"TRADE-OFFS? WHAT TRADE-OFFS? (COMPETENCE AND COMPETITIVENESS IN MANUFACTURING STRATEGY)"

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93/09/SM/TM

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N.B. This is a revised version of INSEAD working paper No. 91/25/SM/TM.

Printed at INSEAD
Fontainebleau,
France

Trade-Offs? What Trade-Offs?

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(This is a revised version of an earlier working paper with the same title, 91/25/SM/TM. This version has been submitted to *California Management Review.*)

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February 8, 1993

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Abstract

Manufacturing strategy is increasingly recognized by academics as essential in achieving sustainable competitive advantage. The reason it has not yet penetrated equally far into the world of business is partly the lack of simple conceptual foundations. As a result, a number of important observations showing up recently in manufacturing strategy literature have not yet captured the attention they deserve, despite their broad implications for managers. This article attempts to clarify some of these issues. It is important to distinguish clearly between internal competences and external measures of competitiveness; ensuring a proper link between the two is a critical factor for success. The points we emphasize are (1) competences don't have to hurt each other, (2) performance relative to the competition is what counts, (3) each product has to meet some minimum requirements to have a chance of selling, and (4) these requirements are continually becoming tougher. We then sketch a scenario where even superior manufacturing may no longer be a source of competitive advantage, but simply a ticket to the ball game.

Trade-Offs? What Trade-Offs?

(Competence and competitiveness in manufacturing strategy)

Charles Corbett **Luk Van Wassenhove**

The field of manufacturing strategy has been around for more than 20 years.[1] Over this period the field has advanced considerably as an academic discipline, but practical achievements have been limited to date. The father of the field, Wickham Skinner, claims that this is partly due to the lack of solid conceptual foundations.[2] Indeed, some important recent developments in thinking on manufacturing strategy and their managerial implications have not drawn as much attention as we believe they deserve. In this paper, we bring a number of these developments together and state them more explicitly. In so doing, we hope to clarify them. We also extrapolate the recent developments in question to an extreme-sounding but currently emerging scenario, describing how manufacturing may eventually cease to be a source of competitive advantage, leaving human resources as the ultimate critical factor. In particular, we use these emerging concepts in manufacturing strategy to provide a conceptual basis for the often-heard complaint among managers that "markets are always becoming more competitive" or "margins are continuously getting smaller." What seems to emerge is the concept of a competitive dimensions life-cycle, suggesting that the well-known product-process matrix is losing its validity.

We are greatly indebted to an anonymous referee of the *California Management Review*, whose comments have led to substantial improvements in this paper.

Dimensions of Competence and Competitiveness

A serious problem in manufacturing strategy literature is the lack of generally accepted definitions of key concepts, such as the frequently used "competitive priorities" cost, quality, dependability, flexibility, and innovativeness. This hampers the development of a coherent theory of manufacturing strategy and results in a lack of operationally useful measurement criteria to facilitate empirical work. We do not pretend to be able to remedy these problems but hope to shed some new light on the issue, by making an explicit distinction between *competence-related* and *competitiveness-related* dimensions and by regrouping the "competitive priorities" in a more logically consistent way.

Dimensions of competence—Manufacturing strategy literature has paid surprisingly little attention to the field of marketing and has developed its own set of "competitive priorities:" cost, quality, dependability, flexibility, and innovativeness.[3] However, these "competitive priorities" are sometimes used as measures of (external) competitiveness and sometimes of (internal) competence, despite the fact that they are two very different sides of the same coin. For instance, "rerouting flexibility," the ability to reroute jobs in the event of a machine failure,[4] is an internal competence, whereas reacting flexibly to sudden changes in demand is a dimension of competitiveness. For a manufacturer, inspecting out defects at the end of the process and preventing them during the process are two very different ways of delivering high quality products; for the customer, there is no difference. We suggest using manufacturing strategy's "competitive priorities" in a strictly competence-oriented sense.

Another problem is the overlap of the dimensions of competence, particularly between dependability, flexibility, and innovativeness. Higher dependability often facilitates more flexibility, whereas flexibility is a step toward enabling more innovation. The latter can be seen by considering a modern, flexible automobile factory, where the assembly line is highly automated. Introduction of a new model is significantly easier than it used to be. Designers use sophisticated computer aided design (CAD) techniques, supplemented by computer aided engineering (CAE) tools for testing the design (computer prototyping) and computer aided manufacturing (CAM) facilities to translate the computer design into machine instruction programs which convert the design into a physical product. Because it is reprogrammable, flexible automation removes the need to design an entirely new production line for each new model, thereby cutting back the time-to-market and

significantly reducing upfront capital outlay. Thus, flexibility enhances innovativeness. Because of these complex and situation-dependent interrelationships, a different classification of dimensions of competence is more appropriate. In our view, *time* encompasses the role of dependability, flexibility, and rate of innovation. Many examples illustrating the increasing importance of the time dimensions are given by Stalk and Hout[5] and by Blackburn.[6] Following the above discussion, we tentatively define three dimensions of competence as follows.

