incremental actions. In this company, where manufacturing plays a rudimentary role in strategy, a pattern of incremental decisions in manufacturing reveals a manufacturing strategy over time. A modest capital budget is spent in reducing manufacturing cost and increasing manufacturing flexibility, primarily through slow and steady investment in CNC machines. In such firms, which are called Stage 1 firms by Hayes and Wheelwright (1984), in their classification in Table III, only small incremental changes occur because investments needed to make a step change in manufacturing are rare.

2. The use of manufacturing improvement programs.

In the last two decades, several innovations in process technologies, philosophies, and practices have been introduced by manufacturing firms. These methods are directed at improving the management of operations and production for better manufacturing efficiency and effectiveness, and have become collectively known as advanced manufacturing technologies, or improvement programs. Swamidass (2000b), in a report examining the use of 17 different manufacturing technological programs in over 1000 manufacturing plants in the USA, classifies such programs as “hard” technologies and “soft” technologies, and provides evidence showing that these technologies

improve efficiency and performance. More than two-thirds of the respondents reported improvements in the following five areas as a direct result of technology use:

(1) inventory turns;
(2) lead time;
(3) rejection and rework rates;
(4) sales per employee; and
(5) return on investment.

We found that, in the wake of drastic changes in manufacturing in recent years, companies are more decentralized, and decision making is now delegated to lower and lower levels. In such companies, bottom up improvement efforts employing soft or hard technologies is logical, while formal manufacturing strategy process withdraws to the background. In a decentralized setting, the improvement programs seem to serve as a substitute for the formal manufacturing strategy development process (Table II).

There is a degree of risk in choosing and implementing technologies as part of improvement programs without considering the larger business strategy (Garvin, 1993). However, in firms that fit Stage 2 in Hayes and Wheelwright's (1984) model in Table III, improvement programs initiated from below serve as a way of keeping up with industry norms and, additionally, serve as a de facto manufacturing strategy. Company A is a good example of this. In this company, the need for improved integration and for better use of resources has led to a collective decision to install an expensive ERP system.

3. Manufacturing competency development.

The concept of manufacturing competency development derives from the business strategy literature and the idea of the learning organization (Prahalad and Hamel, 1990; Hayes et al., 1988). The notion of using competencies as a dynamic basis for manufacturing strategy development is a comparatively recent phenomenon (Spring and Boaden, 1995). Manufacturing competencies fall into seven types (Swink, 2000):

(1) improvement through motivation, learning, waste reduction;
(2) innovation through scanning, creativity, ingenuity;
(3) integration through product introduction flexibility, process ramp-up flexibility, modification flexibility, aggregate change flexibility;
(4) acuity through gaining know-how, information sharing;
(5) control through process understanding, feedback, and adjustment;
(6) agility through volume flexibility, mix flexibility; and
(7) responsiveness through material flexibility, rerouting flexibility, sequencing flexibility, shipment flexibility.

Manufacturing competency development can be seen as more comprehensive than the selective use of manufacturing improvement programs; "improvement" is only one competency in the list above. In Hayes and Wheelwright's (1984) model in Table III, Stage 4 firms use manufacturing as a competitive weapon. That is, manufacturing as a whole, or aspects of it serve as the company's strategic core competence. Far-reaching transformation of the company is possible when competence is enhanced or changed. For example, improved competence or a newly-acquired one can have far-reaching implications such as altering or refining the mission of the business. We find that Stage 4 firms are focused on strengthening their core manufacturing competence in one or more dimensions listed above. The process is well internalized by the organization through planning, involvement and integration. Manufacturing strategy is not merely top-down; it evolves with theinvolvement of everyone. Company B exemplifies the case where core competence development drives manufacturing strategy. Figure 2 adds another dimension to the Hayes and Wheelwright (1984) model in Table III; the new dimension is described after the following case study.

An in-depth case of a UK company

This case concerns a UK manufacturer of gas and electricity metering equipment. The plant employs 170 with annual sales of over £60 million, and profits of £7 million. The plant is designated a "center of excellence" by the international parent company.

The site assembles and refurbishes two main meter systems for electricity and gas payment. Both payments use "smart card" technology so that customers may pre-purchase energy credit units in the form of cards and transfer these to the metering system at home.

Our study is anchored around a key strategic event at the plant occurring in the early 1990s, when the plant relocated to the West Midlands from London. While in London, the firm operated in a traditional manner with extensive piecework and a traditional work environment. In late 1989, the company wished to expand the range of its metering products, but, due to the physical limitations of the plant at London, no expansion of the production facilities was possible at that site.

