"QUALITY UP, TECHNOLOGY DOWN"

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N° 88 / 65

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Printed at INSEAD,
Fontainebleau, France

INSEAD WORKING PAPER N° 88/65

A B S T R A C T

QUALITY UP, TECHNOLOGY DOWN

A report on the 1988 European Manufacturing Futures Survey

Manufacturing has been recognised over the last decade to be an important strategic weapon. Most of the research on manufacturing's role in the company's strategy is based on clinical case studies. The European Manufacturing Futures Project is a long-term project carried out at INSEAD to gather data through a questionnaire on the manufacturing strategy of large European manufacturers. This paper is a report on the sixth survey, which we carried out in the first semester of 1988. The most striking conclusions are: (1) that quality remains the core of European manufacturing strategy; (2) that technology has lost some of its former appeal, and that more attention is paid to "org"ware rather than "tech"ware; (3) success in performance improvement is always the result of a comprehensive set of long term action plans.

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I N S E A D

October 1988

1. INTRODUCTION

The deployment of manufacturing as a weapon in the global competitive battle has gained in importance over the last decade. Most of the scholarly and popular publications have focused on the relative strengths of Japanese (and in more recent years, Korean and Taiwanese) manufacturing vis-à-vis the North American industrial practices. Comparisons with the European manufacturing practices have been less frequent. An important hinderance has been scarcity of comparable data across these regions. Over the past five years, we have built up a database on manufacturing practices across Europe. The data has been gathered essentially through questionnaires. We have done this in collaboration with two other research teams, one in Boston University in the United States and another at Waseda University in Japan. These teams have also used similar questionnaires for their respective regions. The three projects together allow better international comparisons of manufacturing practices. Each year, we gathered data from a sample which varied from 150 to 225 companies. Though quite a large number of companies have answered several times, each year a group of new companies are added to the sample. At this stage, we have data on over 2500 companies in the database.

Results of the previous campaigns and comparisons across the three regions have been reported in Ferdows et. al. (1986), De Meyer et. al. (1986), Miller et. al. (1988). In this paper, we intend to assess the manufacturing practices of 187 large European companies, as they were reported in 1988.

After a short introduction on the methodology used to compile the data and a description of the sample, we focus on manufacturing strategy, the competitive priorities of the respondents, the action programmes, and the performance to which past action plans have led.

The most salient conclusions, which we already want to highlight at this introductory stage, can be summarised in five points. First, it seems that the way European companies want to compete has barely changed in comparison with previous years. Product quality remains the main tool of competition, and the attention paid to increased flexibility is only very slowly on the rise. Second, technology has lost some of its former appeal. More attention seems to be paid to "software" and "orgware" development rather than to deployment of more "techware". Third, total quality programmes are proliferating, and have led to satisfactory results. But there does not seem to be any exciting results with some of the other, more flexibility-related, action programmes. Fourth, the differences among broad industry categories are small. There are, of course, some differences at the margin in the way some improvement programmes are regarded and implemented, but across industries the general trends in action programmes and competitive priorities are similar. Fifth, success in performance improvement, be it on quality, unit production cost or delivery, is always the result of a comprehensive set of long term action plans. There are no magical cause-effect solutions, where one punctual action would lead to improvements. This confirms the view that there are no shortcuts in manufacturing management.

2. METHOD

As in previous years (Ferdows and De Meyer (1985), De Meyer (1986), Ferdows and De Meyer (1987)), a questionnaire was sent to a sample of large European manufacturers. The sample consisted of the 100 largest manufacturing companies in the U.K., France, and the Federal Republic of Germany, and Italy and the 50 largest manufacturing companies for most of the other countries. In total, about 1000 questionnaires were sent out in late 1987 and by April 1988, responses from 187 were received.

The questionnaire consists of three main parts: (1) the business profile of the responding unit (either a plant, a business unit or a company); (2) the competitive priorities for the manufacturing function; and (3) the action plans which have been implemented or will be implemented over the next two years. The logic of this questionnaire lies in the fact that business profile, concerns and competitive priorities form a triad on which the action plans are grafted as symptoms of an underlying manufacturing strategy. Most of the questions are of a closed type, where respondents are asked to indicate their opinions or perceptions on a 7-point Lickert scale.

3. DESCRIPTION OF THE RESPONDING SAMPLE

As in previous years, the responding sample is not statistically representative for the European industry. The 187 responding companies are from 14 countries (Table 1), and, on the basis of a two-digit Standard Industrial Code, can be classified in 19 industrial groups (Table 2). The responding sample is therefore from a large variety of industries and countries but it is not biased towards a particular industry nor geographical region.

The unit of analysis (called "business unit"), for which most of the questions were answered, was chosen by the respondents: 39% answered for an entire company, 41% for a division or group and 20% for a plant.

The average European respondent is from a large, profitable, growing, internationally operating business unit which tends to be the market leader for its primary product or product family (Table 3).

