NEW EVIDENCE ON QUALITY IN MANUFACTURING PLANTS: A CHALLENGE TO LEAN PRODUCTION

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Two major areas of literature were brought together in this research and, as we shall see, this fusion resulted in a challenge to a third area, namely, lean production. The first area was quality, and the literature search included the works of "quality gurus" such as Deming [4], Juran [6], and Crosby [3]. These writers are of direct significance to this research because while they may have differing views in their prescriptions for "successful" quality, the quality gurus were clearly agreed on one thing: there must be senior management commitment to quality within the firm/manufacturing plant. However, they did not specify that this commitment must include senior *manufacturing* personnel. Rather the phrase, "top management," was the umbrella term to denote this commitment from senior management. The problem for many Western firms is that they simply do not have senior manufacturing personnel in the ranks of top management within the firm [5, 7, 10]. The second area of reference concerned manufacturing strategy, and included writers such as Skinner [10], Hill [5], Voss [12], and Brown [2], who have made the case for two key ingredients to be at the center of the manufacturing plant. These ingredients are:

- For senior manufacturing personnel to be involved in the *business* of the firm, rather than acting in a purely technical specialist, functional involvement.
- For explicit manufacturing strategies to be in place which support and, in addition, can *help to shape* the business strategy of the overall firm or business divisions within the firm.

However, there has been little research which shows the specific benefits of these two ingredients to subsequent manufacturing performance in quality. Such specific benefits are provided in this article.

METHODOLOGY

The analysis for this research was gained, essentially, from case study material derived from interviews of 29 divisions/plants within the automobile, telecommunications and computing industries between 1992 and 1996. Interviews took place at senior levels of the plant in order to establish the following information:

1. The seniority of manufacturing personnel within the plant. In some cases the most senior management position in manufacturing would be that of manager rather than director, but it was the *role* of the most senior person rather than the rank of seniority itself which was the main issue here. In short, in this research an attempt was made to determine to what extent there was involvement from most senior manufacturing persons within the plant in terms of their involvement in the *business* of the plant, rather than their purely technical involvement.

2. Whether a manufacturing strategy existed within the plant. The role of the manufacturing strategy was a key issue in determining *enlightened* as opposed to *traditional* plants. In enlightened plants manufacturing strategy played two main roles. First, it helped to translate the business strategy of the plant into a range of specific operational action plans which included quality, determining appropriate manufacturing processes, investment requirements, skills audits and inventory management throughout the supply chain. Second, these capabilities were in turn used to help guide the direction and scope of the business plan; capabilities would be exploited to meet customer needs. Essentially, manufacturing strategy in enlightened plants would be the link between business strategy and operations capabilities.

3. The extent of common links between business and manufacturing strategies. Eight business areas were chosen because they represent "typical" business areas, the final decisions on which tend to come under the responsibility of senior management within firms and which, often, have excluded manufacturing personnel in the decision-making process.

- Decisions regarding the extent of ownership of the supply chain—vertical integration
- Determining the extent of manufacture, as opposed to assembly, within the plant
- Adding to existing plant capacity

- New facilities/location decisions
- Increasing volumes of existing products
- Adding totally new products to existing markets
- Entering totally new product markets
- Investment in new process technology.

4. The time synchronization between business and manufacturing strategies. One of the areas of exploration was the degree of cohesion between business and, where they existed, manufacturing strategies.

THE EMERGENCE OF TRADITIONAL AND ENLIGHTENED GROUPS

We identified the following information. Fifteen of the 29 plants may be labeled enlightened. While this may appear to be high (15/29 = 52%), we should bear in mind that all of the Japanese transplants (of which there were six in this research) are included in the enlightened group. These plants are enlightened because:

- They have senior manufacturing personnel in place at senior management/director level.
- These senior manufacturing personnel are actively involved in the *business strategy* planning process and are not employed purely as technical specialists.
- They have explicit manufacturing strategies.
- These manufacturing strategies feed into, and form part of, the business strategy and can be measured from a total score of the eight key business areas which were listed above.
- There is cohesion in timing between manufacturing and business strategies.

