"TRADE-OFFS? WHAT TRADE OFFS?"

by

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(A Short Essay on Manufacturing Strategy)

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Executive Summary

"Is there a way to avoid trading off one capability for another in manufacturing?" is the question posed by Ferdows & De Meyer (1990). Although the traditional theory of manufacturing claims that this is impossible, Ferdows & De Meyer conclude the opposite using data from the 1988 European Manufacturing Futures Survey. They propose a "sandcone model" to explain how capability improvements can become cumulative, so that e.g. quality improvement programmes can facilitate a cost efficiency increase.

Although the sandcone model represents an important departure from the traditional theory of trade-offs, it still has several limitations: it is manufacturing-driven and inward-looking rather than market-driven and outward-looking; it suggests that quality always comes first, then dependability, then flexibility, and finally cost efficiency; and the competitive priorities used in their model are ill-defined (as in most writings in the field).

In this paper we extend Ferdows & De Meyer's model and suggest an alternative paradigm, which removes these limitations. We first propose using three classes of competitive priorities: cost-based, quality-based, and time-based, as a start to better definitions. We suggest making a distinction between competitive priorities and competitive necessities, criteria which must be met in order to compete. We finally suggest that there is a dynamic hierarchy in these competitive priorities and necessities, and show how first, e.g., high quality can become a competitive necessity, then high speed, and finally also low cost, leaving human resources as the only possible source of competitive advantage. We present our paradigm in the form of an analogy with a tidal wave of competition, washing away the sandcones of ill-prepared firms.

The paradigm suggests that knowledge workers will become all-important in manufacturing industry, and, taking the reasoning to an extreme, that manufacturing will eventually no longer be a source of competitive advantage. The paradigm fits in nicely with the well-known product/process life-cycle matrix, and suggests the existence of a competitive priorities life-cycle. In both cases a firm can escape the force of competition by choosing a market niche.

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1 Introduction: the traditional view

The traditional view of manufacturing strategy is that manufacturing performance is measured along five clearly discernable dimensions: **cost, quality, dependability, flexibility,** and **innovation** (Hayes, Wheelwright & Clark, 1988). This performance depends on the firm's manufacturing strategy which consists of a number of structural decision components (the "hardware" of a firm: capacity, location, technology, and vertical integration) and infrastructural decision components (the "software": human resource management, quality control, production planning and inventory control, information management, performance measurement, and organisational structure). For a long time, it was generally believed that the five competitive priorities should be traded off against one another. "Quality requires a cost premium" and "flexibility hurts dependability", are but a few examples of trade-off thinking. This paper revisits the competitive priorities, puts them in a different, more customer oriented perspective and suggests an alternative dynamic framework for explaining sustainable manufacturing excellence.

We first discuss the usefulness of the five competitive priorities. Customers will, all other things being equal, always prefer lower **cost** to higher cost. An often cited example of the recognition of **quality** as an important competitive priority is mentioned in Garvin (1987). In the volatile semiconductor market, where the Japanese manufacturers were becoming stronger and stronger, differences in quality between US-made products and Japanese products were astounding, as Hewlett-Packard found in 1980 after testing 300,000 chips from three US and three Japanese manufacturers. At incoming inspection, the US chips had between 11 and 19 failures per 1,000 units, which contrasts sharply with the zero failure rate achieved by the Japanese chips.

Customers will also prefer firms that are **dependable**, i.e. firms that deliver the right goods in the right quantity at the time agreed upon. Dependable delivery, even at very short notice, is a requirement for suppliers of automobile manufacturers. Most car makers work with the Just-In-Time system and expect their suppliers to comply; any supplier who cannot reliably meet

demands within a matter of days is out of business.

Buyers also appreciate **flexibility** in their suppliers: they sometimes want to change their order after having placed it, e.g. by requesting more units of the same product (volume flexibility) or by changing specifications slightly (product mix flexibility), without this having consequences for delivery date or price. Fashion stores and book sellers, having placed an order for a line of sweaters or a new novel but finding that the first lot is selling much better than expected, will not enjoy hearing that delivery of follow-up orders will be substantially delayed.

Innovation is the most recent addition to the list of competitive priorities. The ability to introduce new models faster than the competition is also seen as a competitive advantage. It was Honda's ability to introduce or replace 113 models in 18 months, against Yamaha's 37, that won them the motorcycle war in Japan (Stalk & Hout, 1990) and enabled them to hold their position as the world's largest motorcycle manufacturer.

It is generally believed that, in order to be competitive, a firm must direct the majority of its efforts towards one or two of these competitive priorities. This is the well-known concept of **focus**, introduced by Skinner (1974). It implies that one cannot possibly be an excellent performer on all five competitive priorities simultaneously. Since then, many writings on manufacturing strategy have generally revolved around the trade-offs between the five competitive priorities, without questioning whether such trade-offs were indeed still present. The subject of this paper is exactly a critical review of these trade-offs.