Table 1: Distribution of Responses by Country

Country	Number	%
Austria	2	1
Belgium	17	9
Denmark	16	9
Finland	6	3
France	30	16
Germany	38	20
Great Britain	29	15
Holland	9	5
Ireland	5	3
Italy	10	5
Norway	2	1
Spain	9	5
Sweden	9	5
Switzerland	5	3
TOTAL	187	100

Table 2: The Distribution of Responses by Industrial Sector

Industry	SIC No.	Number	%
Food	20	15	8
Paper	26	9	5
Chemicals	28	32	17
Petroleum/Energy	29	4	2
Rubber/Plastic	30	5	3
Glass	32	10	5
Metals	33	5	3
Fabricated Metal	34	4	3
Engines/Turbines	35	24	13
Electric/Electronic	36	36	19
Transport	37	21	11
Instruments	38	9	5
Others (SIC No. 21-5, 27, 31, 39)		13	7
TOTAL		187	

Table 3: Characteristics of the respondents

Median of annual sales revenues	ECU 1,219,929,000
Average pre-tax return on assets	16.4%
Average pre-tax profit as a % of sales	7.8%
Average market share of primary product	26.5%
Average market share of main competition	22.8 %
Average growth rate (units sold)	11.3%
Average number of countries in which the respondent has plants	2.3

Of course not all respondents were profitable and growing; 6% reported a loss for the last fiscal year, and 8% a negative growth.

The typical business unit makes 55% of its sales through its primary product or product family. A large share of its total sales, 28%, is coming from products which are on offer for less than two years; in three years' time this proportion is expected to reach 33%.

The typical European manufacturer in our sample still puts most emphasis on the improvement or maintenance of its existing marketing position in (Table 4a). As we reported in previous years, this is in contrast to the typical Japanese respondent who emphasizes the development of new products for either existing or new markets (Miller et al, 1989). Table 4b indicates that the typical European respondent plans to rely mostly on internal resources for its product-market initiatives.

Table 4a

Average Emphasis on Market Direction (on a scale from 1 to 7

Market Direction	Average emphasis
Developing new products for existing markets	5.7
Maintaining market share in existing markets	5.6
Increasing market share in existing markets	5.4
Developing new markets with existing products	4.5
Developing new products for new markets	3.2

Table 4b

Ways for changing direction and scope over the next five years

Tools for change	Average emphasis
Develop with internal resources	5.3
Acquisition	3.8
Joint Ventures/Partnerships	3.8
Divestitures	2.2

Manufacturing is important to the respondents: on the average, the current manufacturing cost is 65% of the business unit's sales. The **medians** of the components of these costs are shown in Table 5. (We show the medians to minimise the bias caused by the "outliers").

Table 5: Median current and expected cost structure

	Current	Expected in 2 years' time
Total manufacturing costs as a % of sales	65%	62%
R&D expenses as a % of sales	3%	
Allocation of manufacturing costs to:		
- materials	58%	56%
- direct labour	15%	15%
- energy	3%	3%
- manufacturing overheads	20%	20%
of which:		
- indirect salaries, wages, fringes	50%	
- depreciation & facilities expenses	20%	
- corporate allocations	15%	
- other	16%	

Note: Since these numbers are the medians, they do not necessarily add up to 100.

The average total number of people employed by the business units is 4 585. The distribution of this number is highly skewed. The median is only 840. This median is expected to rise to 943 in two years' time. Since we assume that this does not reflect a trend towards a reduction of the capital intensity of the business units, this must be an indication of the intention to grow, and perhaps of a general impression of optimism which characterises the average manufacturer in our sample this year. The median direct labour component of the workforce is 300 or 36% of the total labour force.

All these numbers tend to indicate that the average respondent is a **large, profitable and growing business unit, for which the manufacturing function plays an important role now and is expected to do so in the future. It is depending primarily on its internal resources to introduce more new products and expand its market share. In general, it is fairly optimistic about future growth and markets.** Now, how do these business units compete?

4. THE MANUFACTURING STRATEGY

To describe the manufacturing strategy of the business units, we have four groups of data. The respondents indicated on a 7-point Lickert scale for closed questions what they consider to be their current strengths vis-à-vis the competitors; what they see to be their competitive priorities; what kind of action or investments they have emphasized in the past, and what they intend to do in the future.

The logic behind the analysis in this paper is: (1) current competitive strengths are a consequence of past actions; (2) the evaluation of current strengths leads to a redefinition of competitive priorities; (3) the choice of priorities and the evaluation of the effectiveness of past actions leads to a new portfolio of action plans to be emphasized. The results are summarized in Tables 6,7, and 8, and will be discussed in the following sections.

4.1 Past Action Plans: Emphasis of training, quality and reaction time ... but quality improvement has been most useful

Table 6 lists the top twelve action plans which have been used in the past and those which will be emphasized in the future. These action plans are a subset of the 39 action plans which were offered to the respondents. A complete list is given in Appendix A. Let us first analyse the left-hand column in Table 6--i.e. past action plans.

Action plans which have been greatly emphasized until now are centered around three goals: (a) **training** at all levels; (b) **total quality management**, in particular vendor quality, worker safety and worker training, and (c) **reduction of the reaction time** of the factory through better control over the flow of materials. The largest number of action plans, such as the integration of information systems, the production and inventory control systems, the reduction of lead times and changeover times, all contribute to this latter objective.