Fourteen plants are traditional because they fail in varying degrees to match the cohesion of the enlightened plants. Eight of these plants had no senior manufacturing presence at senior management/director level; 11 of the 14 had no manufacturing strategy at all; and of the three that did have manufacturing strategies, these "strategies," when examined, were, essentially, reactive plans on a more operational level, rather than of any real strategic intent.

THE MAJOR RESEARCH QUESTION

Having determined the division between traditional and enlightened plants the key question became: "Was there a difference between enlightened and traditional plants in terms of how the plants performed in quality?" The most telling data emerged in the percentage failure rates within plants. However, the use, frequency and output of quality circles were also explored. While quality circles and the number of suggestions per employees may be seen, initially, as an *input* of quality, the data were, rather, *output* measures of the effectiveness of quality circles. The data is shown in Table 1.

We can conclude the following points from Table 1:

1. All of the enlightened plants involved at least 95% of their manufacturing staff in quality circles or continuous improvement (CI) groups within their plant; by contrast, the greatest number of employees involved in traditional plants was 50%; some of the traditional plants had no manufacturing involvement in quality initiatives.
2. The percentage failure rate at final inspection ranged from 0.58% to 1.6% in the enlightened plants, compared to the range from 3% to 5.8% in the traditional group
3. All of the enlightened plants remained committed to total quality management (TQM); traditional plants had either not been involved at all in or had abandoned TQM at some point in the past. What became substituted in its place were a number of hybrid approaches, often in the name of reengineering, together with various in-house cost-cutting initiatives.
4. Frequency of meetings for staff ranged between 0 and 4 meetings per month for the traditional plants and from 8 meetings per month to daily meetings for the enlightened plants—all Japanese transplants had manufacturing meetings on a daily basis.
5. Annual suggestions per employee ranged from 5 to 12 in the traditional plants and from 17 to 27 for enlightened plants.
6. Enlightened plants used at least all three of the following as part of the range of the tools and techniques in process quality: work study; statistical process control (SPC) charts; and Ishikawa diagrams. Enlightened plants used these tools *in addition* to their own in-house techniques. Traditional plants did not use all three but had their own hybrid in-house systems *instead* of these approaches.

The data from Table 1 relating to percent of defects at final inspection are illustrated in Figure 1. Figure 2 illustrates the number of suggestions per employee.

FURTHER EVIDENCE FROM THE PLANTS

As well as the quantitative data offered, further insight was gained by "getting behind" the numbers and discussing key issues with senior personnel within the plants. While it would be misleading to say that traditional plants were not aware of the importance of quality—quality was seen as essential for both

groups—a number of points came to light in distinguishing enlightened and traditional plants.

Customer Focus versus Internal Cost Reductions

For the traditional plants there was an association of quality with "getting better all the time" with processes and they saw quality, essentially, in terms of cost cutting. Traditional plants talked of increased productivity and reduced costs and one manufacturing director (plant 28) stated: "We have made great improvements. . .our costs have come down by 22% over 3 years so our quality is good."

Enlightened plants also achieved cost reductions but this was *the result of*, rather than *the sole reason behind*, quality drives. For example, plant number 25 claimed to have saved $700 million between 1987 and 1993 in manufacturing costs. It did so not by any downsizing but by being, instead, committed to continuous improvement which was measured in all manufacturing operations. As one of the plant manufacturing man-