The main question, according to Skinner, is "How can we compete?" This has often been misunderstood and taken to mean "Which single competitive priority should we focus on?" Authors have frequently taken the title of Skinner's article *The Focused Factory* too literally. They assume that strong trade-offs exist between the five competitive priorities and that each firm and each factory should be focused on exactly one competitive priority. Trying to compete on more than one competitive priority would cause confusion and inefficiency. Even Porter (1980) warns companies not to get "stuck in the middle" (between low cost and diversification strategies).

Hill (1989) is one of the few authors who do not strictly follow the traditional trade-off model. In brief, he distinguishes between **qualifying criteria** and **order-winning criteria** and suggests

that manufacturing must meet the qualifying criteria in order to enter or to stay in the market. This will not win orders, but only 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. Hill's model differs from the traditional trade-off model in two ways. First, he introduces the concept of a minimal threshold to be sustainable in business, arguing that providing an outstanding service on one or two of the five competitive priorities is of no use if performance on the other competitive priorities is below the minimum level required by customers. 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 second important aspect of Hill's model is that it is explicitly consumer oriented, in contrast with the traditional trade-off model. Even if our car manufacturer did learn his lesson and 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 high-acceleration cars. Hill recognises this danger by using the term order-winning criteria. In our example, high acceleration might simply not win any orders. In fact, Hill exchanges the inward-looking view normally associated with manufacturing for the outward-looking view characteristic of marketing.

Ferdows & De Meyer reject the traditional trade-off model, and suggest a different construct. They observe, using data from the 1988 Manufacturing Futures survey (Ferdows & De Meyer, 1990), that some manufacturers seem to be able to achieve better performance on many, if not all, of the competitive priorities (cost, quality, dependability, flexibility, innovation). As mentioned before, this was not considered to be possible in the original model, but we repeat that we believe that Skinner's original idea has been misinterpreted, and that he did not mean overall good performance to be impossible. We believe that focus, in Skinner's terms, simply means deciding on what importance weight to assign to the five competitive priorities such that the resulting vector is uniquely defined and clearly outlines manufacturing's mission. If that is the case, it becomes so much easier to align the components of manufacturing strategy (the hardware and the software) with it.

Ferdows & De Meyer observe that quality improvement programmes often lead to cost reduction, hence that the cost-quality trade-off is an illusion. Similarly, increased dependability can lead to increased flexibility. A firm which is entirely dependable and has its process well under control

may find it easier to meet a sudden change in an order than a firm which already has enough difficulties delivering its regular orders on time.

One of the reasons Ferdows & De Meyer suggest to explain their observations is emerging new technology. Some time ago there was indeed a clear trade-off between cost and flexibility; remember the famous statement attributed to Henry Ford: "the customer can choose any colour (Model T Ford) he wants, as long as it is black." It did cost a lot of time and money to change over dedicated hard automation to produce another model. Standardisation and economies of scale were the magic words. Nowadays, with the introduction of flexible automation, this trade-off no longer holds. Automobile assembly lines are nearly fully automated and can produce virtually any mix of different types of cars without losses in efficiency. The economic order quantity has been reduced to one, in fact one almost never produces the exact same car twice.

The other reason, suggested by Ferdows & De Meyer, for their observation that some firms do well on all competitive priorities, is that "the different capabilities have been cumulative and not the result of compromises and tradeoffs" (p. 4). Using the Manufacturing Futures Survey data they find that more firms attempt to simultaneously improve their performance on more than one competitive priority than would be expected using the traditional trade-off model. This causes them to seriously question the trade-off theory. They propose a different model, their cumulative model or sandcone model. According to this model, attempts to improve performance on the competitive priorities should be organised in such a way as to be cumulative, reinforcing rather than replacing one another. They view **quality** 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 the efforts to concurrently improve quality and dependability, **flexibility** improvement (called speed in Ferdows & De Meyer (1990)) should be added to these efforts. Finally, while all the previous efforts are still expanding at increasingly higher rates, cost reduction programmes can be introduced. Note that innovation, sometimes considered the most important competitive priority of the future, is part of flexibility in Ferdows & De Meyer's model.

Ferdows & De Meyer's findings clearly suggest that the competitive priorities are not mutually exclusive as implied by the traditional trade-off model. Instead, there are direct and indirect

relationships between the competitive priorities (quality improvement can directly lead to cost reduction, high dependability can indirectly enhance flexibility). These relationships are valid in a particular direction only. As Ferdows & De Meyer note, for example, it is obvious that cost reduction need not lead to quality improvement.