- *Cost* refers to the sum of all discounted costs to the firm involved in developing, producing, delivering, servicing, and disposing of the product. Conventional cost accounting procedures may not easily provide insights into the true life-cycle costs.[7]
- *Time* refers to all lead-time-related factors, such as average lead-time between receiving an order and delivery of the product, variability of lead-time, lead-time sensitivity to changes in demand, and time-to-market for new products.
- *Quality* refers to all physical aspects of the process and product or service delivered. An example is the number of defects during and after the process. Garvin[8] suggests a list of dimensions of quality: performance, features, reliability, conformance, durability, serviceability, and aesthetics. (His eighth dimension, perceived quality, is a result of marketing efforts.)

Dimensions of competitiveness—A firm's competitiveness in any particular market depends on its ability to meet that market's desires, so any measures of competitiveness must, by definition, be market- or customer-oriented. Measuring competence is not enough. It is therefore natural to turn to the marketing literature, where a firm's competitiveness is said to depend on its "marketing mix," the combination of the 4 Ps of product, place, price, and promotion. Promotion deals with influencing customers' awareness and perceptions of the first 3 Ps and will not be considered here. The following discussion is loosely based on a marketing textbook[9] and has been adapted somewhat so as to mirror the competence dimensions distinguished in the previous paragraph.

- *Price* refers to the sum of all discounted financial costs to the customer involved in ordering, receiving, using, and disposing of the product.
- *Place* refers to everything concerned with delivery of the product, such as place and time of delivery, cancellation and order adjustment conditions, and availability of innovative products.

- *Product* refers to all properties of the physical product itself. Garvin's list is applicable here as well.

Such definitions can obviously be improved upon, but between them they seem to cover all relevant aspects of competitiveness and they are largely nonoverlapping. Eliminating all overlap is not possible, as, for example, price will often depend on delivery conditions.

The two sides of the coin—First, we must note that cost, quality, and time, like price, product, and place, are not simple attributes but complex multidimensional concepts (recall the list of dimensions of quality). Which subdimensions of a competence or competitiveness dimension are relevant is market-dependent: reliability and cost of use may be considered of less concern in sugar cubes than in automobiles, as opposed to taste and packaging. For simplicity, however, we treat these measures as unidimensional in the remainder of this paper.

It should be clear that "price, place, product" and "cost, time, quality" are strongly related. They are, in fact, the marketing and manufacturing sides of the same coin, the outward-looking and inward-looking perspectives on the same concepts. However, they are by no means equal and should not be confused. For instance, if manufacturing does a great job in terms of cost, time, and quality but the market simply has no use for the resulting product, the price-place-product combination will not be highly valued. We will return to this point later. Other factors may also dilute the value of manufacturing's good performance for the customer. Toyota, for example, could produce a car in less than two days but its distribution network needed up to 26 days to deliver the car to the customer.[10] In short, manufacturing competence is not a sufficient condition for competitiveness. In the short run, it is not even a necessary condition, as it may be profitable to sell a product below its unit cost for a period of time. In the long run, however, this is not sustainable; building competences is then a necessary condition for maintaining competitiveness. The distinction between competences and competitiveness is critical in discussing manufacturing strategy since it immediately highlights the fact that core competences in manufacturing are useless if they are not properly aligned with competitive positioning.

Focus—After looking at dimensions of competence and competitiveness, we now turn to the concept of focus as it relates to these dimensions. Skinner[11] introduced the notion that, in order to compete successfully, a firm requires a well-defined *manufacturing mission.* A clear mission enables

manufacturing to support the overall business strategy by concentrating its efforts as effectively as possible. Given a particular competitive stance (i.e., a specific marketing mix), a manufacturing strategy should ensure that the right competences are developed. Skinner later[12] further refined his ideas, arguing that no factory can be expected to perform well by every yardstick. In other words, good manufacturing practice meant focusing on a very limited subset of competences. In a similar vein, Porter[13] warns against the dangers of being "stuck in the middle" by trying to compete on too many fronts at once. Porter's concept of focus deals with competitive positioning (e.g., price competition vs. diversification strategies). The different types of focus are depicted in a highly simplified way in figure 1.

FIGURE 1 ABOUT HERE.

Until recently, manufacturing's job was often reduced to not obstructing deployment of the business strategy and being as cost-efficient as possible.[14] Skinner[15] warns that the key question is not "how can we reduce costs" but "how can we compete," i.e., how can manufacturing play a more proactive role in supporting and even formulating business strategy.

