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Manufacturing Operations in Europe: Where Do We Go Next?

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Abstract: Extrapolating from the results of a 10-year INSEAD Survey, Arnoud De Meyer offers some views on the future for manufacturing in Europe. The model on which the Survey was based indicates that competitive priorities and action plans in manufacturing changed over the 10-year period. Taking lessons from these, the author makes some 'informed guesses' on the future implications for European manufacturers in the form of seven normative features: innovation in the value package; close integration between manufacturing and service; the importance of internationalism; flexible project-based organisation; more integrated management of the value added chain; successful transformation of operational programmes into strategic programmes; and building a knowledge-based organisation.

Will manufacturing still be important in Europe in the coming decade and if so what kind of manufacturing will it be? Delocalisation, restructuring, rationalisation, delayering and reengineering are everywhere with us. And in most cases these programmes lead to a decrease of employment in manufacturing and a hollowing of our European manufacturing base. Is there still a future for manufacturing in Europe, and if so what does it look like?

This paper starts from the premise that there will be no future for Europe without manufacturing. I do not argue that manufacturing will be a large provider of jobs, but its spillover effects into service and information-based industries will be considerable. In the same way that agriculture has become a minor part of the GDP of Europe, but is the source of an agri and agro-industry which creates perhaps up to 40 percent of Europe's domestic product, manufacturing's direct impact on value creation may shrink, but it will become the driving force for the growth of service and information providers. But what kind of manufacturing?

The last fifteen years of manufacturing management have been dominated by what we described as Japanese manufacturing techniques. Three-letter acronyms such as TQM, TPM, JIT, or words like Kaizen and Muda have dominated classrooms, consultant's presentations and office walls of production managers. An enormous effort was made to catch up with the best manufacturers in Asia-Pacific, and manufacturing was put again on the strategic agenda of companies that wanted to create core competencies based on their operations.

My research indicates that European manufacturers have been successful in their efforts to close the gap with their world-wide competitors.¹ Perhaps they haven't reached the level of the best among the world's competitors but they are getting close. The observations made by some of my colleagues based on the best factories in France and Germany point in the same direction (see de Groote *et al.*, 1996). So what is next?

In order to do a bit of crystal ball gazing I propose the following in this paper. I will go through a very brief overview of 15 years of history of Manufacturing Management. Based on the results of a survey that I have carried over the last 10 years I will try to determine some trends in the behaviour of large European manufacturers. By 'informed' extrapolation I may be able to speculate on what the near future in operations and manufacturing holds.

A Brief History of Manufacturing Management

The evolution of Manufacturing Management was to a large extent triggered by two correlated types of observations. The early eighties were characterized by a series of papers on the successes of Japanese manufacturers in the area of inventory reduction and quality management. At the same time there were a number of papers exhorting Western manufacturers to put manufacturing again on the strategic agenda. In one of the more influential books Wheelright and Hayes (1984) argued that manufacturing had to move from internally neutral to externally supportive. Basically they argued that the company had to develop core competencies in manufacturing in line with overall business strategy. Correctly deployed these core competencies could then lead to a competitive advantage in the market. Manufacturing could be turned into a source of competitiveness. This would guide development of manufacturing management throughout the eighties and the beginning of the nineties.

Over the years we also went from a somewhat superficial description of Japanese Manufacturing Techniques, based on industrial or academic tourism, to a deeper conceptual understanding of what some of the best

¹ Most of the empirical data is based on the European Manufacturing Futures Project. A similar survey carried out is administered in the rest of the world by Boston University for the United States, Waseda University for Japan and also in South Africa, Australia, New Zealand, Taiwan, Korea, Mexico and the People's Republic of China.

companies in Japan and elsewhere had been able to achieve. I would classify these insights into four broad categories:

1. *Deviation from zero and variability in the production process cannot be tolerated*: processes have to be understood so well, designed so robustly and controlled so tightly that there will be zero defects, zero tolerances, zero waste, zero inventories and no variability of output; and if we cannot reduce variability, one will design the product and process such that the variability has no impact on the customer. Obviously zero is an ideal target to aim at.
2. *Continuous improvement and constant learning are a must*: production processes can and should be improved continuously by relying on workers who are closest to the production processes. The improvements should become part of company know-how and organisational learning which are at the heart of competitiveness.
3. *Human resources are the most important asset of the company*: total automation may be a dream for some boardrooms, but it is the balanced interaction between people, capital equipment and information that leads to competitiveness.
4. *Time is a resource and speed is an output with a high value*: time is a production resource equal to people, capital, materials information and systems. Wasting time lengthens throughput times, creates delays in product development, etc. Delivery speed or speed in turning around a request for product adaptations has a high value for the customer.