2 The sandcone model

Ferdows & De Meyer like to depict their model as a sandcone with different layers (Figure 1). In their sandcone analogy, the sand represents improvement programmes. The finest and driest sand will represent cost improvement programmes, the slightly firmer but still fine sand stands for flexibility, dependability is symbolised by damp and reasonably firm sand while solid wet sand represents quality improvement programmes. It is clear that any sand poured on to a higher-level improvement programme will only stay in place if the layers underneath are sufficiently solid and well-developed, whence the choice of analogy. Pouring some heavy "quality sand" on top of a cone of fine dry "cost sand" will flatten the cost cone, squashing it into oblivion. This is the intention of the analogy: starting a quality improvement programme after a cost reduction programme will annihilate the cost reductions achieved. The sandcone analogy suggests starting with a pile of wet sand, to lay a solid foundation: a quality improvement programme is considered a solid foundation for improvement programmes in other areas. Once a solid pile of wet sand has been made, one can start pouring on some slightly less wet and heavy sand, symbolising that improvement programmes in dependability can be started but only in addition to constantly expanding quality improvement programmes. Similarly, flexibility improvement can be worked on when the quality and dependability improvements are sufficiently advanced, but in order to preserve a solid basis, the amount of effort spent on quality improvement must still increase. It is clear that if the fine dry cost sand is put anywhere else than on top of the cone it will be wasted: do not work on reducing costs until quality, dependability and flexibility improvement programmes are already well under way.

The sandcone model is dynamic in nature, in contrast with the traditional static trade-off model, in that it describes how firms should direct their improvement programmes over time. One of the important assumptions underlying the sandcone model is that the firm under con-

sideration is operating without slack. It is clear that a firm with slack in its processes can in some circumstances achieve a lasting cost reduction without impairing its performance on the other competitive priorities. We will henceforth assume that we are dealing with so-called "lean" organisations.

We agree with Ferdows & De Meyer that the traditional trade-off model is no longer valid in today's highly dynamic and global competitive environment. The sandcone model, besides offering a natural and elegant pictorial analogy, constitutes an important step towards explaining manufacturing performance. We see at least four reasons for this.

- The first major contribution of the sandcone model is that the traditional model of antagonistic competitive priorities is replaced by a protagonistic model in which it is no longer necessary to give up on one competitive priority in order to be able to fully concentrate on another.
- The second contribution by Ferdows & De Meyer is that they suggest a hierarchy and reinforcement between the competitive priorities. They suggest that quality comes first, followed by dependability, flexibility, and then cost, in that order, and that improving lower levels such as quality reinforces efforts on higher levels such as cost.
- A third contribution is the recognition that the narrow interpretation of the concept of focus is not correct: firms can and must compete on several competitive dimensions concurrently.
- Finally, a fourth contribution of the paper is that it provides some empirical support for the sandcone model, a fact which unfortunately is all too rare in manufacturing strategy literature.

In the remainder of this section we explain why, although we consider the sandcone model to be very valuable, we would like to take the arguments a step further.

First, it is unlikely that firms will always have to continue to spend increasingly more effort on improving lower-level competitive priorities in order to be able to achieve moderate improvements in higher-level competitive priorities. The sandcone model suggests that a firm should continuously increase its total improvement efforts over time. It seems more logical to get the train rolling and sustain the effort, i.e. don't slow down, rather than continuously increase effort as the sandcone analogy might suggest. We are therefore more inclined to follow Hill (1989) in suggesting the

existence of qualifying criteria. Meeting these criteria is sufficient to enable a firm to compete, and above the qualifying levels a firm may decide for itself which orders to win and how. The difference is more fundamental than one might realise at first sight since the traditional inward-looking view of manufacturing literature is replaced by the market-oriented concept of winning orders.

Second, Ferdows & De Meyer place quality, dependability, flexibility and cost in a strict order. We believe that the order and the relative importance of the competitive priorities is market-dependent: firms operating in a cost-competitive environment may not survive if they first spend a large amount of effort on not directly relevant competitive priorities as flexibility and dependability, or on improving an already sufficient level of quality.

Third, Ferdows & De Meyer use the traditional but rather ill-defined competitive priorities cost, quality, dependability, and flexibility, including innovation under flexibility. We have already noted that particularly the last three competitive priorities are strongly interrelated: higher dependability often facilitates higher flexibility, whereas high flexibility is a step towards enabling more innovation. The latter can be seen by considering a modern, highly flexible automobile factory, where the assembly line is nearly fully 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. Flexible automation, by being reprogrammable, removes the need to design an entirely new production line for each new model, thereby cutting back the time-to-market for a new model and significantly reducing upfront capital outlay. Flexibility thereby enhances innovativeness. It is because of these complex and situation-dependent interrelationships that we believe that a different classification of competitive priorities is more appropriate, as we suggest in the following section.

3 An alternative paradigm

In this section, we propose a paradigm which follows Ferdows & De Meyer in rejecting the traditional trade-off model and removes some of the limitations of their sandcone model.

We observed above that the traditional distinction of the competitive priorities into cost, quality, dependability, flexibility and innovation is not an entirely satisfactory one, partly due to its being ill-defined. We note in passing that the discipline of manufacturing strategy is not helped by the poor definition of its important concepts. In many cases it is left to the reader to guess what an author really means by quality, flexibility, speed, etc. Some semantic work is definitely needed very urgently.

We suggest that the three essentially different competitive priorities are **quality**, **cost** and **time**. This is in line with the growing attention given to time as a new source of competitive advantage (see e.g. Stalk & Hout (1990)), and it provides a much clearer classification of competitive priorities. It is, after all, general knowledge that time is money.