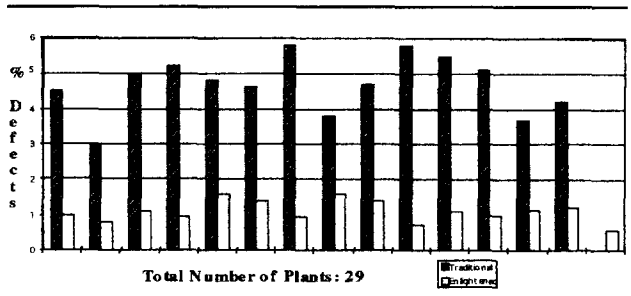

FIGURE 1: Percent of failure at final inspection

TABLE 1: Data on Quality Within the Plants

Plant No.	Plant Site	Country of Ownership	Industry	% Failure at Final Inspection	Use TQM Now/In the Past?	% Involved in Quality Circles or CI	Frequency of Meetings (per month)	Annual Number of Suggestions per Employee	Tools Used
1	UK	USA	Automobiles	4.5	NO/YES	0	0	5	NONE
2	UK	USA	Automobiles	3	NO/YES	0	0	12	SPC
3*	UK	European	Automobiles	0.98	YES/YES	>95	8	22	SPC; I; WS
4	UK	European	Automobiles	5	NO/NO	50	1	8	SPC
5*	UK	Japanese	Automobiles	0.8	YES/YES	>95	DAILY	27	SPC; I; WS
6*	UK	Japanese	Automobiles	1.1	YES/YES	>95	DAILY	22	SPC; I; WS
7*	UK	Japanese	Automobiles	0.95	YES/YES	>95	DAILY	18	SPC; I; WS
8*	USA	Japanese	Automobiles	1.6	YES/YES	>95	DAILY	24	SPC; I; WS
9*	USA	Japanese	Automobiles	1.4	YES/YES	>95	DAILY	25	SPC; I; WS
10*	USA	Japanese	Automobiles	0.97	YES/YES	>95	DAILY	20	SPC; I; WS
11	USA	USA	Automobiles	5.2	NO/YES	0	0	7	NONE
12	USA	USA	Automobiles	4.8	NO/YES	0	0	8	NONE
13*	USA	USA	Automobiles	1.6	YES/YES	>95	8	17	SPC; I; WS
14	USA	USA	Automobiles	4.6	NO/NO	<30	2	10	SPC
15	USA	USA	Automobiles	5.8	NO/YES	<40	2	9	SPC
16*	USA	USA/Japanese	Automobiles	1.4	YES/YES	>95	DAILY	22	SPC; I; WS
17*	UK	USA	Computing	0.72	YES/YES	>95	DAILY	23	SPC; I; WS
18	UK	USA	Computing	3.8	NO/NO	<40	4	8	SPC; I
19*	UK	USA	Computing	1.1	YES/YES	>95	DAILY	17	SPC; I; WS
20	UK	USA	Computing	4.7	NO/YES	<40	2	10	NONE
21	USA	USA	Computing	5.8	NO/YES	<40	2	8	NONE
22	USA	USA	Computing	5.5	NO/YES	<40	4	7	NONE
23*	USA	USA	Computing	0.98	YES/YES	>95	8	24	SPC; I; WS
24*	USA	USA	Computing	1.13	YES/YES	>95	10	22	SPC; I; WS
25*	USA	USA	Telecoms	1.2	YES/YES	>95	10	24	SPC; I; WS
26	USA	USA	Telecoms	5.1	NO/YES	<40	1	7	SPC
27	USA	USA	Telecoms	3.7	NO/YES	<40	1	9	SPC
28*	UK	USA	Telecoms	0.58	YES/YES	>95	12	16	SPC; I; WS
29	UK	Scandinavian	Telecoms	4.2	NO/YES	<40	1	9	SPC; I

* = Enlightened; I = Ishikawa diagrams; WS = work study; SPC = SPC charts.

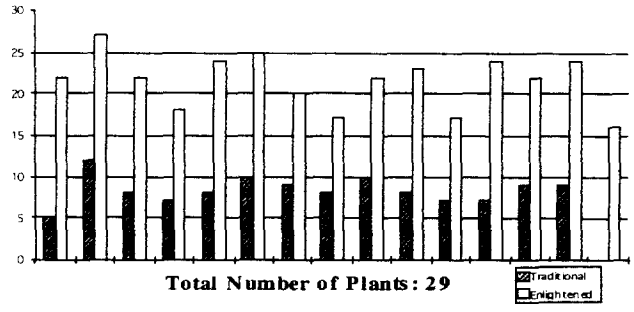

FIGURE 2: Annual number of suggestions per employee

agers (plant 17) explained: "There's not a great deal of point in being a low cost producer if your customers want delivery competence from you and they're prepared to pay for it."