The view that being competitive means "focusing" on a few dimensions of competence and competitiveness is still widespread. Many writings in manufacturing strategy have revolved around these trade-offs between the various dimensions without realizing that some classical trade-offs are either gradually disappearing or substantially changing their nature. Let us consider the following simple example. Company *ABC* is losing market share because of its low quality products. In a major effort to improve quality it rethinks its products, processes, and procedures. This leads to substantial simplifications and therefore reduces costs. The exercise also facilitates the introduction of Group Technology (cell layouts) and flexible automation, thereby increasing flexibility without a corresponding cost increase. Finally, the simple and high quality processes, designed to maximize flexibility, also turn out to be very dependable and to facilitate new product introduction.

The above example is both real and far from being unique. It clearly shows the changing nature and increasing complexity of trade-offs, the core subject of this paper. This does not mean, however, that trade-offs can be discarded. The managers of company *ABC* obviously still have to make trade-offs when deciding on how to compete.

Recent Observations

In this section, we look at the most recent developments in thinking about competence and competitiveness in manufacturing strategy literature. Several authors have recently emphasized that:

- competences are not necessarily mutually exclusive but can reinforce one another and are dynamic in time;
- competitiveness must be defined relative to firms competing for the same customer base;
- there is a distinction between qualifying criteria and order-winning criteria;
- qualifying criteria and order-winning criteria evolve over time.

These points may sound self-evident, but they have not drawn much attention so far despite the fact that they clearly have huge implications for the theory and practice of manufacturing strategy.

Cumulative competence building—We described above how the concept of focus was often interpreted as the need to make a trade-off between conflicting competences, e.g., quality has a cost premium, so achieving high quality and low cost simultaneously would not be possible. Ferdows and De Meyer[16] dispel this view using data from the 1988 Manufacturing Futures survey.[17] They observe that some manufacturers seem to be able to achieve better performance on many, if not all, of the dimensions of competence (cost, quality, dependability, flexibility, innovation).[18]

Ferdows and De Meyer suggest that "the different capabilities have been *cumulative* and not the result of compromises and *trade-offs*."[19] Consequently, they reject the traditional trade-off model and propose a different construct: the *cumulative model*. According to this model, attempts to improve performance should be organized in such a way as to reinforce rather than replace one another. Their data suggest that *quality* could be viewed as a precondition to all lasting improvements in manufacturing performance. Once the groundwork for quality has been laid, a firm can begin to also direct some attention to *dependability*, while at the same time continuing to expand its quality improvement efforts. Next, while still increasing concurrent efforts to improve quality and dependability, *speed* improvement should be added. Finally, while all the previous efforts are still expanding at increasingly higher rates, *cost* reduction programs can be introduced.

Ferdows and De Meyer's findings clearly suggest that the competences are not mutually exclusive as implied by the traditional trade-off model. Moreover, the sandcone model is *dynamic* in nature in that it describes how firms could direct their improvement programs over time. Ferdows and De Meyer's quality-dependability-flexibility-cost sequence was found empirically and therefore has no normative content. It does, however, have a clear intuitive appeal. An argument for this particular sequence could be as follows. Achieving consistently high quality often requires a high degree of control over the process and is therefore the driver for subsequent improvements. This control (in combination with an accurate due-date setting system) enables a high degree of dependability. Not being able to meet due-dates under normal circumstances implies that being able to react flexibly to unforeseen circumstances will also be impossible. Without quality and dependability, flexibility will soon degenerate into chaos. Finally, when the process is fully understood and well under control so that quality, dependability, and flexibility requirements can be met, potential cost reductions will become apparent. Trying to cut costs first often has an adverse effect on quality and dependability and therefore indirectly leads to a deterioration in competitiveness. This is Skinner's "productivity paradox," which is supported by empirical results arising from the PIMS database on competitive strategies and performance.[20]

Although quality can be a powerful driver, a similar case can be made for time.[21] Taking time out of a process can indeed focus attention on quality (e.g., rework) problems and reduce costs. Fast cycle time capabilities obviously improve flexibility and innovativeness (time-to-market). Time and quality are two sides of the same coin. Both can be powerful drivers for continual improvement programs. The choice between the two depends on the particular setting. Cost, on the other hand, is increasingly seen as a result, not a driver, which implies that across-the-board cost-cutting programs should be implemented with great care.

Competitiveness is relative—Many managers do not seem to realize that a firm's competitiveness is not determined by its own performance, but by its performance relative to that of the competition.[22] Manufacturing performance must eventually be measured in the marketplace using customer-oriented criteria instead of internal measures. This is the reason why earlier on we distinguished between price-place-product competitiveness dimensions and cost-time-quality competence dimensions. The former measures are by definition relative measures. The cost-time-quality measures, by contrast, reflect the competences required from manufacturing to achieve the desired competitiveness and therefore need to be absolute measures. A plant manager just

wants to know in how many days he or she has to get the product out, not by how many days to beat the competition. For a marketing manager, the situation is exactly reversed.