We define these competitive priorities as follows. We use Taguchi's (1986) definition of **quality** (p. 1):

> "Quality is the loss a product causes to society after being shipped, other than any losses caused by its intrinsic functions."

Taguchi restricts loss to two classes: loss caused by variability of function (when a product does not perform as well as it should, like clothes losing their colour after being washed), and loss caused by harmful side effects (e.g. in medicine, an excellent sedative can produce terrible side-effects). Not all loss is considered a quality problem: alcohol is meant to be intoxicating, and the problems caused by drunks are therefore not due to a quality problem in alcohol, but to the ethical choice made by society in allowing the use of alcohol. Bread knives are another example of this: they are intended for slicing bread, and the fact that they can be used as lethal weapons does not affect their quality. A car, on the other hand, causes a loss to society if it does not perform as it should, e.g. if it breaks down very often. When its economic life is over, a car is added to the already enormous scrapyards found everywhere, thereby damaging the environment and causing more loss

to society. This illustrates one advantage of Taguchi's definition: environmental consequences of a product, which are becoming increasingly important, can be captured in the concept of quality.

We define the cost of a product to include all explicit costs a product causes to the customer, including costs involved in discovering the existence of the product, the costs involved in ordering it, the costs of receiving the product, the costs of using the product and the costs of disposing of it after use. In the automobile example: if the manufacturer mentioned earlier is only a small firm, it will have to realise that customers will need to spend more effort to discover its existence to enable them to consider purchasing the car. Some car manufacturers offer a drive now, pay later policy, thereby in fact creating a negative ordering cost equal to the interest savings gained by the customer. A car which accelerates from 0 to 100 mph in under 10 seconds will presumably consume large quantities of fuel, thereby increasing its operating costs. Finally, when the car is no longer useful to the consumer, he or she must dispose of it, rather than let it rust in the back garden. This also involves costs which may depend on the model.

The third and last competitive priority we distinguish is time. Time encompasses the traditional competitive priorities dependability, flexibility and innovation, which can easily and unambiguously be defined in terms of time. Dependability is the proportion of all orders delivered at the agreed time (which includes at the right place and in the right quantities). Flexibility is the responsiveness to customers, the time needed to respond to a customer's demands or changes in these demands. Innovation is the number of new products introduced in any given time. Many examples can be found (e.g. in Stalk & Hout (1990)) of drastic improvements in time-based performance. Toyota was dissatisfied with the response time of a supplier, who needed 15 days after arrival of the raw materials at his factory to turn out a component. Toyota went to work, and managed to reduce the response time to 1 day. Firms that have reduced their lead times so strongly no longer face the problem of having to forecast sales far into the future: rather than producing to forecasts which often turn out to be far from accurate, they can produce to order, providing their customers with a much more reliable and flexible service.

Time-based innovation is also recognised as a powerful way to compete, as we saw in the Honda-Yamaha example. Stalk & Hout (1990) mention some benefits of being a time-based innovator: taking the position as a technological leader, being able to ask a higher price because the product is newer and more desirable, and the ability to set standards by being the first with innovation

and to use market response to establish the standard. To see how important this last factor can be, recall the earlier days of video recorders. There were three different systems: the VHS system, developed and backed by several Japanese manufacturers, Sony's Betamax, and the V-2000 system developed by Philips. The VHS system, often considered technically the inferior of the three, was introduced with aggressively low prices, allowing the VHS group to win market share quickly; potential buyers noticed that VHS was taking market share from the two competing systems, and therefore considered VHS a more sensible investment. VHS has by now become the world standard. Sony and particularly Philips have suffered heavy losses and corporate traumas when they were forced by the market to join the VHS train.

We believe that there is a **dynamic hierarchy** of competitive priorities, which distinguishes **competitive necessities** and **competitive priorities**. The competitive necessities are equivalent to Hill's qualifying criteria, and can be viewed as "thresholds of excellence": a firm has very little chance of surviving in the marketplace if it cannot meet the standards set by these competitive necessities. The hierarchy is dynamic because over time, as products and processes mature, more and more competitive priorities will become competitive necessities. An entirely new product has no competitive necessities at all, any firm can compete in such a market, assuming that barriers to entry, such as high initial capital investment, can be overcome. After a while the product design standardises and high quality becomes a competitive advantage. As the market matures, consumers come to expect high quality in the product, so that quality is transformed from a competitive priority into a competitive necessity. We already mentioned the car that turned to rust in three years: not too long ago, this was not uncommon for cars, but nowadays manufacturers have to offer up to ten years guaranteed rust-free driving in order to stay in business. Anti-rust treatment used to be a competitive advantage for car manufacturers, nowadays it is a competitive necessity.

As the market matures even more, the time-based competitive priorities also become competitive necessities. In the high-volume car manufacturing world, dependable Just-In-Time delivery is the accepted standard, and any supplier who cannot meet this standard has no chance of competing. We mentioned the Toyota supplier whose response time was reduced from 15 days to 1 due to Toyota's reorganising the supplier's manufacturing organisation: it was either reorganise or forget about supplying Toyota. For another example, consider the personal computer market.