Modern manufacturing management obviously encompasses much more than these four statements, but many of the case studies describing success stories of the late eighties and the beginning of the nineties can be explained by part or all of these four categories.

These insights helped European manufacturers to catch up. But the recent successes of the US manufacturing companies indicate that many companies went further. Their success can be explained by a combination of process reengineering (Hammer and Champy, 1993), value innovation (Kim and Maubergne, 1997) and knowledge management. While in many cases BPR remained a more sexy word for rationalisation, there are quite a few examples around where it led to a radically different way of catering to the customers' needs, or to a different portfolio of values offered to the customer.

But where does that leave us here in Europe, and what can we do to go beyond catching up? In order to understand this I'd like to take some time to describe some trends in manufacturing in Europe between 1986 and 1996.

Ten Years of Empirical Research on Manufacturing Strategy

In 1984 we started, at INSEAD, to monitor manufacturing strategy in Europe. In order to do so we administered every second year a survey of 200 large European manufacturers in close collaboration with research teams all over the world.² In 1986 a major redesign of the questionnaire was implemented and thus we will limit ourselves here to data covering the period from 1986 to 1996.

The questionnaire was based on the model of manufacturing strategy developed by Skinner. Stripped down to its minimum, his model suggests there are a set of eight to ten issues in manufacturing around structure (capacity, process technology, vendor and distributor relations and location) and systems (quality, flow management, human resources management and organisation, new product policies and control systems) that have to be addressed. There is no right answer for each of these issues, but there is a set of answers that is internally consistent, and externally coherent with the business strategy. But that coherence is difficult to determine, unless one uses some intermediary variables, that translate the business strategy into variables such as efficiency, quality, flexibility or dependability, that have some meaning as strategic goals for manufacturers. In our research we have translated these manufacturing issues into action plans. The intermediary variables we have called competitive priorities.

What I would like to explore with you here in this paper is how these competitive priorities and action plans have evolved over the last decade.³ This will be a partial analysis only. Over the years we did not change the structure of the questionnaire, but adapted the content of each of the questions. Manufacturing evolved over those years, and some action plans which were hot in the eighties (e.g. quality circles) virtually disappeared from the radar screen in the nineties, while new programmes (e.g. QFD or TPM) emerged only in the late eighties. In order to do an analysis over the last decade we had to limit ourselves to the items that were always present in the questionnaire. This may have the advantage that we limited ourselves to robust action programmes and competitive priorities.

Let us take a look at Table 1. We learn from this that price competition, the ability to make rapid volume changes and to deliver in a dependable way have risen in importance over these 10 years. On the other hand the ability to offer consistent quality (conformance quality) or high performance products (design quality) have declined in importance. Does this suggest that quality is replaced gradually by price competition? That would obviously be a bit too simplistic. Price competition has not been rising forever.

² The original survey was administered first by J.G. Miller at Boston University in 1981.

³ A more detailed and rigorous analysis is provided in De Meyer and Pycke, Separating the fads from the facts: trends in manufacturing action programmes and competitive priorities from 1986 till 1996. INSEAD working paper TM 96/21/TM. Here we limit ourselves to the statistically significant results.

Table 1. Trends in Competitive Priorities over the Period 1986 – 96

Competitive priority: the ability to	Average level of significance	Trends 1986 – 96
• Profit in price competitive markets	0.98	Rising***
• Make rapid volume changes	0.88	Rising**
• Offer dependable deliveries	1.09	Rising**
• Introduce new products quickly	0.96	No conclusion
• Provide fast deliveries	1.02	No conclusion
• Offer a broad product line	0.88	No conclusion
• Offer a consistent quality with low defects	1.17	Declining**
• Offer high performance products	1.02	Declining***

*Normalised scale, 1= average significance; **P-level of 5%; ***P-level of 0.01%.