Qualifying criteria and order-winning criteria—A third important point has recently been formulated by Hill,[23] among others. Hill introduces the notion of *qualifying criteria* and *order-winning criteria*, suggesting that manufacturing must at least meet the qualifying criteria in order to enter or stay in the market. This will not win orders, but merely prevent a company from rapidly losing orders to its competitors. Once these qualifying criteria have been met, manufacturing has to turn its attention to ways in which orders are won. In other words, there is a minimal threshold to be sustainable in business; achieving outstanding performance on one or two competitive dimensions is of no use if performance on another dimension is below the minimum level required by the market. Designing a car to go from 0 to 100 mph in less than 10 seconds is useless if rust drives it to the scrapyard in under 3 years.

The novelty of this view is that it is explicitly customer-oriented. Hill exchanges the inward-looking view normally associated with manufacturing for the outward-looking view characteristic of marketing. Competitiveness is not only relative to the competition but also to market desires. Even if our car manufacturer did learn his lesson, got rid of his rust problem, and met any other qualifying criteria to compete in the market, he still runs the risk that there is simply no demand for such high-acceleration cars. Hill recognizes this danger by using the term order-winning criteria. In our example, such high acceleration might simply not win any orders. Technically superior computers have been driven from the market due to poor customer service and lack of software.[24] Manufacturing competences should be carefully aligned with what the market wants.

The qualifying criteria and order-winning criteria refer, in principle, to conditions for competitiveness, but such conditions can be translated into requirements in terms of competences, i.e., the manufacturing mission. Therefore, we let qualifying criteria and order-winning criteria refer both to the price-place-product dimensions and to the cost-time-quality dimensions.

Each competitive dimension may have qualifying levels and order-winning levels. For example, the market may consider a five-year no-rust guarantee a minimum level and every year above that could be an order-winner. In some cases where more is not better, there would simply be a qualifying level but no order-winning levels. Any family car should have a reverse gear, but a gearbox with three reverse speeds is unlikely to attract any extra customers. Figure 2 contains a

simple graphical illustration of this point.

FIGURE 2 ABOUT HERE.

Dynamics—The final important observation[25] to be made is that the competitive environment is constantly changing. There are two closely related ways in which the hierarchy of qualifying and order-winning criteria discussed above changes over time.

- *Qualifying criteria become tougher.* The minimum performance levels which must be met in order to prevent the loss of market share become higher. One must constantly improve in absolute terms simply to prevent being wiped out of the market.
- *Order-winning criteria become qualifying criteria.* This is a similar principle: what at one time is considered by customers to be a valuable extra feature can, as they become used to it and as the competition copies it, become a standard minimum requirement. In other words, competitive advantage is a perishable good with a short (and shortening) shelf-life. Constant improvement in competences is needed just to hold on to the same competitive advantage. Product differentiation and price differentiation decline as a market matures, i.e., competitors gradually become more alike,[26] lending some empirical support for this principle.

As an example, good, durable, anti-corrosive treatment for cars has changed from an extra to a necessity, raising customers' minimum requirements with respect to quality. For this reason, performance levels at any given moment in time are only of temporary importance. The rate of improvement or, better still, the relative rate of improvement (with respect to the competition) is far more important. However far ahead a firm may be, another firm with a higher rate of improvement will always overtake at some point in time. And we should go even further by looking at the rate of increase in the rate of improvement (the second-order derivative). A firm which is currently far ahead, with a higher but constant rate of improvement, may at some later time be staring at the heels of the firm which was continually learning how to improve faster.

Looking into the Crystal Ball

Having discussed some recent developments in manufacturing strategy, it is tempting to perform an intellectual experiment by extrapolating them into the near future. That is done in the first part of this section; the second part makes a link to product and process life-cycles. It should be emphasized that this section is not based on any solid theory or empirical foundations, although the developments outlined here can already be observed in some branches of industry.

Knowledge workers: the ultimate factor?—Above we saw how continuous improvement is necessary just to maintain one's competitive position. Let us now draw a potential scenario of shifting qualifying and order-winning criteria over a product's life-cycle. An entirely new product has no qualifying criteria at all; any firm can compete in such a market, assuming that barriers to entry such as high initial capital investment can be overcome. All aspects of cost-time-quality competence are potential order-winners. After a while the product design standardizes, the market gradually matures, and customers come to expect a certain level of quality, so that quality is transformed from an order-winner into a qualifier. We have already mentioned the car that turned to rust in three years: not too long ago this was not uncommon for some cars, but nowadays manufacturers have to offer up to ten years' guaranteed rust-free driving in order to stay in business. Anti-corrosive treatment used to be an order-winning criterion for car manufacturers; nowadays it is a qualifying criterion.