When small "personal" computers first entered the market, they were frequently of poor quality (many defects, some structural), supplied by highly unreliable firms (due dates were frequently missed by several months), with no flexibility (production capacity was often fully utilised), very slow in innovation (introducing a new model personal computer could easily take five years). Above all, the personal computers were extremely expensive: the price-performance ratio has drastically reduced over the years. Gradually, as personal computers were increasingly used in business, customers came to expect a high level of quality; so-called "IBM compatible" PC's, which could run only half of the software developed for IBM PC's, not an unusual phenomenon at the time, were no longer tolerated. Presently, the ability to deliver quickly and on time is becoming increasingly important.

The US industrial door market example shows the importance of flexibility and how it has almost become a competitive necessity. 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 customised. 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 in 80% of the distributors in the country.

Innovation, frequently introducing new models and new products, is being recognised as an important competitive priority. However, innovation can also become a competitive necessity. 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 became important attributes for consumers. 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, a firm has to continuously introduce style and colour changes to keep up with what has essentially become a volatile fashion market.

In the end, cost becomes the only competitive priority left to compete on. This reverts back to the observation we made in the beginning of this paper: all other things being equal, a customer will prefer lower cost to higher cost. Once all firms have achieved the same standards 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 revolutionalising the business. Quite a few of the Japanese FMS are capable of running untended for several shifts. These systems, consisting of general-purpose CNC machines (Computer Numerically Controlled) are very reliable, can make a wide variety of parts and can easily adapt to new demands. 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 utilisation. 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.

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 competitive factor. Assume you operate in the industrial fashion clothes market (e.g. Benetton, The Limited, etc.). Quick response and personalised design are rapidly becoming competitive necessities. Therefore you create a team of highly creative designers, you supply them with the latest in CAD technology and put them together in a pluche building in some fashionable town (how about Paris?). You also buy the latest in high resolution video conferencing equipment to allow your important customers (New York?) to create their personalised 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 colourful 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 5000 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 ravished customer neatly receives 5000 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 revolutionalise a business in a matter of years. It is the global system design for rapid response that makes it work, not any particular technology or concept. The example also illustrates a simultaneous competitive effort on cost, quality and time since all components are vitally important in this highly competitive and volatile global market. Finally, one should realise that this technology or system, if you will, might soon be available to all competitors. When that happens, the designers will turn out to be the only component that makes the 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 perform well, i.e. to be more innovative, or worse, loses its designers to its competitors, may not survive, despite the advanced technology. The critical factor for success in such a market will be human resources management. In fact, any small group of talented designers can be in business in no time!

This example goes even further than those given in e.g. Stalk & Hout (1990), who show that time can be an important source of competitive advantage. It shows that even time can become a competitive necessity. Innovativeness lies in the hands of a relatively small number of knowledge workers, and in how they create and enlarge the knowledge base of the firm through increased learning. Granted, 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 tidal wave analogy of competition given in the following section.

4 The tidal wave analogy

In order to enhance comparability between Ferdows & De Meyer's model and the model presented in the previous section, we will propose an analogy along the same lines as the sandcone model. Consider a sandy beach, when the tide is out. At the waterline, the sand is firm; going inland, finer sand covers the bottom layer of firm, wet sand. As the tide comes in, the beach gets smaller,

and the previously dry sand becomes firmer and wetter. In Ferdows & De Meyer's model, we could view the firm sand as equivalent to quality, the moderately firm sand as time (or flexibility, dependability and innovation), and the dry fine sand as cost. They advocate choosing a site in the "quality" area of sand to establish a sandcone. To build this sandcone, they advocate gradually taking sand from more and more "inland" areas to pour on the sandcone, thereby continuously widening their base at an increasing speed. This is shown in Figure 2.

When the tide is out, the product still relatively new and the market slowly maturing, this is indeed possible. However, at some time the tide will start coming in. Firms who keep their sandcones in the quality area of the beach will be the first to be washed away, although they might be able to keep their heads above water somewhat longer if their sandcastle was sufficiently strong and well-developed (or if they can convince their government to dig trenches around the sandcastle). As the tide comes in and reduces the area of the beach, the competitive choices a firm has in the market become more and more restricted. The waterline marks the difference between competitive necessities and competitive priorities. The firms which do not remain in the rapidly drowning quality area find a shrinking beach to compete on, as quality increasingly becomes a competitive necessity. The forward-looking firms have by now established themselves in the time-area of the beach (after all, the time sand is based upon a solid layer of quality sand), for the time being unthreatened by the rising requirements, the tightening qualifying criteria for competing. This situation is shown in Figure 3.