Table 6: TOP TWELVE ACTION PLANS

Presently emphasized		Emphasized for next two years	
Integration of information systems between Manufacturing and other functions	(3)	Zero defects	(13)
Worker training	(5)	Vendor Quality	(3)
Vendor Quality	(2)	Integration of information systems between Manufacturing and other functions	(1)
Production and Inventory Control Systems	(9)	Integration of information systems with Manufacturing	(6)
Management training	(8)	Worker training	(2)
Integration of information systems with manufacturing	(4)	Manufacturing lead time reduction	(10)
Worker safety	(10)	Supervisory training	(8)
Supervisory training	(7)	Management training	(5)
Reducing setup/changeover times	(13)	Production and Inventory Control Systems	(4)
Manufacturing lead time reduction	(6)	Worker safety	(7)
Computer Aided Manufacturing	(19)	Defining a manufacturing strategy	(21)
Computer aided design	(20)	Just in Time	(17)

Note: The numbers between brackets indicate the rank in the other list, i.e. in the list on the right side, (13) in front of zero defects indicates that it ranks only 13th in the list of present action plans. The basis for the rankings of the two lists were somewhat different. The list on the left side shows the programmes which have been highly emphasized in the recent past by the largest number of respondents. The list on the right hand side shows the top 12 action plans with the highest average score on a 7-point Likert scale.

How useful have these programmes been? We have two ways of judging this. First, we asked the respondents to indicate usefulness of eight organizational innovations which included quality improvement programmes, internal reorganization, and lead time reduction. As one might expect, there was a high correlation between the different items on each of the two lists of 8 organisational innovations and 39 action programmes. Through a factor analysis, they could be reduced to two factors:

- a "total quality" factor, combining quality improvement programmes, worker training programmes, process controls and worker participation and motivation programmes;

- a "flow smoothing" factor, combining internal restructuring and organization, restructuring of the procurement network, integration of information systems and lead time reduction programmes including J.I.T.

Comparing these two groups of programmes, the respondents are clearly far more satisfied with the usefulness of the total quality related programmes. In other words, quality improvement programmes seem to yield results!

Another clue to assessing usefulness of a programme is to see if the company which has been emphasizing it in the past, plans to continue emphasizing it in future. In Table 7a, we have shown one such analysis. List 1 in this table shows those actions losing their past high emphasis by more than one-third of the respondents; list 2 (in the same table) shows those action plans which have lost their past high emphasis by a quarter of the respondents. If we compare these lists with the lists in Table 6, it can be seen that none of the programmes currently on the top list is losing management attention.

In Table 7b, we show the other side of this coin--i.e., programmes which are gaining in emphasis. Here the lists are provided for programmes which are gaining emphasis by more than 50% and 40% of the respondents, respectively. As it can be seen, most of these programmes are the same as the ones in Table 6.

Taken together, Tables 7a and 7b indicate that most of the currently emphasized programmes continue to receive attention, and in fact most are receiving increasing attention. In particular, it can easily be seen that "total quality programmes" (not defined above) continue to receive particularly increasing attention. We interpret this as a sign of satisfaction with these programmes.

Table 7a:

Action plans emphasised in the past, but not in the future

List 1: Programmes losing emphasis by more than 33% of respondents

Value analysis/product design

Reducing the size of the manufacturing units

Plant relocation

Narrowing product line/standardisation

Closing plants

List 2: programmes losing emphasis by between 25% and 33% of respondents

Giving workers a broader range of tasks

Group technology

Reconditioning physical plants

Robots

Quality circles

Table 7b:

Action plans not emphasized in the past, but to be emphasied in future

List 1: programmes gaining emphasis by more than 50% of respondents

Worker training

Management training

Supervisor training

Zero defects

Defining a manufacturing strategy

Integration of information systems between manufacturing and other functions

Integration of information systems in manufacturing

Vendor quality

Improving new product introduction

List 2: programmes gaining emphasis by between 40% and 50% of respondents

Manufacturing lead time reduction

Reducing set-up time

Developing new processes for old products

Just-in-time

Flexible Manufacturing Systems

Statistical Quality Control (process)

Statistical Quality Control (product)

Production and Inventory Control

4.2 What are we good at? Quality yes, flexibility and prices no!

The respondents were asked to assess their current strengths relative to their competitors (defined by themselves) along nine specific manufacturing capabilities. Table 8 shows their answers. Examining the entries in Table 8, one can conclude that the average respondent in our sample feels it has superior competitive capability clearly with respect to being able to offer consistent reliable quality and providing high performance products; where they fell relatively weaker is in the ability to offer low prices and the capability to change product design rapidly and change the production volume quickly.[1] For the rest--abilities related to speed and reliability of delivery, breadth of product line offered, and making quick changes in production plan, they are about at par with competition.

This profile of strength probably reflects a deeply engrained conviction that European companies should compete less on price and more on quality.

Table 8: Current Strengths

	Stronger than Competitors
Consistent reliable quality	69%
High performance products	63%
Broad product line	57%
Fast deliveries	53%
Dependable deliveries	52%
Quick change in production plan	47%
Rapid volume changes	39%
Rapid design changes	38%
Offer low prices	31%

4.3 What do we want to be good at: Quality, but also flexibility!

Against this background of past actions and current strengths, we can better judge the objectives for the future (Table 9). The ability to offer consistent reliable quality stands out as the most important priority.

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1. A Wilcoxon matched pair rank order test also shows that these two entries on top of the list in Table 8 are significantly different from the rest at $p < 5\%$.