In fact if we examine the detailed evolution, in the late eighties price competition as a competitive priority went down, and it is only since the beginning of the nineties that it has shot up (Figure 1). This obviously coincides with the increase in global competition as it is exemplified by the fall of the Berlin Wall and the opening of Eastern European markets, the creation of the European open market in 1993 and the implementation of the WTO agreements or the drastic devaluation of the Chinese currency in 1994.

However, the analysis has also to be corrected for the average level of emphasis that is put on some of these priorities. Therefore we have mapped the significant risers or climbers (Figure 2) according to the trend versus the average importance of the priority during this 10-year period.

What do the four quadrants in Figure 1 mean? Let me make a proposal for their interpretation. A combination of high average importance, but decline in importance is a strategy of the past. High average importance and rising importance is probably what manufacturers are working on now. Lower average importance, but rising importance are objectives for the future. If one accepts this categorisation we see that quality is important but of the past. If you don't have quality you simply don't play the game anymore. Dependable deliveries today's objective. Price competition (and thus cost efficiency) and ability to be flexible in adapting oneself to volume changes are objectives for the near future.

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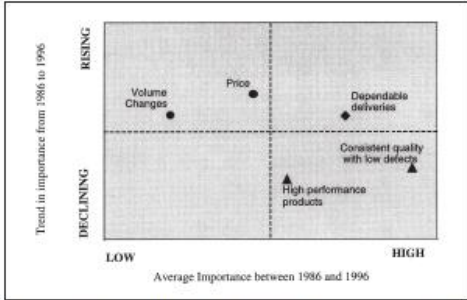


Figure 1 Competitive Priorities in Europe Over the Last Decade

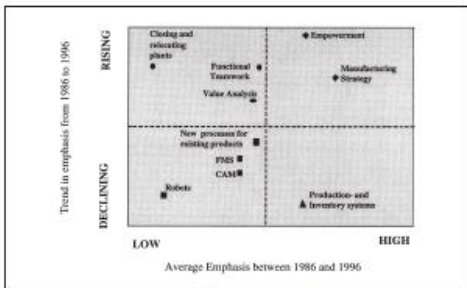


Figure 2 European Manufacturing Action Programmes, 1986 to 1996

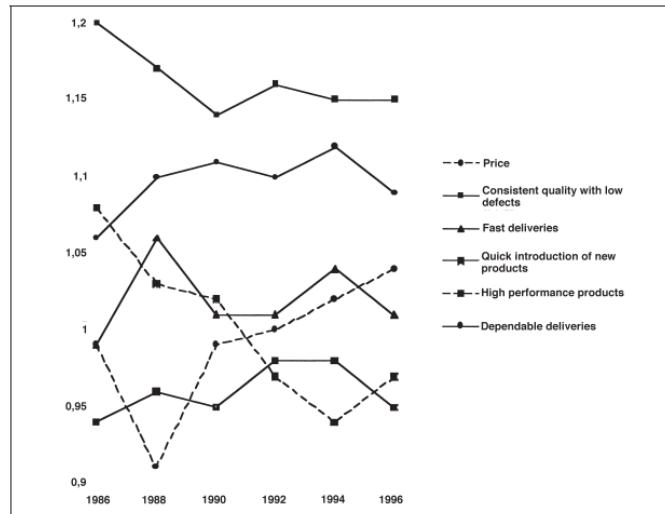


Figure 3 Importance of Competitive Priorities

We did a similar analysis for action programmes (Figure 3). Though we regularly had between 35 and 40 action programmes in the questionnaire, only 17 remained in our questionnaire throughout these years. This indicates there are some fads and fashions in manufacturing that have come and gone. But here we will focus on the action plans that had lasting value. Five programmes have consistently been rising in importance over the last decade: giving workers a broader range of tasks, relocation of plants, functional teamwork, taking a strategic view of manufacturing and value analysis and product redesign. For me these relate to three underlying categories: internationalisation, innovation and emphasising the human resources. This last category is supported when one looks at the declining action programmes: four out of five have to do with stand-alone technology, and one with traditional materials management systems.