The energy payment systems division relocated to the West Midlands in early 1991 with the aim to start afresh with revised work practices and new products. Most of the managerial staff was relocated from London but most direct labor was newly recruited from the local labor market.

Reasons for the relocation

The relocation decision brought a quantum change. The new products eliminated the need for certain processes such as the molding of plastic cases for the meters. The assembly and testing operations, together with sales and design engineering, were identified by the plant's manufacturing director as thecore competencies of the plant. At the new site, manufacturing was to emphasize this core competence of the plant.

Electronic meters were not competing head-on with the mechanical meters made by other firms. The electronic meters were perceived as unnecessarily advanced by the utility companies at first. Later, a major gas company in the UK, who required new systems to help combat fraud and facilitate debt collection, wanted to exploit the electronic meter technology. This enabled the plant to win a sizable contract to develop a new payment system for the gas company.

At about the same time, the electricity market was de-regulated and the early 1990's recession was affecting electricity customers, causing debts and a higher rate of electricity supply disconnection. Consequently, the pre-payment meter system was adopted by the electricity power industry also.

Who are the players?

Figure 3 is a map of the manufacturing strategy decisions at this plant from 1989 to 1997. From this map, we see that the corporate planning team (cell 1) triggered the decisions that led to the relocation decision (cell 14); this is clearly a top-down approach to manufacturing strategy development. A year later, inearly 1991, the plant was losing money, when at the initiative of the manufacturing director (cell 2) an incremental (emergent) strategy (cell 10) led to a focused strategy through a long-term gas company contract and secondary sales to electric utilities. Finally, in cell 3, we see that the manufacturing manager makes investments in improvement programs to reduce lead time and waste.

It is important to note that strategic planning occurs at the corporate planning team level, an incremental or emergent strategic decision was made at the level of the manufacturing director and, finally, the use of improvement programs were employed by the manufacturing manager.

During late 1991 and 1992, JIT production was implemented (cell 15). The reason for this decision was the manufacturing manager's goal of reducing lead-time and waste (cell 7), which was driven by the need to be a world-class supplier to a major gas company.

How was manufacturing strategy developed?

We see in Figure 3 that, over time, the strategic decisions of smaller scope drift into lower management levels. From the third row of the map, the heart of the manufacturing strategy development processes used in the company can be deduced. For the relocation decision, a SWOT analysis of geographic and economic factors took place (cell 9). The decision to focus on the gas company (cell 10) was an opportunistic, emergent strategy, a deviation from traditional top-down strategic planning. Later, the implementation of manufacturing improvement programs in the year 1991 onward (cells 11 and 12) improved the strategic advantage of the company.

Strategic direction over time

In Figure 3, as we move left to right along the X-axis, we see the evolution of the overall manufacturing strategy and the process of developing it. It begins with a fresh start as a formally developed strategy to build a new plant, where production reaches capacity in early 1991. Then, manufacturing strategy acquires a product focus on specific customers (1991). Finally, competencies are improved through appropriate manufacturing improvement programs (1992 onwards). It is notable that, over time, the company uses formal and less formal manufacturing strategy development processes.

The strategic role of manufacturing affects strategy development process

As we have discussed above, the strategic role of manufacturing and the strategy development processes are related. This relationship is described graphically in Figure 2. The diagonal shows the most likely process to accompany the various strategic roles of manufacturing in a company. Figure 2 does not rule out the existence of companies that are off diagonal, but they are less likely. Our observations of several US companies confirm that the diagonal is the most likely dynamic in practice; that is, as the role of manufacturing in strategy progresses from stage to stage, the strategy development process also changes along the diagonal in Figure 2.

By moving away from the diagonal, a company may spend more effort in the process than appropriate, or, on the contrary, the firm may devote less effort in the manufacturing strategy process to the firm's detriment. It is clear that the traditional planning model of manufacturing strategy is valuable, but other processes are evolving. During our investigation, we also found that a company may use more than one approach to manufacturing strategy over extended periods of time. The above case illustrates this phenomenon.

Conclusions

If a plant does not have top-down formal manufacturing strategy planning, it might use one of three emerging alternative processes:

(1) a chosen pattern of actions;
(2) manufacturing process improvement programs; and
(3) the pursuit of manufacturing competency.

We found that the use the alternatives have not hindered the success of the three companies featured at the start of the paper. Figure 2 explains why there may be more than one appropriate process for manufacturing strategy development.

The use of an incremental approach and improvement programs as substitutes for manufacturing strategy is appropriate if the top management prefers to decentralize and delegate the decisions to lower levels. An annual capital budget allowed for the manufacturing function may be used by the top management to exercise minimal control while delegating the process to lower levels.