Second in importance is the ability to make dependable delivery promises. Fast delivery and providing high performance products is a third category. Rapid design changes and flexible production plans is a fourth category. And the ability to offer low prices, a broad product line or to make rapid volume changes is least important, if not unimportant.

When we compare these competitive priorities with the companies' perception of their current strengths with respect to their competitors (Figure 1), one gets a very mixed picture. Some of the competitive priorities to be emphasized or de-emphasized coincide with relative strengths or weaknesses and are thus a continuation of the past. Other competitive priorities seem to be in contrast with past strengths or weaknesses.

To test this, we have calculated the correlation between current relative strengths and the importance of the competitive abilities over the next five years. If we take a correlation coefficient of .20 as a cut-off level, then there is a high correlation between the present strength and the future priorities only for rapid design changes (.33), rapid volume (.21), high performance products (.24) and the ability to offer a broad product line (.44). In other words, those who, for example, consider themselves already strong in rapid design changes will continue to emphasize this as a competitive priority.

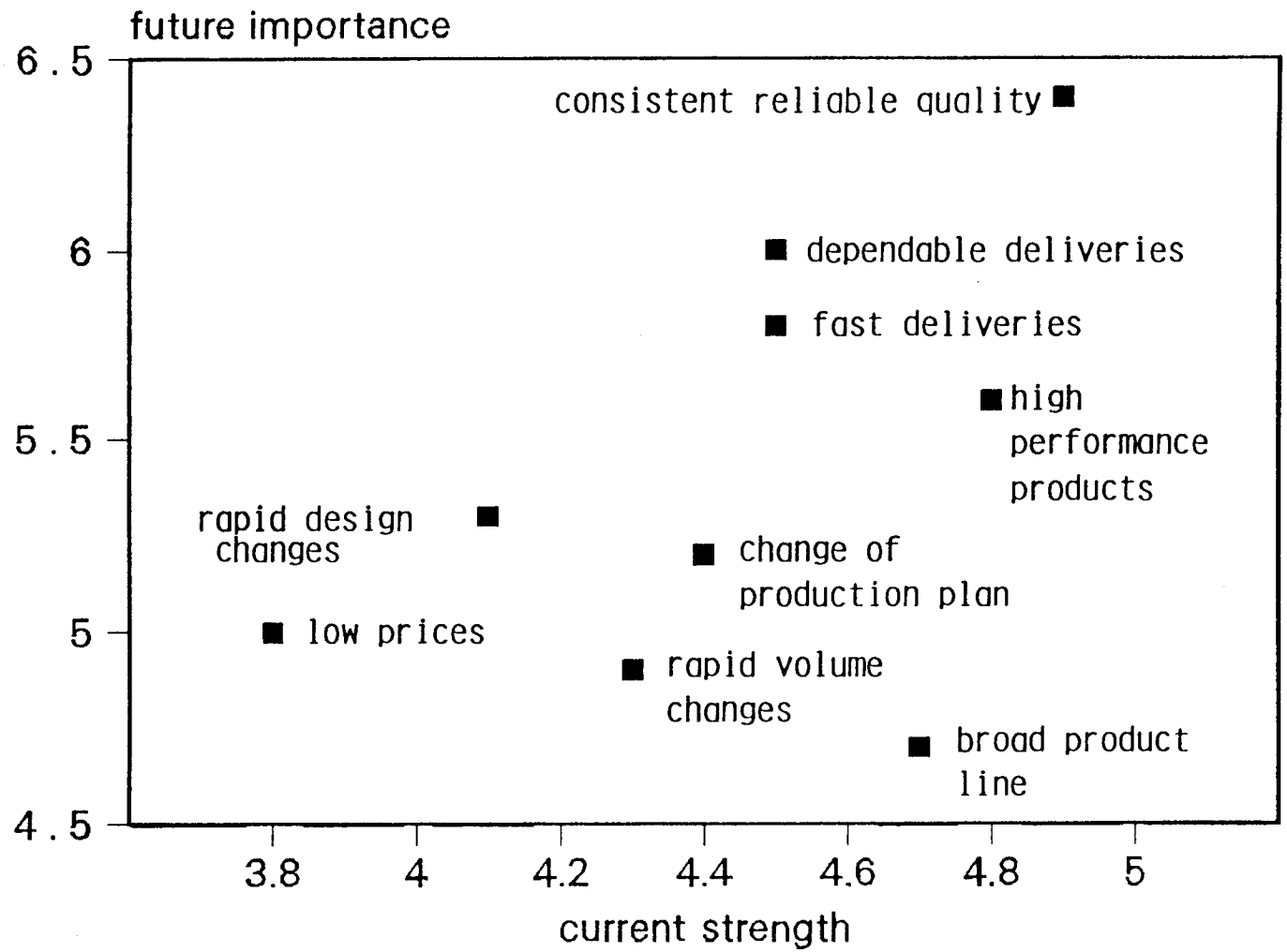
For none of the competitive abilities we could find a negative correlation: on the average the companies will not de-emphasize their strengths or reverse the trend in their weaknesses.