But the tide keeps rolling in. The beach is shrinking, competition is becoming fiercer and competitive stance is more and more restricted. Finally, the time-part of the beach is under water, leaving only the firms who have moved to cost-based competition as survivors. All quality- and time-based sandcones have by now been engulfed by the unrelenting force of the waves steadily claiming the beach for the sea. And even the cost-based cones may not be safe: at places the tide will come in far enough to cover the entire beach, and the water will be right up to the sea-wall, leaving not a single sandcone or uncovered patch of beach in sight. The few firms remaining in that segment will be clinging to the sea-wall, needing all their human resourcefulness to keep them from slipping or falling down and being devoured by the hungry waves of competition. This situation is depicted in Figure 4.

It is interesting to reflect on the character of competition at this stage. Clearly, size may no

longer provide a barrier to entry. Half a dozen people and some readily available technology may be sufficient to set up business. The critical ingredient is the competence of a small group of people. As a result companies will need to focus sharply on managing intellectual assets, i.e., on what their key people should work on. Project selection then becomes important. This, in turn, will require a constant and close attention to the fit between the market and the distinctive competences of the company's key knowledge workers. Since the latter will be highly valued in the marketplace, one can expect a high turnover. Consequently, companies will have to concentrate on how to preserve and transfer knowledge, and on how to learn, i.e. increase knowledge as an organisation. Companies acquiring knowledge faster than their competitors will show superior performance.

Note that the ultimate consequence of our tidal wave analogy, as it is 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 discernable in some sectors of industry, its consequences are not yet clear and deserve further research.

From the exposition above and the analogy it should be clear that the tidal wave "model" is different from the traditional trade-off model and the sandcone model. We summarise these differences in the concluding section.

5 Conclusion

We have suggested a new way of looking at the traditional competitive priorities by classifying them into quality-based, time-based (dependability, flexibility, innovation) and cost-based categories. We agree with Ferdows & De Meyer that the traditional view that a trade-off between competitive priorities must always be made is not valid, but we consider the model they suggest to replace the trade-off theory too restricted. We propose a different model, with far-reaching implications. Our model follows Ferdows & De Meyer's sandcone model in rejecting the traditional trade-off culture and suggesting a hierarchy in the competitive dimensions. We also follow the sandcone model in suggesting that this hierarchy is dynamic in nature as opposed to the

traditional trade-off model which is static.

We depart from the sandcone model in that we define three competitive priorities (cost, quality and time) rather than the traditional set of five, ill-defined competitive priorities (cost, quality, dependability, flexibility and innovation). Our model also differs from the traditional trade-off model and the sandcone model in its orientation: whereas almost all writings on manufacturing performance are inward-looking, our model is outward-looking. We follow Hill (1989) in directing our attention to order-winning criteria, and not just to internal measures of manufacturing performance. The hierarchy we suggest in the competitive priorities is market-driven, and not manufacturing-driven as is the case in the sandcone model. The dynamic hierarchy distinguishes competitive necessities and competitive priorities, acknowledging the fact that the maturity of the market implies that a firm must meet some minimum standards, the qualifying criteria or competitive necessities, in order to be able to compete. Above these standards, it can match its competitive priorities with whichever order-winning criteria it decides to meet.

Several concluding remarks are in order. First, observe that our tidal wave model ties in nicely with the good old product/process matrix (Hayes & Wheelwright, 1979). However, whereas the product/process matrix deals with product and process life cycles, our tidal wave model suggests the concept of a **competitive priorities life cycle**. The latter is not necessarily congruent with the gradual move down the diagonal from small order production in a job shop to continuous flow high volume processes. In fact, shrinking product life cycles and flexible new technologies may force us to revamp the "ride-along-the-diagonal" theory. Perhaps the idea of a competitive priorities life cycle as offered by our tidal wave analogy can be useful towards that end.

Second, just like companies can decide to avoid the slide towards high volume cost competition in the classical product/process matrix context by choosing a particular market niche (e.g. B&O in hi-fi), similar moves are conceivable to protect oneself (at least temporarily) from the tidal wave of competition.

A third remark concerns the dynamic hierarchy of the competitive priorities. Although the quality-time-cost sequence is probably a common one, it is by no means the only one conceivable. Moreover, for reasons of clarity, we oversimplified our exposition. In reality, competitive priorities are complex multilayered concepts rather than monolithic entities. Garvin (1987), e.g., suggests

eight dimensions of quality. It is perfectly conceivable that a single dimension may become a competitive necessity at some point (e.g. conformance), whereby competition may temporarily shift to, say, dependability, only to move to quality again when a few firms quickly introduce many additional product features. It follows that what we are dealing with is a complex dynamic hierarchy of multidimensional competitive elements. Further research into understanding these dynamics is necessary.

Finally, whereas Ferdows & De Meyer present some empirical evidence which partially supports their model, we do not have any empirical evidence at all; this is an obvious and interesting direction for future research. We have, however, described examples showing that the tidal wave model which we describe is useful. In fact, as some examples show, the tide is rolling in quickly in some businesses and companies who do not prepare for the tidal wave of competition will be washed away.