As the market matures further, the time-based competitive dimensions also become qualifying criteria. In the high-volume car manufacturing world, dependable Just-In-Time delivery by suppliers to assemblers is the accepted standard, and any supplier who cannot meet this standard has no chance of competing. A Toyota supplier's response time was reduced from 15 days to 1 due to Toyota's reorganizing the supplier's manufacturing organization: it was either reorganize or forget about supplying Toyota.[27]

The example of the US industrial door market shows the importance of flexibility and how it has almost become a qualifying criterion. The industrial door manufacturers, faced with an almost infinite variety of width, height, and material combinations, historically had needed almost four months to supply doors that were out of stock or customized. The Atlas Door company became the market leader within 10 years by being able to respond to any order within weeks. Already

Atlas has replaced the leading door suppliers for 80% of the distributors in the country.[28]

Rate of innovation (frequently introducing new models and new products) is being recognized as an important dimension of competition. However, innovation can also become a qualifying criterion. This has happened in the motorcycle market as a result of the Honda-Yamaha war. Honda introduced so many new models in so little time that motorcycle design became a matter of fashion, where newness and freshness are important attributes for consumers.[29] A similar trend can be observed in personal hi-fi: a walkman which was designed three years ago may still be just as good a walkman as any new model, but there have been so many design changes that it will look hopelessly out of date. Designing a musically good walkman is no longer sufficient to be competitive, and a firm has to introduce style and color changes continuously to keep up with what has essentially become a volatile fashion market. The Swatch revolution is another example.

In the end, cost becomes the only dimension left to compete on. Once all firms have achieved the same competences with respect to quality and time performance (dependability, flexibility and innovation), the task becomes how to manage operations in the most efficient way. For instance, in discrete parts production, Flexible Manufacturing Systems (FMS) are revolutionizing the business. An FMS consists of a "computer-controlled grouping of semi-independent work stations linked by automated material-handling systems."[30] Flexible Manufacturing Systems are very reliable, can make a wide variety of parts, and can easily adapt to new demands. Quite a few of the Japanese FMSs are capable of running untended for several shifts. All costs in the development of tools, fixtures, and programs are sunk before the first unit is produced. The only variable costs are those of materials and energy, which often amount to less than 10% of total costs. In this environment, companies will have to concentrate on steady adjustments of product mix and price to maintain full capacity utilization. Simultaneously, there will be a need for pointed emphasis on reduction of fixed manufacturing costs and the time required to generate new products, processes, and programs. This whole process of continuously tightening market requirements is illustrated in Figure 3.

FIGURE 3 ABOUT HERE.

Finally, when all firms have access to the same flexible technology, they can, at least in theory, all perform equally well on quality, time, and cost. In this situation, the only difference between firms is the people working for them and how the knowledge these people create is managed to

enhance learning; human resources management now becomes the critical competence. Let us look at a scenario where this is happening.

Competing in the fast lane—*Assume you operate in the industrial fashion clothes market (e.g. Benetton, The Limited, etc.). Quick response and personalized design are rapidly becoming qualifying criteria. Therefore you create a team of highly creative designers, you supply them with the latest in CAD technology and put them together in a posh building in some fashionable town (how about Milan?). You also buy the latest in high resolution video conferencing equipment to allow your important customers (New York?) to create their personalized garments on-line with the help of your designers. Telecommunication also allows you to transfer any newly created design within minutes to some offshore manufacturing facility (how about Hong Kong?) where the CAM translation of the design can drive a machine. A new product (say a colorful sweater) is ready within hours of its conception by the customer! The anxious customer can appreciate his creation within 24 hours because you make sure that an express carrier flies it to him (from Hong Kong to New York, wasn't it?). Your happy customer will obviously immediately place an order for 500 garments. You anticipated this impulsive reaction and have in the meantime already contacted your network of subcontractors over the globe by satellite to enquire who has the capacity and the willingness to immediately produce the stuff (at the lowest cost, of course). Your happy customer neatly receives 500 items of his high quality product within 3 days after it was first conceived.*

The example seems far-fetched? Sorry to disappoint you, it is real! It shows what is happening in some industries. It also shows how a clever combination of readily available technologies can revolutionize a business in a matter of years. The global system design for rapid response *is what makes it work, not any particular technology or concept. The example also illustrates a simultaneous effort on cost, quality and time, since all components are vitally important in this highly competitive and volatile global market. Finally, this technology or system might soon be available to all competitors. When that happens, the designers can turn out to be the only component that makes a difference.*

"Hot" designers, who can interactively develop a flashy new design with a client via a computer system, are extremely rare. When all firms in this market have access to the same technology, these designers will be the bottleneck. A firm which is not able to stimulate its designers to be more

innovative or, worse, loses its designers to its competitors, may not survive despite the advanced technology. In fact, any small group of talented designers can itself be in business in no time. The ultimate consequence of our scenario as presented here is that, in the end, manufacturing no longer provides a source of competitive advantage. Rather, it would gradually shift into a service role to engineering and development. Although the trend is clearly discernible in some sectors of industry, its consequences are not yet clear and deserve further research.