Table 9: Competitive abilities

Competitive priorities for the next five years
Offer consistent reliable quality
Make dependable delivery promises
Provide fast deliveries Provide high performance products
Make rapid design changes and introduce new products quickly Change production plan quickly
Offer low prices Make rapid volume changes Offer a broad product line

Note: The items are grouped in groups which are significantly different from each other with a Wilcoxon matched pair rank order test ($p<5\%$).

figure 1 : future importance versus current strength



How does this profile differ from previous years? When we look back to the results between 1983 and now, we see a constantly high emphasis on quality, a gradual decrease in the importance of low prices to the benefit of the improvement in delivery systems and design flexibility. In fact, when we compare the answers to this question in 1987 and 1988,[2] company by company, it is clear that the ability to make changes in design and introduce new products quickly, and the ability to make rapid volume changes are receiving significantly greater emphasis in 1988 than in 1987. Some of the other differences between the full samples of 1987 and 1988 in the rank order may be consequences of the differences in sample. The intention to become more flexible in volume and design is, however, undeniable.

This trend towards flexibility is not accompanied by a strong intention to do this at low prices. The correlation between the emphasis on the ability to offer low prices and flexibility priorities is negative, though not significantly different from zero. "Cost efficient flexibility" is not yet a goal for our respondents! Flexibility and cost efficiency are still seen by most of our respondents as trade-offs, rather than as complementary goals. This is in contrast to what we have observed in the Japanese data in previous years (De Meyer et. al. 1988). The Japanese seem to have been aiming at both an increase in flexibility and cost efficiency. They seem to consider them as complementary objectives, not as trade-offs.

In summary, it becomes clear that the average European company in our sample is **opting for a portfolio of goals which consist of a heavy emphasis on reliability in quality and delivery, is starting to make more efforts to become flexible, in the first instance with fast deliveries and faster introduction of new products, but is gradually de-emphasizing competition on the basis of price.**

4.4 And how is this translated into action?

The portfolio of future top action plans (Table 6) is not that different from the portfolio of the recently emphasized action plans. One finds the same items in both lists, though the rank order might be slightly changed. These small changes in rank order are not significant. The pursuit of zero defects, the implementation of Just-in-Time and the definition of a manufacturing strategy, are the three real major "risers" in this list. The "drop-outs" are the pure technology oriented programmes such as CAD and CAM. There seems to be an awareness that excellence in manufacturing does not emanate from throwing money at technology, but requires more investment in what to do (i.e. define the strategy) and gradual improvement of the manufacturing organisation at large (including vendors and other functional groups in the company). And in Tables 7a and 7b, we see more evidence of this (as mentioned before). The top "drop-outs" are mostly related to reduction of the activities, traditional cost improvement programmes, standardisation or pure technology-oriented actions such as robots. The notable exceptions are the implementation of quality circles, value analysis and job enlargement. The first has probably to do with the disillusionment of some companies with too hasty or isolated introduction of quality circles. For the second and the third, however, as we will discuss later, we do not have a good explanation.

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2. 95 companies or business units answered in both years.

The newly activated action plans are in unison with the competitive priorities for the future: quality programmes, training, integration of the supply chain, reduction of lead times, flexibility and speed in product introduction.

How does this compare to the "future plans" indicated by the respondents of the previous year's survey?. Is there any change in the answers for those companies which answered both in 1987 and 1988? Table 10 shows those programmes with significant changes in emphasis in these two years. The list is quite similar in its general trend to the difference between presently emphasized and future action plans, and as such our observations from the 1988 responses are confirmed.

In short, becoming more responsive in production is clearly on the rise. Production and Inventory Control systems are getting more attention, but this in conjunction with manufacturing lead time reduction. The control system will probably be used to become more responsive to customers' demands. The more traditional cost-efficiency programmes such as reconditioning of physical plants, automation of jobs or developing new processes for old products are reduced in importance.

Table 10: Differences in future action plans between 1987 and 1988

Increased in importance:	Manufacturing lead time reduction Production and Inventory Control Systems
Decreased in importance:	Giving workers a broader range of tasks Preventive maintenance Computer Aided Manufacture Developing new processes for old products Reconditioning physical plants Automating jobs

A bit of an enigma for us is the reduced emphasis on the job enlargement plans. Both in the comparison between 1987 and 1988, and the change in emphasis between present and future action plans, the plan to give workers a broader range of tasks is reduced in importance. Combined with the prominent and improved position of worker training, the continuing low position in the list of action plans of job enrichment (give workers more planning responsibility, which is only 30th on the list of future action plans), we get the impression that European production managers want to keep their workers at the task they are performing, but intend to give them, through training, the tools to carry out these tasks as efficiently as possible.

Let us summarize. European manufacturers' future action plans have not changed much from past practice. **The incremental changes are in line with an increased emphasis on flexibility and responsiveness, and a reduced emphasis of some traditional cost efficiency improvement programmes.** The plans with respect to people management seem to evolve in a somewhat different way from what one would expect from the present literature on human resource management: **rather than job enlargement and enrichment, the motto seems to be to allow the workers to improve through training.**

4.5 And what about the differences between industries?

The disadvantage of the previous analyses is that they lump different industries together. To understand some of the industry differences, while keeping sample sizes which permit statistical analysis, the respondents were regrouped in five broad categories which we labeled as follows: food and tobacco, chemicals (including petrochemicals and metallurgy), machinery (including the automotive industry), electrical, electronics and instruments and a residual category of "others". This last category will not be considered in the analysis.