The use of top-down planning and core competence requires more direct involvement of the top management. The use of multiple processes should not be ruled out. For example, the top management may specify the core competencies to be emphasized in manufacturing with input from lower levels as needed. However, while the top-level executives may take the lead and decide the requisite core competence in manufacturing, they may then

delegate the subsequent strategic manufacturing decisions to initiate improvement programs to lower levels. Consequently, for several years, incremental strategies and improvement programs for sustaining the manufacturing core competence may be left to lower levels of management. This is evident in the case of the UK firm.

The implications of Figure 2 for research are many. First, propositions implied in Figure 2 might be tested using a large sample of manufacturing firms. Another research stream may investigate the effect of the various strategy development processes on performance. An important research question could be: "How do we ensure that the strategy developed by the various processes is consistent with the business strategy of the firm or the strategic business unit?".

What should a company do?

Manufacturers may reevaluate their manufacturing strategy development processes in the light of the alternative processes unearthed. A company ought to pick one that best suits its needs now. One important contribution of this paper is that, over time, the company may successfully change the process as fittingly illustrated by Figure 3.

	1. Incremental patterns of actions	2. Adoption of improvement programs	3. Top-down planning/ audit	4. Core competency development
Baines *et al.* (1993)		Prescriptive, internally supportive	Four design processes, all viewed as deliberately planned	Externally supportive – manufacturing is proactive
Clark (1996)		Provides the basis for capabilities for manufacturing	Important, but on its own leads to static view of strategy	Learning: using technologies more effectively than others
Kim and Arnold (1996)		Links competitive priorities to manufacturing improvement programs	Linking competitive priorities to structure and infrastructure choices	
Leong and Ward (1995)	Observed stream of decisions or actions	Structured, time-phased, and evaluated actions Typically involve broad worker participation	Hierarchical corporate planning framework, fits manufacturing and corporate goals	Portfolio of manufacturing capabilities, seen as the competitive priorities
Marucheck *et al.* (1990) – empirical study		All companies used MRP and maintained accurate data bases	All companies followed a hierarchical process	
Mills *et al.* (1995); Platts (1994)	Alternative descriptive view that must be considered in conjunction with planning		Component of MS process (procedure)	

Table I.Alternative manufacturing strategy development processes and relevant literature

Process 1	Patterns of incremental actions (emergent)	In firms where manufacturing plays a rudimentary role in strategy, a pattern of incremental decisions in manufacturing may reveal a manufacturing strategy over time in the absence of a formal, well-articulated plan
Process 2	Adoption of improvement programs	Process technologies, philosophies, and practices that are directed at improving the management of operations and production for better manufacturing efficiency and effectiveness are implemented. In some companies, bottom-up improvement efforts employing one or more technologies or techniques may not be part of a formal manufacturing strategy process, but may actually serve as a substitute for a formal manufacturing strategy process that does not exist
Process 3	Top-down planning/audit	A top-down approach in which the manufacturing function is required to perform specified focused manufacturing tasks derived from business strategy and corporate strategy. This process is audit-based: The current performance of the manufacturing system is assessed against the demands of the business strategy and customer requirements
Process 4	Core competency development	Core manufacturing competencies are specific capabilities such as innovation, integration, and agility that world-class manufacturing firms use as a competitive weapon. Far-reaching transformation is possible when competence is enhanced or changed; the mission of the business could be altered or refined

Table II.Alternative manufacturing strategy development processes

Stage 1	Minimize manufacturing's negative potential: "internally neutral"	Outside experts are called in to make decisions about strategic manufacturing issues Internal, detailed management control systems are the primary means for monitoring manufacturing performance Manufacturing is kept flexible and reactive
Stage 2	Achieve parity with competitors: "externally neutral"	"Industry practice" is followed The planning horizon for manufacturing investment decisions is extended to incorporate a single business cycle Capital investment is the primary means for catching up with competition or achieving a competitive edge
Stage 3	Provide credible support to the business strategy: "internally supportive"	Manufacturing investments are screened for consistency with the business strategy A manufacturing strategy is formulated and pursued Longer-term manufacturing developments and trends are addressed systematically
Stage 4	Pursue a manufacturing-based competitive advantage: "externally supportive"	Efforts are made to anticipate the potential of new manufacturing practices and technologies Manufacturing is involved "up front" in major marketing and engineering decisions (and *vice versa*) Long-range programs are pursued in order to acquire capabilities in advance of needs