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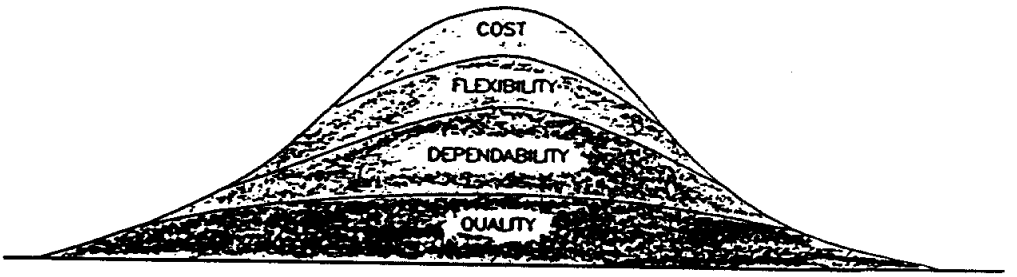

Figure 1: The sandcone model

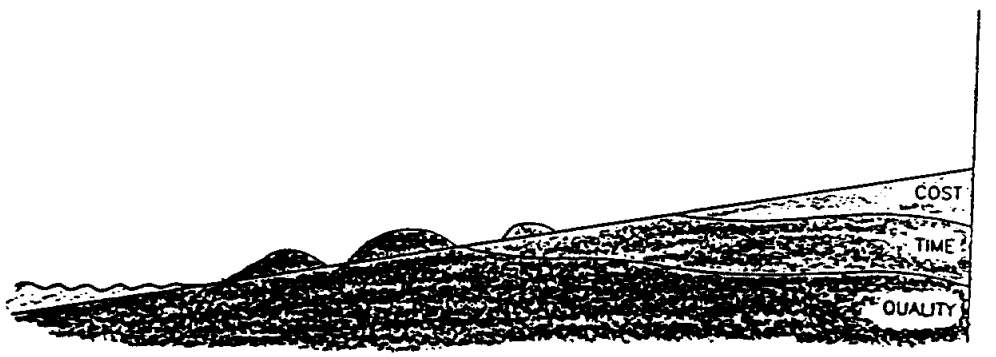

Figure 2: The tidal wave analogy: quality-based competition

Figure 3: The tidal wave analogy: time-based competition

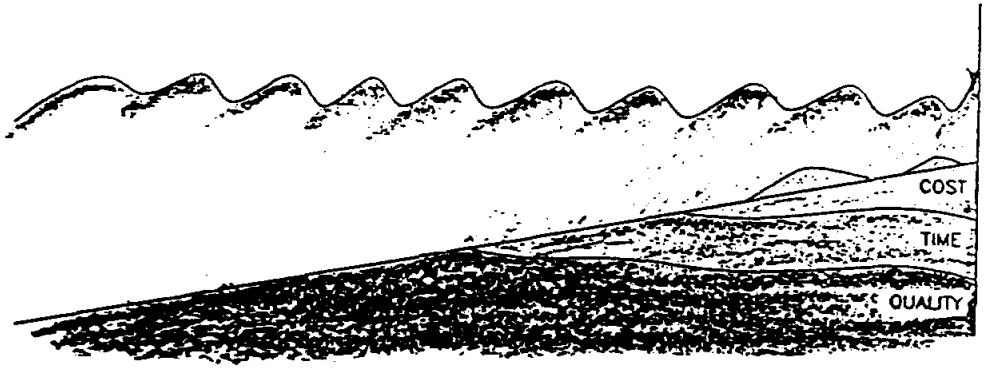

Figure 4: The tidal wave analogy: human resources are all-important

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90/43 FIN	Robert KORAJCZYK and Claude VIALLET	"Equity Risk Premia and the Pricing of Foreign Exchange Risk", May 1990.
90/44 OB	Gilles AMADO, Claude FAUCHEUX and André LAURENT	"Organisational Change and Cultural Realities: Franco-American Contrasts", April 1990.
90/45 TM	Soumitra DUTTA and Piero BONISSONE	"Integrating Case Based and Rule Based Reasoning: The Possibilistic Connection", May 1990.
90/46 TM	Spyros MAKRIDAKIS and Michèle HIBON	"Exponential Smoothing: The Effect of Initial Values and Loss Functions on Post-Sample Forecasting Accuracy".
90/47 MKT	Lydia PRICE and Wilfried VANHONACKER	"Improper Sampling in Natural Experiments: Limitations on the Use of Meta-Analysis Results in Bayesian Updating", Revised May 1990.
90/48 EP	Jae WON PARK	"The Information in the Term Structure of Interest Rates: Out-of-Sample Forecasting Performance", June 1990.
90/49 TM	Soumitra DUTTA	"Approximate Reasoning by Analogy to Answer Null Queries", June 1990.
90/50 EP	Daniel COHEN and Charles WYPLOSZ	"Price and Trade Effects of Exchange Rates Fluctuations and the Design of Policy Coordination", April 1990.