In Table 11a we summarised in a qualitative way the results of a chi-square test, used to test the hypothesis that there were no differences between the industries. The action plans mentioned in Table 11a indicate whether the respondents in a particular industry would in majority have used (shown as "+") or not used (shown as "-") the particular action plan in the past. In Table 11b the data on future action plans are summarised. The action plans mentioned are those for which, on the basis of an analysis of variance test, the influence of the industry categorisation on the future emphasis put on a particular action plan could not be rejected. The entries in the table indicate the average score of each industry group for this action plan.

What should be concluded from this? First of all, that there is not much of a difference between the industries.

The food industry has invested more in worker safety and production and inventory control systems, and will, in comparison to the others, invest less in JIT, CAD, CAM. They are more interested than the chemicals industry, however, in improving their capabilities to introduce new products.

The chemicals group has put comparatively low emphasis on production and inventory control systems, but is the only group which has invested in capacity expansion. Moreover, they stood out by their attempts to reduce the manufacturing lead times. There will be almost no shift in this relative position when one looks at the future.

The machinery group stands out by its investments in technology: CAD, CAM, and robots were heavily emphasized. Also quality and flow related action plans were important. It is the group which in the future will spend more efforts on people. Giving people a broader range of tasks and worker training is given more attention. Technology and flow oriented programmes will remain important in the future. The growing emphasis on manufacturing lead time reduction, value analysis and product redesign and group technology is also interesting. This indicates perhaps an increased effort to manage the complexity of the growing number of new product introductions.

The electronics/electrical group is quite similar to the previous group. Technology flow and quality were heavily emphasized. The most striking past action plan in comparison to the other groups is the emphasis on vendor lead time reduction. This theme of lead time reduction will be continued and strengthened in the future action plans, and this clearly in a context where they feel the need to improve the capability to introduce new products.

Table 11a: Differences between past and present action plans (1)

Action Plan	Food n=16	Chemicals n=62	Machinery n=50	Electronics n=45
Worker safety	+	+	-	-
Manufacturing lead time reduction	-	+	-	-
Vendor lead time reduction	-	-	+	-
Computer aided manufacturing	-	-	+	+
Computer aided design	-	-	+	+
Capacity expansion	-	+	-	-
Plant relocation	-	-	+ (2)	-
New processes for existing products	=	+	+	+
Vendor quality	-	+	+	+
Just-in-Time	-	-	+	=
Robots	-	-	+ (2)	-
Production & Inventory Control Systems	+	-	+	+

(1) Differences were significant on a 5% level, based on a chi-square test.

(2) Although the majority or responsents had not engaged in this particular action plan, this particular industry stood out for having had a much higher emphasis.

Table 11b: Differences in emphasis on future action plans (1)

Action plan	Food n=16	Chemicals n=62	Machinery n=50	Electronics n=45
	(Numbers are average score on 7-point Low to high Likert scale)			
Giving workers more planning responsibility	4.1	4.6	5.0	4.5
Working training (2)	5.5	5.8	5.9	5.6
Zero defects (2)	5.6	5.8	6.1	6.1
Manufacturing lead time reduction	5.1	5.4	5.8	6.2
Vendor lead time reduction	5.2	5.0	5.3	5.8
Computer aided manufacturing	4.7	5.0	5.5	5.3
Computer aided design	3.5	4.5	5.9	5.7
Value analysis/product design	4.2	4.2	5.3	5.3
Group technology	4.4	4.2	5.1	4.7
Capacity expansion	4.6	5.3	3.9	4.2
Developing new processes for existing products (2)	5.8	5.4	5.6	4.8
Just-in-Time	4.7	5.4	6.0	6.0
Robots	3.7	3.4	5.1	4.5
Improving new product introduction capability	5.8	5.1	5.7	5.9
Production & inventory control systems	5.5	5.2	5.7	6.0

(1) Significance level: 5%

(2) Significant only on a 10% level.

5. PERFORMANCE

How do the various improvement action programmes affect performance? We added a new set of questions in the 1988 survey to look for an answer to this rather important question. We asked the respondents to rate the performance change along eight measures:

- quality index of conformance to design specifications (quality)
- average unit production cost for a typical product (unit production cost)
- inventory turnover
- speed of new product development (development speed)
- on-time delivery
- delivery speed
- overhead costs
- batch sizes

For each measure, we asked for a change in index between 1985 and 1987. For example, if unit cost would have been reduced by 10% from 1985 to 1987, the index would have been 90. If quality would have been improved by 20%, the index 120, and so on. Since the distribution of these indices is somewhat skewed, averages as well as medians are given in Table 12. Though the averages are not too far away from 100, the standard deviations are quite high and suggest that some companies have made dramatic improvements over the last two to three years.