Table III.Stages in the strategic role of manufacturing

Figure 1.A formal top-down process for developing manufacturing strategy [not available on this version]

Strategic Role of Manufacturing (Hayes and Wheelwright[2])	Alternative Manufacturing Strategy Development Processes			
	1. Patterns of Incremental Actions	2. Adoption of Improve-ment Programs	3. Top-Down Planning / Audit	4. Core Competency Development
Stage 1: Internally Neutral	Most Likely Combination of Process and Stage **(Company C)**			
Stage 2: Externally Neutral		Most Likely Combination of Process and Stage **(Company A)**		
Stage 3: Internally Supportive			Most Likely Combination of Process and Stage	
Stage 4: Externally Supportive				Most Likely Combination of Process and Stage **(Company B)**

Increasing Role of Manufacturing

Figure 2.Managing strategy development processes and the strategic role of manufacturing

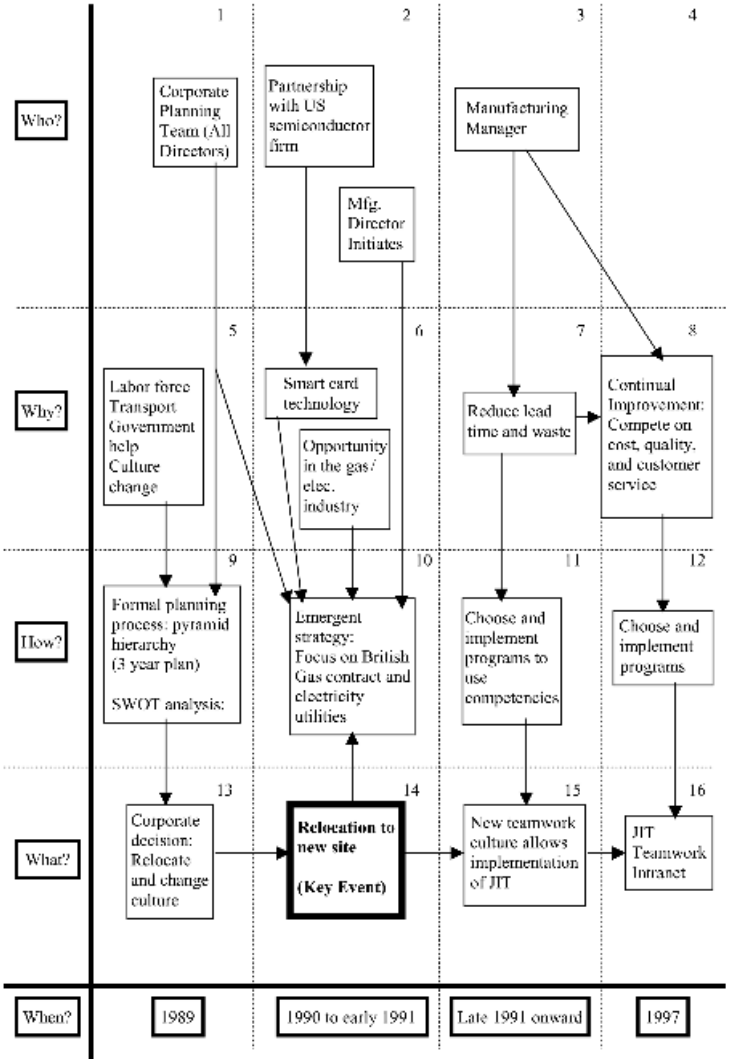

Figure 3.Manufacturing strategy development in a UK company

References

Adam, E.E., Swamidass, P.M. (1989), "Assessing operations management from a strategic perspective", Journal of Management, Vol. 15 No.2, pp.181-203.

Baines, T.S., Hambein, D.J., Harrison, D.K. (1993), "A unified classification of manufacturing strategies and design processes", Engineering Management Journal, pp.281-6.

Clark, K.B. (1996), "Competing through manufacturing and the new manufacturing paradigm: is manufacturing strategy passé?", Production and Operations Management, Vol. 5 No.1, pp.42-58.

Darlow, N.R. (1999), "An investigation into the role of formal planning processes in manufacturing strategy formulation", Staffordshire University, Stoke on Trent, PhD thesis.

Darlow, N.R., Baines, T.S. (2000), "Capturing the process of manufacturing strategy formulation", in Hayhurst, D.R. (Eds),MATADOR: Proceedings of the 33rd International Conference, Springer-Verlag, London.

Fine, C.H., Hax, A.C. (1985), "Manufacturing strategy: a methodology and an illustration", Interfaces, Vol. 15 No.6, pp.28-46.