This is exactly the opposite of the deployment of human resources.

Again we have to be careful to control for the average emphasis (Table 2). If we apply a similar interpretation of the four quadrants (assuming that low importance combined with declining importance indicates that the action programme is not strategically important), we observe that past actions were concentrated around traditional

materials management, current actions around people and strategic thinking, and the future on innovation and internationalisation.⁴

Table 2. Trends in Implementation Emphasis in Action Programmes over the Period 1986 – 96

	Average level* emphasis	Trends 1986 – 96
Giving work to broaden range of tasks	1.08	Rising***
Closing and relocating plants	0.67	Rising***
Functional teamwork	0.98	Rising***
Developing a manufacturing strategy to support the business strategy	1.17	Rising***
Value analysis	0.96	Rising***
Integrating information technology in the business unit	1.14	No conclusion
Supervisor training	1.96	No conclusion
Statistical process control	1.07	No conclusion
Developing new processes for new products	1.08	No conclusion
Integrating IT in manufacturing	1.15	No conclusion
Computer aided design	0.94	No conclusion
Reconditioning physical plants	0.88	No conclusion
Developing new processes for existing products	0.97	Declining***
Flexible manufacturing systems	0.95	Declining***
Computer aided manufacturing	0.95	Declining***
Robots	0.69	Declining***
Production and inventory control systems	1.08	Declining***

*Normalised scale, 1=average emphasis; ***significant on a 0.1% level.

What are the major conclusions? First rising importance of price as a competitive priority is a clear indication of the internationalisation process, and it is not finished. Table 3 shows the expected level of increase in domestic and overseas production sales and procurement.⁵ These numbers have to be interpreted with care: the typical respondent is in charge of one factory or a few factories, and does not necessarily have an integrated view of the whole firm. But the expected changes are all significant and point in the same direction: production, purchasing and sales all become more international. Secondly, the quality movement has reached a peak and is declining. The peak can be detected in the late eighties. Thirdly, rapid volume changes become more important, which is understandable in a world where JIT factories have to supply a jittery and mature market. Finally, manufacturers are putting more emphasis on human resources and less on stand-alone technology.

⁴ My colleague H. Katayama from Waseda University did a similar analysis on the Japanese data. For a number of technical reasons related to the data he found less significant results. The only rising priority was the ability to provide fast deliveries, while he found with respect to action programmes a decline in traditional materials management systems and FMS. Interesting however is the rising importance (at a high level of emphasis) of the effort to integrate information systems across the business unit. This is in line with some of the work of Bensaou that indicates that Japanese companies that are very fast moving catch up with respect to the implementation of sophisticated information systems (Bensaou and Earl, 1996).

⁵ For the sake of comparison we decided that for a European manufacturer the whole of Europe is a domestic market.

Table 3. Expected Increase in Internationalisation

	Europe
Domestic sales in 1995 as % of total	79
Expected change as %	-4
Domestic production as % of total	92
Expected change as %	-4
Domestic purchasing as % of total purchase	83
Expected change in %	-5

Table 4. Competitive Priorities (1996): Ranking of the Importance of Competitive Priorities over the Next Five Years

Europe	Japan
Consistent quality/low defects	Competition based on price
Reliable products	Reliable products
Dependable deliveries	Dependable deliveries
Competition based on price	Fast deliveries
Fast deliveries	Quick introduction of new products
High performance products	Consistent quality / low defects
Quick introduction of new products	High performance products
Product support	Customize products
Customize products	<i>Offer broad product line</i>
Rapid volume changes	Effective after sales service
Effective after sales service	Design flexibility
Offer broad product line	Product support
Rapid mix changes	Rapid mix changes
Durable products	Durable products
Easy availability of products	Easy availability of products
Design flexibility	Rapid volume changes

And Today?

Before we speculate where this will lead, we may want to spend some time on the more detailed results of the 1996 survey itself. Based on the European data and the data provided by my Japanese colleague, Katayama Hiroshi, we can derive some insights. In Table 4, Table 5, and Table 6 we have put together the rank order of competitive priorities, perceived pay-off of past action programmes, and future emphasis on action programmes. The items in bold are those which are significantly higher for the other region.⁶ What do we learn?