Table 12: Average index for eight performance indicators for 1987 (1985 = 100)

	Mean	Median	Standard Deviation
Quality	109	105	17
Unit production cost	100	98	14
Inventory turnover	113	110	27
Development speed	106	100	19
On-time delivery	108	103	17
Delivery speed	108	105	19
Overhead costs	100	100	15
Batch sizes	98	100	29

Table 13: Correlation between the performance indices

	Unit Production	Inventory Turnover	Development Speed	On-time Delivery	Delivery Speed	Overhead Costs	Batch Sizes
Quality conformance	.04	.08	.19**	.17*	.09	.06	
Unit production cost	-	-.01	-.08	-0.14	-.10	.28**	-.07
Inventory turnover		-	.01	.21**	.22**	.08	-.11
Development speed			-	.29**	.27**	.05	.18*
On-time delivery				-	.51**	.02	.03
Delivery speed					-	.03	.16*
Overhead costs						-	.06

** $p < 0.01$
* $p < 0.05$

The first point which becomes clear is that improvement in specific performance measures seldom occur in isolation. In Table 13, we show the correlations between the different performance measures. Examining Table 13, one can distinguish three factors: a "cost efficiency" factor which consists of improvements in unit production cost and overhead costs, a "total quality" factor which consists of speedy and on-time delivery combined with higher inventory turnovers and better quality, and a "flexibility" factor which combines development speed with fast and on-time deliveries but increased batch sizes. The fact that these correlations exist indicates that most performance improvement programmes are not designed to obtain improvements on one dimension only.

How have these performance improvements been obtained? To obtain some insight into this, we looking into two groups of respondents for each measure: those companies which did better than the average, and those which did not improve performance at all or performed worse. Those in between were discarded. Then we checked, for each measure, which action plan had been emphasized in the past by each group. The results of this analysis are summarised in Table 14.

One has to be very careful with conclusions about cause and effect relationships in this Table. For example, the companies that did not do well on unit production cost have given their workers more planning responsibility; this does not necessarily mean that the cause of an increased unit production cost was enlarging planning responsibilities of the workers. It could in fact be the reverse--that is, because costs are increasing the company is giving workers more planning responsibilities. With this caveat in mind, we can interpret the results.

Being successful in quality improvement is clearly a task which requires an all-encompassing effort. Indeed, the higher performers in quality have been emphasising specific quality action programs as well as more general actions. Reconditioning physical plants, investing in statistical process quality control and emphasising quality circles should contribute directly to quality improvements in the plant itself. But good quality is quality which is designed into the product. Group technology, value analysis and product redesign, narrowing product lines, are all related to "designing in" quality. Production linkages are equally important: vendor quality is strongly emphasised. And finally, good quality is associated with an investment in people, and a change in attitude. Giving workers more planning responsibility and emphasising zero defects as a philosophy are also characteristics of a high quality performance. If one needed to be convinced that excellent quality is the result of a strategically oriented quality programme, then we find strong evidence in this data.

Those companies which have improved unit production cost have emphasised the development of new processes for their existing products as well as statistical process quality control. It is interesting to note which action programmes are not mentioned here. We do not find the traditional cost improvement programmes of automating jobs or inventory reduction, for example. Instead, we find programmes which have an indirect impact on costs.

The improvements in inventory turnover seem to be associated with zero defects programmes and implementation of Just-in-Time. These associations have a high face validity. While Just-in-Time is of course much wider in scope than only inventory reduction, the improved inventory turnover is definitely a tool and result of Just-in-Time. And if a zero defect programme is successful, one would assume that the increased reliability of

the output will lead to lower safety stocks. For this performance index, the list of actions emphasized by the business units whose performance deteriorated from 1985 until 1987 is rather long. Some of them have confirmed intuition: those companies which went through major restructuring (capacity expansion, plant relocation, reducing the size of the manufacturing units) have done this at the expense of an increased inventory. More difficult to explain is the relation between a bad inventory performance and product standardisation or integration of information systems across functions. It is unclear which are the causes and which are the effects! The increase in inventory could be a temporary result of these action plans. Our own view is that companies with a deteriorating inventory position try to improve it with investments in information systems and by reducing the product range.

The improvement of the speed of new product development seems again to be the consequence of a wide range of factors. Working on improving the new product introduction capability, value analysis and production redesign and developing new processes for new products has resulted in success. But the development speed seems to be dependent on quality programmes too. Vendor quality and zero defects are more deployed by the better performers. One explanation is that new products are introduced faster when one can work with the suppliers, and when the company aims to do things right the first time!

On-time delivery and delivery speed are highly correlated performance indices (coefficient .51). Therefore one can treat them together. Again zero defects, i.e. doing it right the first time, is associated with on-time delivery. Giving workers more planning responsibility, or pushing the responsibility to the lowest level where the information is available to meet delivery targets, also seems to be a successful tool. The speed of delivery has not been improved in those organisations which went through a major reorganisation of manufacturing.

That reduction of overhead costs is associated with capacity expansion is of course expected. With larger capacity, the overhead costs might increase in absolute terms, but in relative terms they often come down immediately after the increased capacity is on line. Value analysis and product redesign probably lead to less components, smoother production, and consequently to less production complexity, thus lowering the overhead costs. The link between lower overhead costs and automation is less clear.

Finally, the reduction of batch sizes is the consequence of an almost obvious set of action programmes: manufacturing lead time reduction, reducing set-up times and just-in-time programmes. It is less evident how closing plants would lead to lower batch sizes unless the responding business units have been closing the less flexible plants. There is, however, no evidence in the questionnaire which would corroborate this result.