General Accounting Office (1990), Case Study Evaluations, General Accounting Office, Washington, DC, Transfer Paper 10.1.9. US.

Garvin, D.A. (1993), "Manufacturing strategic planning", California Management Review, pp.85-106.

Hayes, R.H., Wheelwright, S.C. (1984), Restoring our Competitive Edge: Competing Through Manufacturing, Wiley, New York, NY.

Hayes, R.H., Whellwright, S.C., Clark, K.B. (1988), Dynamic Manufacturing: Creating the Learning Organization, The Free Press, New York, NY.

Hill, T.J. (1985), Manufacturing Strategy, Macmillan, London.

Kim, J.S., Arnold, P. (1996), "Operationalizing manufacturing strategy – an exploratory study of concepts and linkage", International Journal of Operations & Production Management, Vol. 16 No.12, pp.45-73.

Kotha, S., Swamidass, P.M. (2000), "Strategy, advanced manufacturing technology and performance: empirical evidence from US manufacturing firms", Journal of Operations Management, Vol. 18 pp.257-77.

Leong, G.K., Ward, P.T. (1995), "The six Ps of manufacturing strategy", International Journal of Operations & Production Management, Vol. 15 No.12, pp.32-45.

Marucheck, A., Pammesi, R., Anderson, C. (1990), "An exploratory study of the manufacturing strategy process in practice", Journal of Operations Management, Vol. 9 No.1, pp.101-23.

Mills, J.F., Platts, K.W., Gregory, M. (1995), "A framework for the design of manufacturing strategy processes – a contingency approach", International Journal of Operations & Production Management, Vol. 15 No.4, pp.17-49.

Mills, J.F., Platts, K.W., Necly, A.D., Richards, H., Gregory, M.T., Bourne, M. (1996), Creating a Winning Business Formula, Works Management, London.

Mintzberg, H. (1978), "Patterns in strategy formation", Management Science, Vol. 24 No.9, pp.934-48.

Mintzberg, H. (1987), "Crafting strategy", Harvard Business Review, pp.66-75.

Platts, K.W. (1994), "Characteristics of methodologies for manufacturing strategy formulation", Computer Integrated Manufacturing Systems, Vol. 7 No.2, pp.93-9.

Prahalad, C.K., Hamel, G. (1990), "The core competence of the corporation", Harvard Business Review, Vol. 63 No.3, pp.79-91.

Schroeder, R.G., Lahr, T.N. (1990), "Development of manufacturing strategy: a proven process", Proceedings of the Joint Industry University Conference on Manufacturing Strategy, Ann Arbor, MI, pp.3-14.

Skinner, W. (1969), "Manufacturing – the missing link in corporate strateg", Harvard Business Review, Vol. 47 No.3, pp.136-45.

Skinner, W. (1974), "The focused factory", Harvard Business Review, Vol. 52 No.3, pp.113-19.

Spring, M., Boaden, R.J. (1995), "One more time: how do you win orders? A critical reappraisal of the Terry Hill manufacturing strategy framework", International Journal of Operations & Production Management, Vol. 17 No.8, pp.757-79.

Swamidass, P.M. (1986), "Manufacturing strategy: its assessment and practice", Journal of Operations Management, Vol. 6 No.4.

Swamidass, P.M. (2000), "Manufacturing flexibility", in Swamidass P.M. (Eds),Innovations in Competitive Manufacturing, Kluwer Academic Press, Boston, MA.

Swamidass, P.M. (2000), "Manufacturing technology use in the US and benefits", in Swamidass P.M. (Eds),Innovations in Competitive Manufacturing, Kluwer Academic Press, Boston, MA.

Swamidass, P.M., Darlow, N.R. (2000), "Manufacturing strategy", in Swamidass P.M. (Eds),The Encyclopedia of Production and Manufacturing Management, Kluwer Academic Press, Boston, MA, pp.417-22.

Swamidass, P.M., Newell, W.T. (1987), "Manufacturing strategy, environmental uncertainty and performance: a path analytic model", Management Science, Vol. 33 No.4, pp.509-24.

Swamidass, P.M., Darlow, N.R., Baines, T.S. (1999), "Assessing manufacturing strategy process using an event-based process mapping approach: methodology and cases", Charleston, SC, Presented at POMS 1999.

Swink, M. (2000), "Core manufacturing competencies", in Swamidass, P.M. (Eds),Encyclopedia of Production and Manufacturing Management, Kluwer Academic Publishing, Boston, MA.

Yin, R.K. (1994), Case Study Research: Design and Methods, Sage, Thousand Oaks, CA.