⁶ The interpretation of the data requires quite some caution. I encourage the readers to look at patterns rather than the difference between two programmes which are close to each other in this ranking.

European manufacturers emphasise strongly delivery as a competitive priority for the next five years: both dependability and ability to react very quickly in case of rapid changes in market requirements. This is strongly in line with trends we have already observed, and indicates that service of delivery has risen strongly in importance. The data from my Japanese colleague points in the direction of innovation.

Table 5. Past Pay-off of Action Programmes (1996) (in Descending Order of Pay-off, from Highest to Lowest)

Europe	Japan
ISO 9000	ISO 9000
Continuous improvement	Continuous improvement
Cross-functional teams	Customer partnerships
Worker training	<i>CAD and/or CAE</i>
Management training	Integrating IT within manufacturing
<i>Supervisor training</i>	Value analysis
Reorganizing plant networks	Certification for customers
Developing a manufacturing strategy	Reorganising plant networks
Customer partnerships	New processes for new products
Functional teamwork (e.g. QC)	Reconfiguring plant layouts
Developing new performance measures	<i>Integrating IT across the business unit</i>
Empowerment	New processes for old products
Reconfiguring plant layouts	Supplier partnerships
Improving manufacturing processes to protect the environment	Developing a manufacturing strategy
Total Quality Management (TQM)	Improving manufacturing processes to protect the environment
Integrating IT within manufacturing	Integrating IT with suppliers and distributors
Certification for customers	Closing or relocating plants
CIM	Functional teamwork (e.g. OC)
Concurrent engineering	FMC or FMS
Outsourcing manufacturing	SQC and/or SPC
Design for manufacture	JIT
Total productive maintenance (TPM)	Increased use of recyclable materials
Integrating IT with suppliers and distributors	Taking back products from customers
Increased use of recyclable materials	Reengineering business processes
Simple pick and place robots	Design for manufacture
Complex robotic systems	Improving products and inventory systems (e.g. MRP)
Taking back products from customers	Complex robotic systems

Customisation and design flexibility score significantly higher in Japan than in Europe as competitive priorities.

How did we get where we are today (Table 5)? Investment in people (training, teamwork and empowerment) seems to be the answer from this sample of European manufacturers. Innovation and integration of information systems are the answer from the Japanese respondents. And all of us benefited from quality efforts (ISO 9000 and continuous improvement). New and high on the list is also the idea of customer partnerships. By contrast, ‘traditional’ Japanese manufacturing techniques are out of fashion and score very low in terms of perceived feedback. The law of decreasing marginal returns seems to apply in manufacturing management.

Will we continue these action programmes in the future (Table 6)? The emphasis on ISO 9000 is ebbing away. This seems to be logical: the highest return from ISO 9000 type of actions comes the first time you do it. Afterwards it risks becoming a bureaucratic hassle. The pattern of human resources-type programmes in Europe continues, while the emphasis on innovation-enabling technology (e.g. CIM, CAM, and integration of IT) remains high in Japan. Customer partnerships score high everywhere. This indicates a further education towards the extended or virtual enterprise as I have already described (De Meyer, 1992).

Table 6. Future Emphasis on Action Programmes (1996) (in Descending Order of Emphasis, from Highest to Lowest)

Europe	Japan
Continuous improvement	Integrating IT within manufacturing
Cross-functional teams	Integrating IT across the UB
Worker training	Reorganising plant networks
Developing a manufacturing strategy	Customer partnerships
Customer partnerships	<i>New processes for new products</i>
Supervisor training	ISO 9000
Empowerment	Developing a manufacturing strategy
Integrating IT across the UB	Value analysis
Management training	Certification for customers
Integrating IT within manufacturing	Continuous improvement
Total Quality Management (TQM)	Integrating IT with suppliers and distributors
Supplier partnerships	Empowerment
Benchmarking	Cross functional teams
Developing new performance measures	Management training
CAD and/or CAE	JIT
Design for manufacture	CIM
Closing and relocating plants	CAM
Reconditioning physical plants	Improving product and inventory systems (e.g. MRP)
FMC or FMS	Outsourcing manufacturing
CAM	SQC and/or SPC
CIM	Simple pick and place robots
Taking back products from customers	FMC or FMS
Simple pick and place robots	Closing and relocating plants
Complex robotic systems	Complex robotic systems

Where Will This Lead Us?