90/51 EP	Michael BURDA and Charles WYPLOSZ	"Gross Labour Market Flows in Europe: Some Stylized Facts", June 1990.
90/52 FIN	Lars Tyge NIELSEN	"The Utility of Infinite Menus", June 1990.
90/53 EP	Michael Burda	"The Consequences of German Economic and Monetary Union", June 1990.
90/54 EP	Damien NEVEN and Colin MEYER	"European Financial Regulation: A Framework for Policy Analysis", (Revised May 1990).
90/55 EP	Michael BURDA and Stefan GERLACH	"Intertemporal Prices and the US Trade Balance", (Revised July 1990).
90/56 EP	Damien NEVEN and Lars-Hendrik RÖLLER	"The Structure and Determinants of East-West Trade: A Preliminary Analysis of the Manufacturing Sector", July 1990
90/57 FIN/EP/ TM	Lars Tyge NIELSEN	Common Knowledge of a Multivariate Aggregate Statistic", July 1990
90/58 FIN/EP/TM	Lars Tyge NIELSEN	"Common Knowledge of Price and Expected Cost in an Oligopolistic Market", August 1990
90/59 FIN	Jean DERMINE and Lars-Hendrik RÖLLER	"Economies of Scale and Scope in the French Mutual Funds (SICAV) Industry", August 1990
90/60 TM	Peri IZ and Tawfik JELASSI	"An Interactive Group Decision Aid for Multiobjective Problems: An Empirical Assessment", September 1990
90/61 TM	Pankaj CHANDRA and Mihkel TOMBAK	"Models for the Evlauation of Manufacturing Flexibility", August 1990
90/62 EP	Damien NEVEN and Menno VAN DIJK	"Public Policy Towards TV Broadcasting in the Netherlands", August 1990
90/63 SM	Sumantra GHOSHAL and Eleanor WESTNEY	"Organising Competitor Analysis Systems", August 1990
90/64 SM	Sumantra GHOSHAL	"Internal Differentiation and Corporate Performance: Case of the Multinational Corporation", August 1990
90/65 EP	Charles WYPLOSZ	"A Note on the Real Exchange Rate Effect of German Unification", August 1990
90/66 TM/SE/FIN	Soumitra DUTTA and Piero BONISSONE	"Computer Support for Strategic and Tactical Planning in Mergers and Acquisitions", September 1990
90/67 TM/SE/FIN	Soumitra DUTTA and Piero BONISSONE	"Integrating Prior Cases and Expert Knowledge In a Mergers and Acquisitions Reasoning System", September 1990
90/68 TM/SE	Soumitra DUTTA	"A Framework and Methodology for Enhancing the Business Impact of Artificial Intelligence Applications", September 1990
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90/76 MKT	Wilfried VANHONACKER	"Managerial Decision Behaviour and the Estimation of Dynamic Sales Response Models", Revised October 1990
90/77 MKT	Wilfried VANHONACKER	"Testing the Koyck Scheme of Sales Response to Advertising: An Aggregation-Independent Autocorrelation Test", October 1990
90/78 EP	Michael BURDA and Stefan GERLACH	"Exchange Rate Dynamics and Currency Unification: The Ostmark - DM Rate", October 1990
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90/88 OB/MKT	Susan C. SCHNEIDER and Reinhard ANGELMAR	"Cognition in Organisational Analysis: Who's Minding the Store?" Revised, December 1990
90/89 OB	Manfred F.R. KETS DE VRIES	"The CEO Who Couldn't Talk Straight and Other Tales from the Board Room," December 1990
90/90 MKT	Philip PARKER	"Price Elasticity Dynamics over the Adoption Lifecycle: An Empirical Study," December 1990

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91/01 TM/SM	Luk VAN WASSENHOVE, Leonard FORTUIN and Paul VAN BEEK	"Operational Research Can Do More for Managers Than They Think!," January 1991
91/02 TM/SM	Luk VAN WASSENHOVE, Leonard FORTUIN and Paul VAN BEEK	"Operational Research and Environment," January 1991
91/03 FIN	Pekka HIETALA and Timo LÖYTTYNIEMI	"An Implicit Dividend Increase in Rights Issues: Theory and Evidence," January 1991
91/04 FIN	Lars Tyge NIELSEN	"Two-Fund Separation, Factor Structure and Robustness," January 1991
91/05 OB	Susan SCHNEIDER	"Managing Boundaries in Organisations," January 1991
91/06 OB	Manfred KETS DE VRIES, Danny MILLER and Alain NOEL	"Understanding the Leader-Strategy Interface: Application of the Strategic Relationship Interview Method," January 1990 (89/11, revised April 1990)

91/07 EP	Olivier CADOT	**"Lending to Insolvent Countries: A Paradoxical Story,"** January 1991
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91/23 TM	Spyros MAKRIDAKIS and Michèle HIBON	**"Exponential Smoothing: The Effect of Initial Values and Loss Functions on Post-Sample Forecasting Accuracy"**, April 1991 (Revision of 90/46)
91/24 TM	Louis LE BLANC and Tawfik JELASSI	**"An Empirical Assessment of Choice Models for Software Evaluation and Selection"**, May 1991