This example goes even further than those given earlier, which show that time can be an important source of competitive advantage, and demonstrates that even time can become a qualifying criterion. Innovativeness lies in the hands of a relatively small number of knowledge workers and how they create and enlarge the knowledge base of the firm through increased learning. We are still a long way from this extreme form of competition in many sectors (and may not ever get there in many others), but the example does help in appreciating the implications of the recent observations discussed in the previous section.

FIGURE 4 ABOUT HERE.

Competitive dimensions life-cycle—We can place the preceding scenario in perspective by relating it to the well-known product-process matrix (see Figure 4) by Hayes and Wheelwright,[31] which suggests a link between product and process life-cycles. What we have outlined can be seen as a *competitive dimensions life-cycle*, where the dividing line between qualifying criteria and order-winning criteria changes with the product's phase in its life-cycle. The sequence in which competences evolve from order-winning criteria to qualifying criteria, as outlined in the previous scenario, is the same as that suggested by Ferdows and De Meyer's empirically found cumulative competence building model, so that the market-driven hierarchy of dimensions of competitiveness could be supported by the manufacturing-driven hierarchy of competences. In the marketing and business strategy literature, it is apparently an accepted fact that during a product's life-cycle the focus of competition shifts from product-based to service-based to price-based, repeatedly and rapidly in the case of the computer industry, for example, and more slowly in other industries, resulting in narrowing profit margins.[32] The product-process matrix, however, dates further back to the time of classical trade-off thinking, where competences were not considered potentially cumulative but rather mutually exclusive. The competitive dimensions life-cycle is not necessarily congruent with the gradual move down the product-process matrix diagonal, from

small-order production to assembly lines to continuous-flow high-volume processes. We observed earlier that flexibility could be achieved before low costs and that flexibility could become a qualifying criterion before cost. Flexible new technologies allow firms to reach points closer to the left-bottom (continuous flow, low standardization) corner of the product-process matrix, combining customized products with high efficiency. It becomes clear that we may have to revamp the "ride-along-the-diagonal" theory. Rather than link choice of process to the product's phase in its life-cycle, the goal is to estimate current and future competitive structures and develop the appropriate competences. The multi-billion-dollar question is to predict correctly what the next competitive battleground will be and how to develop the appropriate competences.

Conclusions

Several concluding remarks are in order. First, firms can at least temporarily escape the slide toward high-volume cost competition by choosing a particular market niche (such as B&O in hi-fi or Aston Martin in automobiles). Second, the quality-time-cost sequence may be a plausible one, but it is by no means the only one possible; as we noted above, each of these dimensions is itself a multidimensional concept. It is perfectly conceivable that a single subdimension may become a qualifying criterion at some point (e.g., the conformance subdimension of quality) and competition may temporarily shift to, say, dependability, only to move back to quality again (this time to the features subdimension) when a few firms quickly introduce many additional product features. What we are dealing with is a complex dynamic hierarchy of multidimensional competitive elements. Further research into understanding these dynamics is necessary. Third, the competitive dimensions life-cycle may often be a true cycle, rather than a one-way process, and therefore never come to an end. This would be due to, among others, the human element, continuously finding new ways of improving quality, time, and cost performance beyond what was considered possible before. Fourth, although we quote some empirical support for some of the points raised, much more empirical work is needed to investigate the validity and generality of these issues.

Having reached the end of this paper, the reader may ask "So what?" A lot of the confusion that surrounds the field of manufacturing strategy can be removed by clearly distinguishing between

internal measures of competence and external measures of competitiveness. The whole task of manufacturing strategy, and therefore of the manufacturing manager, can then be formulated as "to link the competences developed internally and the competitiveness required in the market." By building these competences carefully and cumulatively, he or she will be better prepared for the continuously increasing demands from the marketplace; failing to do so will cause the company's product to drop from distinctly attractive to barely adequate to unmarketable, and the company will eventually be squeezed out of the market. This means that one should build a set of competences compatible with the prevailing competitive requirements and adapt those competences to changing market demands. In fact, the ability to secure this link is the ability to survive. It is important to realize that this requires a long-term vision and commitment which conflict with the short-term, quick-fire attitude still prevailing in many Western firms.