Table 14: Relationship between action plans emphasized in the past and performance

Performance Measure	Actions of better-than-average group	Actions of worse-than-before group
Quality (conformance to design)	Giving workers more planning responsibility Zero defects Value analysis/product redesign Group technology Narrowing product lines/ standardisation Vendor quality Reconditioning physical plants Flexible manufacturing systems Process Statistical Quality Control Quality circles	
Unit Production Cost	Developing new processes for existing products Process Statistical Quality Control	Giving workers more planning responsibility Plant relocation
Inventory turnover	Zero defects Just-in-Time	Capacity expansion Plant relocation Narrowing product lines/ standardisation Integration of information systems across functions Reducing size of manufacturing unit
Speed of new product development	Zero defects Value analysis/product redesign Developing new processes for new products Integration of information systems in manufacturing Vendor quality Improving new product introduction capability	Reducing size of manufacturing unit
On-time delivery	Giving workers more planning responsibility Zero defects	
Delivery speed		Manufacturing reorganisation Integration of information systems across functions
Overhead costs	Value analysis/product redesign Capacity expansion Defining a manufacturing strategy Automating jobs	
Batch sizes	Manufacturing lead time reduction Reducing set-up times Closing plants Just-in-Time	

6. CONCLUSION

This year's questionnaire reveals that the average European company in our sample is doing quite well: profits and growths are positive. It is against this positive background that one has to see the conclusions, summarised in six points below:

i. The competitive priorities of the European manufacturers have not changed in comparison to previous years. Quality remains at the top of the priorities and flexibility related capabilities, though receiving more attention, are still relatively at the bottom. Is this because these manufacturers have chosen to compete on quality and nothing but quality? If our assertion made in previous papers that flexibility will be the key tool in the next competitive battle proves to be correct, then the attitude of European manufacturers seems to lag with respect to the realities of global competition. After last year's survey, we warned about the risk of complacency. The relative prosperity of European manufacturers as reflected in this year's survey is, of course, not conducive to reducing this risk.

ii. The average European manufacturer has seemingly come to the conclusion that technology in isolation is not the all round answer to manufacturing problems and concerns. In comparison to previous years, this manufacturer is putting less emphasis on "techware"--such as C.A.D. or C.A.M.-- and more on "software" and "orgware"--such as training, management information systems, and the like. It is peculiar in this context that quality circles and the broadening of workers' planning responsibilities are decreasing in importance. Our data shows that quality circles are still emphasised by those companies which are successful in improving their quality performance. Therefore, there must be significantly different approaches to implementation of quality circles, which influence its outcome.

iii. Quality programmes have proliferated. Statistical quality control, vendor quality, zero defects, all have received more emphasis. And the results are positive. Those who invested in these quality-related action plans seem satisfied with the results, and have seen an improvement in their quality indices. But it is also confirmed that quality results are not easily obtained. They require a coherent and encompassing programme of activities inside the plant, improvements in the design engineering and upgrading of the supplier links.

iv. European manufacturers are not breaking new ground with these quality-related programmes. Europeans are just discovering that quality improvements can reduce costs. But the new field related to flexibility still seems uncharted. True they are working on reductions of set-up times, J.I.T. and F.M.S., but it is not clear whether these manufacturers still see flexibility and costs essentially as tradeoffs or do they believe they can be improved together.

v. Successful manufacturing strategies are less industry-specific than one would think. Of course, every industry has its own specific action programmes. But in every industry, improvement in quality ranks high and programmes such as zero defects and vendor quality are receiving much attention.

A few of the marginal differences between the industries deserve some attention and raise intriguing questions:

a) Chemical and food companies seem to ignore the J.I.T. pressure building up in their downstream operations. Are they in for a surprise? Hence, are they losing precious time to prepare their systems?

b) The electronics group is really feeling the pressure to improve new product reaction time. They are attacking new product introduction capability, manufacturing lead time, vendor lead time more than the rest. Are there lessons to be learned from this industry which would help other industries to build up this capability?

c) The machinery industry, being traditionally a rather "manufacturing-intensive" group, seems to be generally more aggressive on more action programmes. The machinery group has to work harder in building manufacturing strength--and do this at a time when not much new capacity is added. So "green field" solutions are more difficult--they have to concentrate more on making the existing systems, people, vendors, equipment work better. This is a challenge which probably continues from the past, but the pace seems to be accelerating. Will this acceleration continue in future?

vi. Performance improvements are never the result of a simple isolated actions. Quality improvements are not only the result of statistical process control, but also requires working with vendors, giving workers planning responsibility, and a change in attitude of the company. Speed of new product development requires better management of the redesigned process, but also quality management and working with vendors.

APPENDIX A: LIST OF ACTION PLANS

Included in 1988 Questionnaire

Giving workers a broad range of tasks
Giving workers more planning responsibility
Changing labour management relationships
Manufacturing reorganisation
Worker safety
Management training
Supervisor training
Preventive maintenance
Zero defects
Manufacturing lead-time reduction
Vendor lead-time reduction
Computer-aided manufacturing
Computer-aided design
Reducing setup/changeover time
Value analysis/product redesign
Group technology
Capacity expansion
Reducing size of manufacturing units
Plant relocation
Developing new processes for new products
Developing new processes for old products
Narrowing product lines/standardising
Defining a manufacturing strategy
Integrating information systems between manufacturing and other functions
Integrating information systems within manufacturing
Vendor quality
Reconditioning of physical plants
Just-In-Time
Robots
Flexible manufacturing systems
Closing plants
Statistical quality control (product)
Improving new product introduction capability
Quality circles
Automating jobs
Production/inventory control systems
Reducing the size of manufacturing workforce (including hourly and salaried)

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