In enlightened plants manufacturing strategy was used to satisfy a wide range of customer needs (in the above case, delivery speed was vital) and was not concerned with costs only. Such an approach was anathema to the approach of traditional plants which were intent, essentially, on low-cost production. Traditional plants viewed quality essentially in terms of process—getting better at manufacturing processes, measured, ultimately in terms of costs.

Linking Product and Process Quality

Linking process and product quality is a key to successful overall quality improvements [1]. This ability was central to enlightened plants. For example, between 1992 and 1994, at the terminals operation of plant number 23, a series of aggressive changes were made in order to regain its competitive position. Product cost was reduced by redesigning the entire product line for improved manufacturability and flexibility. Senior manufacturing personnel were both vital and central to these changes. For example, in plant 23, senior manufacturing personnel worked closely with both design and marketing personnel in ensuring customer satisfaction. As a result, plant number 23 was able to announce that it offered the industry's lowest priced, highest quality terminals with off-the-shelf availability. The aim was not to reduce costs; rather, the aim was to link manufacturing capability with market requirements. Added technology was used to track quality through each process and, as a result, costs were reduced by 18%.

Differences in Approaches to Total Quality Management

In the traditional plants, TQM had largely been abandoned and was replaced, in some instances, by initiatives such as business process reengineering (BPR). One manufacturing manager (plant 11) explained: "TQM feels old now. . .to hell with all that . . .we've got to get our costs down." BPR was seen as a license to do just that: the first "fruits" of their BPR efforts was the firing of over 600 staff who, formerly, had been sold the idea of TQM at the plant!

Cynicism was evident at one of the plants who claimed they had "done quality" (their words). The sentiment was expressed by a senior marketing manager (plant 20):

> We've had all the buzz words here. . .we're an American company and so as soon as some sort of guru-speak comes out from over there we've had to latch onto it over here. . . Management By Walking About, CI, TQM, we've done them all. . .

Not surprisingly TQM had been abandoned in favor of cost-cutting initiatives in the name of quality. By contrast, the long-term vision and commitment to quality became a central part of the language and culture within the enlightened plants. One transplant manager (plant 9) stated: "Our philosophy with quality is very simple: stick with it and keep doing it. . .that doesn't sound very academic for you, does it? But it's our approach and it works."

THE CHALLENGE TO LEAN PRODUCTION

The research did not deliberately set out to challenge existing research by others on manufacturing. However, the implications of this research go beyond the ideas of lean production discussed in *The Machine That Changed the World* [13] and challenge the claims of the lean approach to manufacturing. The claims of the authors of the lean thesis are both bold and clear and a brief summary is valid here. Ultimately, it is claimed, the lean message will spread to all manufacturing:

> . . .the adoption of lean production, as it inevitably spreads beyond the auto industry, will change everything in almost every industry—choices for consumers, the nature of work, the fortune of companies, and, ultimately, the fate of nations [13, p.12].

The characteristics of lean production as outlined in [13] are:

- Integrated production, with low inventories throughout, using Just-in-Time management
- Emphasis on prevention, rather than detection, in quality

- Production is pulled in response to customers, rather than pushed to suit machine loading or other in-house ideas of scheduling
- Work is organized in teams, using multiskilled work-force problem solving to eliminate all non-added value
- Close vertical relationships, integrating the complete supply chain from raw material to customer.

Much of the above will seem familiar to those who understand the key areas of TQM, Just-in Time, and so on. Lean production attempts to combine all of these key areas under one heading. The essence of lean production is that every form of waste should be eliminated—waste includes all operations that do not add value. However, this had already been stated by Schonberger [9] and others before the publication of the lean thesis and is a key issue in quality.