More emphasis on price competition and thus a continuing drive for delocalisation, a refocusing on human resources, a decline in the emphasis of quality as a competitive tool, and a group of Japanese manufacturers which emphasise innovation through a more intensive deployment of IT. What does this imply for European manufacturers? I will provide an ‘informed guess’ as to where this will lead in Europe as a series of seven normative statements.

1. Lowering costs is necessary to win the price battle, but is exhausting, and not necessarily the strength of European manufacturing. We have to admit that even in a world where technology and capital investment is high, labour cost kills our competitive position. Innovation in the value package that we offer the customer must be the answer. More R&D and shorter delivery times seem to be the obvious answers, because that is where the competition from overseas cannot beat us. But let's be careful! R&D investments are rising everywhere, and one only has to look at the investments made by a Samsung, Acer or Chinese software developer to understand that innovation is everywhere. Is speed of delivery the answer? Yes, we do have the geographical advantage of being close to the largest consumer market in the world. But counting on that can be a dangerous game. More and more products gain in software content, and we are not far from a world where customisation will be exclusively software-driven. Speed of delivery can then be provided with standard products which come from abroad and which are customized at the last moment with software beamed in via satellites from Bangalore, Manila, Sao Paulo or Hanoi. I am perhaps jumping ahead, but I simply want to warn that the mantra of high value added products as a strength for Europe's manufacturing (as compared to what South East Asian or Latin American companies would be able to produce) will not last forever. More is needed.
2. That 'more' has in my opinion to come from a very close integration between manufacturing and service. The emphasis on delivery and rapid volume changes is already pointing in that direction. Let me try to illustrate this with a somewhat simplistic and slightly disguised example. Everybody who knows a bit about France will remember that France's population is heavily concentrated in a few Surban areas, and that the rural areas are relatively empty. Moreover, distribution is highly concentrated with a few large chains of super and hypermarkets, which usually have their shops in shopping centres at the gates of Paris, Lille, Lyon, Marseilles or other big cities. These distribution companies have a huge market power and try to reduce their inventories as far as possible. They consequently push the inventory holding to their suppliers. Let us now take the example of a yoghurt producer. For reasons of economies of scale and quality management he would like to concentrate production in rural areas, close to the producers of milk. Yet the consumption is mainly, if not exclusively, in urban areas. From a producer's point of view one would build a large factory in a rural area, and deliver a few times per week by truck to the urban areas. But the powerful distributor requires low inventories, and the shelves to be filled two to three times per day. One can easily imagine that supplying two to three times per day with a large truck from a rural area to the different shopping centres around Paris is a nightmare. The logic would thus be to have small production centres close to each of the big cities. But they don't allow economies of scale which are required to meet price pressures imposed by the distribution. One solution applied by a well-known fresh food producer, when I translate it into the yoghurt example, was to produce in big volume the yoghurt in a very efficient factory in a rural area, ship it by big container trucks to small filling stations located in

urban areas, but in locations which were easy to reach, and distribute three times per day (four in the Christmas season) to different hypermarkets with small delivery vans. This example illustrates how the design of the production system was adapted in order to combine production efficiency with service. The delivery frequency offered by the supplier was even higher than the distributor expected it to be.

3. Internationalisation will not go away. In the international context it becomes of utmost importance to manage both architecture of the plant network and fit between performance indicators and the charter of a plant within the global network.