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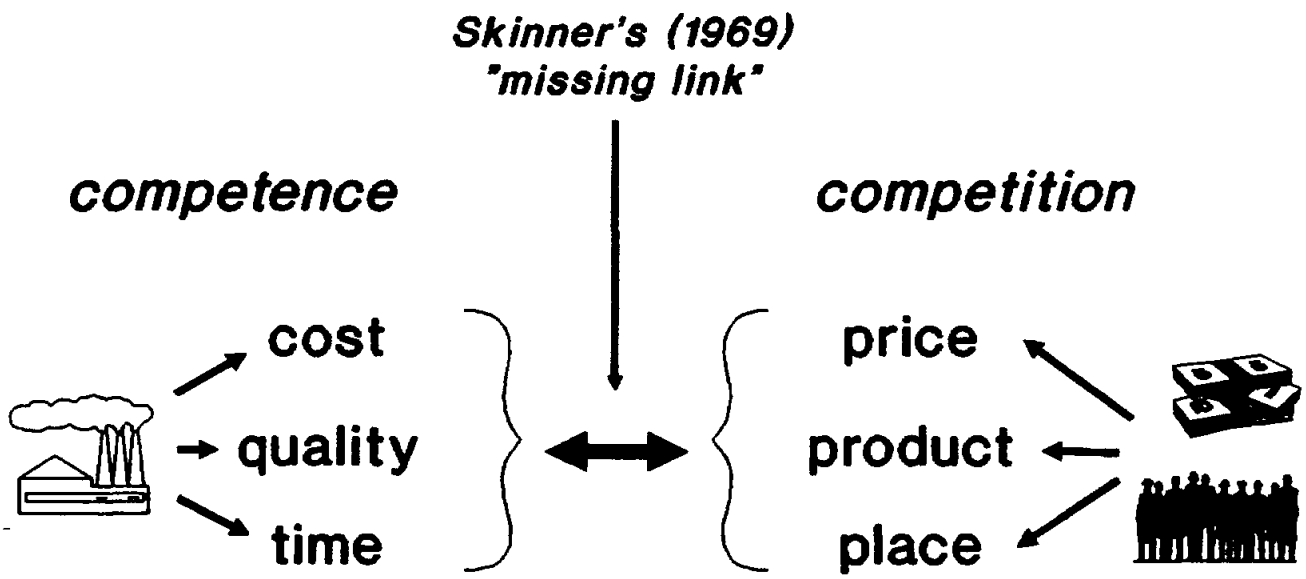
11. Skinner (1969), op. cit.
12. W. Skinner, "The Focused Factory," *Harvard Business Review* (May/June 1974), pp. 112-121.
13. M.E. Porter, *Competitive Strategy* (New York, NY: The Free Press, 1980).
14. This corresponds to a Stage I or Stage II view in the framework cited in Hayes, Wheelwright and Clark. Letting manufacturing play a more important part in supporting and even formulating business strategy corresponds to a Stage III or Stage IV view.
15. W. Skinner, "The Productivity Paradox," *Harvard Business Review* (July/August 1986), pp. 55-59.
16. K. Ferdows and A. De Meyer, "Lasting Improvements in Manufacturing Performance: In Search of a New Theory," *Journal of Operations Management* (Vol. 9, No. 2, April 1990), pp. 168-184.
17. The European Manufacturing Futures Project has been administered at INSEAD since 1983. For this project a sample of large European manufacturing companies are surveyed on a regular basis through a mailed questionnaire.

18. This is already hinted at by Skinner (1986). More recently, Skinner (1992) argued that trade-offs do still exist but should perhaps be called "performance relationships" or something similar, as they do not necessarily imply negative relationships between factors.
19. Ferdows and De Meyer, op. cit., p. 169.
20. Skinner (1986), op. cit., and R.D. Buzzell and B.T. Gale, *The PIMS Principles (Linking Strategy to Performance)* (New York, NY: The Free Press, 1987), Ch. 6.
21. Blackburn, op. cit.
22. Buzzell and Gale, op. cit. This observation has also been made by Hayes, Wheelwright and Clark, op. cit., (Ch. 5), and by H.E. Edmondson and S.C. Wheelwright, "Outstanding Manufacturing in the Coming Decade," *California Management Review* (Summer 1989), pp. 70-90.
23. T. Hill, *Manufacturing Strategy, Text and Cases* (Homewood, Il: Irwin, 1989). The same observation can be found in Hayes, Wheelwright and Clark, op. cit., (Ch. 12), in Edmondson and Wheelwright, op. cit., and, to some extent, in Buzzell and Gale, op. cit., (pp. 113-114).
24. Buzzell and Gale, op. cit., pp. 117-118.
25. Most clearly found in Edmondson and Wheelwright, op. cit., (p. 75), and in Hayes, Wheelwright and Clark, op. cit., (pp. 375-376).
26. Buzzell and Gale, op. cit., pp. 204-205.
27. Stalk and Hout, op. cit.
28. Ibid.
29. Ibid.
30. R. Jaikumar, "Postindustrial Manufacturing," *Harvard Business Review* (November/December 1986), pp. 69-76; quoted from p. 70.
31. R.H. Hayes and S.C. Wheelwright, "Link Manufacturing Process and Product Life Cycles," *Harvard Business Review* (January/February 1979), pp. 133-140. Some of the limitations of the product-process matrix are already mentioned in R.H. Hayes and S.C. Wheelwright, *Restoring Our Competitive Edge (Competing Through Manufacturing)* (New York, NY: John Wiley, 1984).
32. Buzzell and Gale, op. cit., p. 206.