PROBLEMS WITH LEAN MANUFACTURING

Whilst Womack et al. [13] provide compelling evidence which distinguishes high performing plants (which they term 'lean') and others (which have no name but are not 'lean'), there was no discussion of the relationships between high performance levels and any of the following:

Seniority of manufacturing personnel within the plants. For the enlightened plants, whose capabilities seem to match those of 'lean' plants in [13], this involvement was critical and contributed to the subsequent manufacturing performance. All of the enlightened plants had senior personnel (across all functions, including manufacturing) who remained committed to quality. The role and involvement of senior manufacturing personnel were important factors in the enlightened plants for three reasons:

- They helped to 'champion' the quality drives within the manufacturing function.
- They provided guidelines and direction in areas such as skills audits, training, quality manuals and measurement of process quality.
- They set the tone for complete (i.e., process and product) quality and focused these efforts on customers, rather than just in-house capability.

The importance of the role of manufacturing personnel in terms of the *business*, rather than as a purely technical input. This was a key feature of the enlightened plants. However, the advocators of lean production have homed in on the *operational* capabilities without addressing the link between this operational performance and manufacturing involvement at senior levels in terms of the *business* of the plant/firm. The authors believe that the lean approach is an applicable recipe to Western firms and that this recipe is not confined to the automobile industry only. However, the authors do not state that duplicating Japanese or best German practices depends to some degree on having senior manufacturing personnel at the board level who, themselves, help set the agenda for both internal and external factors which greatly influence quality through: (1) the nature, scope and extent of horizontal strategic alliances; (2) strategic partnerships with suppliers; and (3) commitment to training.

The contribution of manufacturing strategy and how this links with business priorities within the plants. There is no mention of a manufacturing strategy in [13]. Indeed, manufacturing strategy is noticeable by its absence—again, in the enlightened plants this factor was vital. Quality became a central part of the manufacturing strategies within the enlightened plants, and customer needs were clearly understood in terms of flexibility and delivery requirements.

CONCLUSIONS

What distinguishes the research in this article from other research is this: whereas the measurements of process quality of an enlightened plant would be similar to "world class" or "lean" plants (described respectively by Schonberger [9] and Womack et al. [13]), it is the *reasons behind* the results which are of interest to this research. In much of the literature on quality, process capability is seen purely at the operations level and while many writers (e.g., [6, 8, 9]) urge the need for top management commitment they say very little about *senior manufacturing* personnel's specific contribution, other than in measuring and monitoring process capability. In the enlightened plants in this research, the tools and techniques of quality on an operational level are not, by themselves, sufficient to explain their performance. Instead, a strategic view, often involving cultural change brought about by senior management within the plant, was a major issue. For the enlightened plants, senior manufacturing personnel's involvement was both vital and central. First, they championed—and remained committed to—quality. Second, they saw quality in terms of a wide range of capabilities and not just prevention of defects and cost reductions—customer satisfaction achieved through a range of production capabilities was the aim within enlightened plants. Third, manufacturing strategies helped to define the in-house standard to satisfy customer needs, once the external market requirements for quality had been understood and agreed to by senior marketing, manufacturing and other key personnel within the plant.

Clearly, in the enlightened plants TQM was not seen as a "program" but as a way of life. The biggest challenge for many plants is to see quality as a *strategic* issue, rather than as a "quick-fix," cost-cutting solution which clearly pervaded in some of the traditional plants. Three major factors have emerged in this research: the seniority of manufacturing personnel; their role in helping to shape business of the plants, rather than being employed as technical specialists; and the contribution of manufacturing strategies which feed into and form part of business strategies within plants. These three factors are absent from the research to date on lean production and may be a major omission in explaining the causes behind world-class manufacturing capabilities in some plants.

While it is naive to provide a prescriptive panacea for ensuring quality, the above data provides insight into identifiable links between management commitment, strategy and subsequent plant performance in quality. Manufacturing plants would do well to learn from their enlightened counterparts.

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