Several authors have proposed models to map plants. Many authors make the distinction between product and process oriented plants. One of the most useful is the categorisation proposed by Ferdows (1997). He maps plants according to two dimensions: the first is primary strategic role of the plant, the second is extent of technical activities carried out at the plant or value added created at the plant. Vereecke (1997) has proposed a different way of distinguishing between different plants:

- the *isolated* plant which has no contacts with other partners in the plant network
- the *blue print receiver*, or a plant that simply receives all the innovation from other plants
- the *integrated* plant which receives and provides information and is fully integrated in supply networks between nodes of the plant network
- the *fully integrated network player* which plays a dominant role in exchange of information and influences to a great extent the orchestration of the network

This paper does not intend to evaluate the merits of each of these models for classification, but the really important point is the need to have a strategic view of the architecture of the network. What is the role of each plant? How will this role evolve? How are the management systems and key performance indicators adapted to different charters or roles of the plants? It does not make sense to design a differentiated network of plants and then to apply a standard set of key performance indicators to it. Performance indicators and management style have to be adapted to the role of the plant.

One of the key tasks of the international production manager is to be the architect of the network and differentiated management systems, as well as the orchestrator of flows of goods, knowhow, people and capital between nodes of the network.

4. Mass customisation, speed in delivery and product design, increasing service content and internationalization will require more-flexible organisations. Manufacturing organisations will drift away from the traditional structure of repetitive manufacturing companies. They will get closer to what some describe as the project-based organization (Fortune, 1995). Repetitive manufacturing will not disappear,

but new customer demands will require different organisational solutions. I have observed recently two interesting experiments. In one organisation the concept of a job had been replaced by that of a role. In this company, strategists draw broad trajectories along which the company can evolve, resource providers make capital, human resources, know-how and information available. But the core of the action is with project managers who manage the organisation as a collection of finite and unique tasks or projects. In order to achieve their goal they deploy specialists, or 'talents'. Another organisation has structured itself along its core processes. Instead of an operations, marketing or development manager, they have a transformation manager, a supply chain manager, a new product development manager and a learning and process implementation manager. These two approaches are obviously specific to the respective organisations. But they both render the organisation structure flatter, and more aligned with the value creation process on which the company has built its competitive advantage.

5. Already in 1992 we observed that quite a few typical manufacturing management programmes e.g. JIT, Design for Manufacture and worker empowerment were actually about breaking down walls that were constructed around the manufacturing task. We pleaded then for the creation of a Virtual Factory, or a factory that would extend itself beyond the factory walls and would integrate with its suppliers, distributors, the surrounding environment and other functions in the company, e.g. marketing and engineering. The emphasis on customer partnerships is confirming an evolution towards a more integrated management of the value added chain.
6. In a recent paper (De Meyer and Kim, 1996) we developed a model to help us better understand how companies can leverage their operational capabilities into strategic drivers for the organisation. We started from a very simple observation: many companies have recently built their strategy on conceptual models which find their roots in operations. Time-based Competition comes from JIT systems, TQM finds its roots in statistical process control, BPR in process analysis, and the learning organisation in continuous improvement techniques. On the other hand we observed also that some programmes like MRP II, FMS or CIM did not lead to company-wide strategic programmes. We wondered why that was and have come to the conclusion there is something in the way these programmes were developed that made the difference. Successful transformations from operational into strategic programmes were usually internally developed, approached with an attitude of 'these are programmes without a beginning or an end', built in a very organic, brick by brick approach and 'software' oriented. We also saw a lot of interaction between bottom up and top down implementation, lots of experimentation and an ability to widen the scope of a programme in those companies that are the leaders in these transformations. Modern manufacturing can be the breeding ground for new strategic competencies and it will be a challenge to recognize these programmes and develop them into strategic drivers.

7. Finally, knowledge management is becoming pervasive in manufacturing. The most successful manufacturing organisations will be those which learn faster than their competitors. Building such a knowledge-based organisation requires quite a steep change in managers' attitudes. Dutta and De Meyer have described it as three challenges: First, how can one turn managers from readers into writers, or from consumers of information to providers of information?; this is far from obvious in a society where information is often equated with power. Second, how can we avoid information overload and turn information into action-oriented knowledge? Third, how can we go from a situation in which information is pushed onto managers to a situation where information is pulled, i.e. where managers collate efficiently and effectively the information which they want and need?

These are seven normative statements for the success of manufacturing. A whole programme for manufacturing managers. But if it succeeds, there is a bright future for Europe.

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