Figure 1. Types of Focus in Manufacturing Strategy



manufacturing strategy

Skinner (1974): no factory can do well at everything; focus on a few core competences

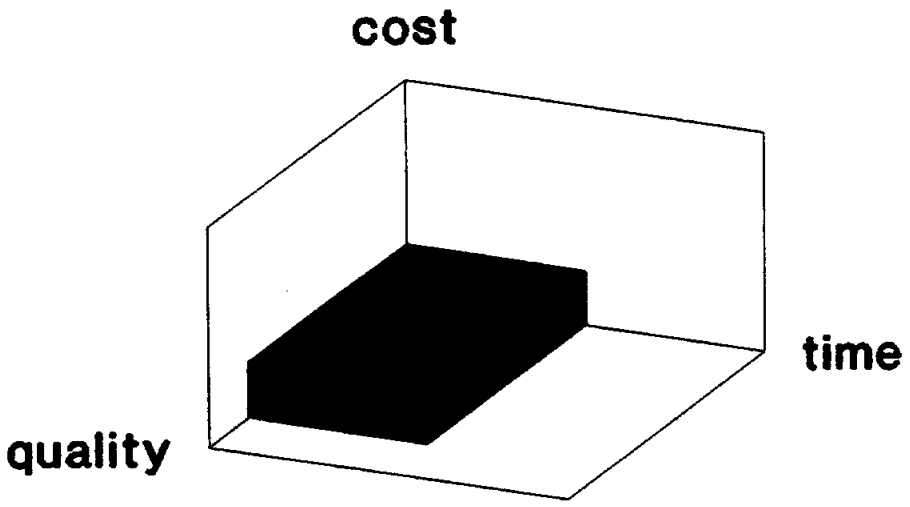
manufacturing mission

Skinner (1969): set a clear task for manufacturing, for it to focus on

business strategy

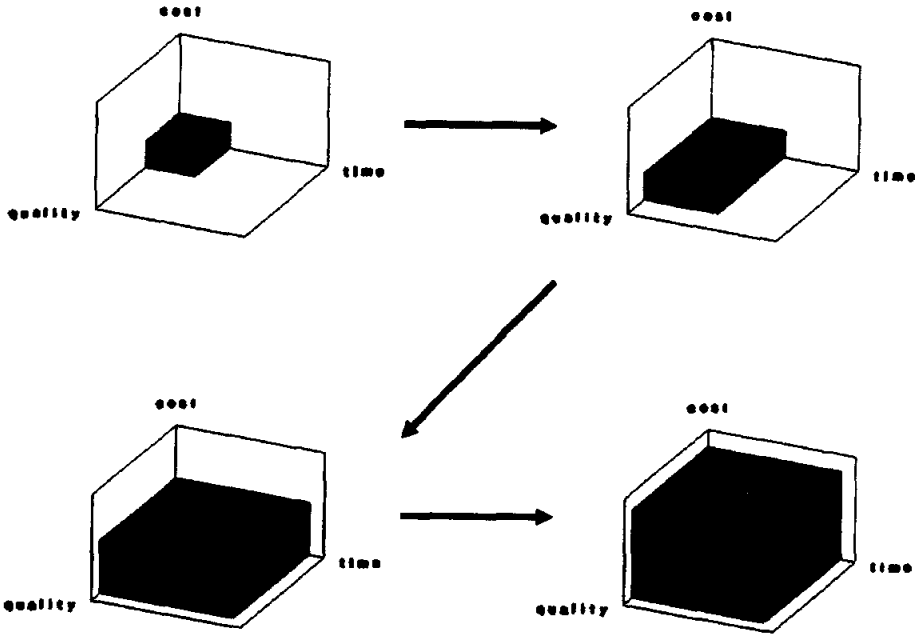
Porter (1980): don't get "stuck in the middle"; focus competitive positioning

Figure 2. Qualifying Levels and Order-Winning Levels



Note: The outer cube represents the total range of possible cost–quality–time combinations available; the inner cube represents the qualifying levels for each dimension. Competition only takes place in the remaining space.

Figure 3. The Competitive Squeeze



Note: Although the outer cube is constant in size in this picture, advances in technology increasing the range of cost–quality–time available will change the shape of the outer cube. In this way, the squeeze becomes a repetitive phenomenon.

Figure 4. The Product-Process Matrix

	Product structure, product life cycle stage			
Process structure, process life cycle stage	Low volume - low standardization, one of a kind	Multiple products, low volume	Few major products, higher volume	High volume - high standardization, commodity products
Jumbled flow (job shop)	•			
Disconnected line flow (batch)		•		
Connected line flow (assembly-line)			•	
Continuous flow				•
priorities	flexibility-quality		dependability-cost	

Source: R.H. Hayes and S.C. Wheelwright, *Restoring Our Competitive Edge (Competing Through Manufacturing)* (New York, NY: John Wiley, 1984), p. 216.

Note: The product-process matrix illustrates how the appropriate choice of process changes with a product's evolution through its life-cycle. Product-process combinations far off the diagonal were considered uncompetitive.