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Quality issues in lean production implementation: a case study of a French automotive supplier

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ABSTRACT *Among the major changes related to the emergence of lean production that the European automotive component sector has undergone over the last 5 years, new approaches to quality management is one of the most significant. However, there is very little literature, in terms of case studies or examples, that focuses on the daily struggle in companies of transforming these strategies into working practice. The research reported in this paper illustrates, by means of a case study, how a French automotive supplier has confronted the challenge and adopted quality management-related concepts of lean production in its operation. Lean quality management is analysed in six domains: top management support-leadership policy, customer relationships, product design process, process flow management, continuous improvement and market outcomes. It is concluded that if quality is managed in an integrated way where management support and customer relationships condition the operations context, quality management can become a resource enabling suppliers to create distinctive competitive advantage and thus achieve positive market outcomes.*

Introduction

Lean production was born in Toyota City in Japan, in the 1950s, and grew from Toyota's crusade against waste. Today, it is viewed as a formidable strategic weapon to succeed in increasingly competitive markets. Lean production is a system designed to compete on the assumption that sustained product advantage is unlikely, and therefore rather than avoid competition, face it head-on. To engage successfully in confrontation, a firm must become expert at developing low-cost, high-quality products that have the functionality customers demand (Cooper, 1996). The integration of systems that manage functionality, cost and quality allows firms to become lean competitors.

The literature suggests that several organizations have attempted to make their organizations lean, but that the result often is 'mean' only in terms of eliminating jobs, diverting revenues from customers and extracting profits from suppliers (Womack & Jones, 1996). Few organizations have demonstrated their ability to act lean, i.e. agile and responsive when

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facing increasingly aggressive competition. The automobile industry provides a compelling illustration of how US and European carmakers, who historically relied on mass production, have shifted their focus to lean production in order to produce cars lower in cost and higher in quality, like their Japanese counterparts. These Western companies are facing two main difficulties: they must make their processes lean over a very short time period (a few years); and implement lean techniques and lean thinking in long-established production sites where traditional mass production has been the dominating production philosophy (Abo *et al.*, 1994).

The key point in achieving lean production is that firms must learn to view the process of managing as a total inter-firm system solution within entire production chains and not as a collection of independent techniques applied in independent companies. This total system solution to lean production has forced auto manufacturers to push their suppliers to introduce lean production techniques into their production processes to achieve integration and rapid, frequent flows of goods and information within production chains (Levy, 1997).

Research in the area of buyer–supplier relationships within the framework of 'lean' has until now been focused on the development of general frameworks for analysis and on the conceptualization of a large number of factors that are changing in these relations with the development of lean production. Both qualitative research (e.g. Laigle, 1994; Lamming, 1993) and quantitative surveys (e.g. Cusumano & Takeishi, 1991; Helper, 1991; Helper & Sako, 1995) adopt very broad frameworks for identifying models of supplier–assembler relationships. The objective might be to indicate strategies for going lean, or to compare Japanese, US and Japanese transplant auto-plants by mapping differences concerning supplier relations and management. For both managers and scholars, this kind of research has identified a new area of highest strategic importance and academic interest. However, there is very little literature, in terms of case studies or examples, that focuses on the daily struggle in companies of transforming these strategies into working practice.

The research reported here attempts to fill this void. The major purpose of this study is to illustrate, by means of a case study, how a French auto supplier has confronted the challenge and adopted quality management-related concepts of lean production in its operation. The case study will examine the issue and role of quality in the auto supplier's lean production strategy by analysing factors and techniques identified through a review of literature on quality management within lean production and quality management assessment. This research, though exploratory in nature, will hopefully produce results for further investigation as well as create systematic experience for practitioners.

Review of the literature

The literature section of this paper is divided into three parts. The first part sets the economic context of the study by presenting the structure and importance of the French automotive component sector. The second part provides a summary of the existing literature on lean production and lean enterprise with specific focus on aspects of quality. In part three, frameworks for studying quality management are reviewed and analysed.

The automotive component sector

The automotive industry is considered in all industrialized and newly industrialized countries as a key sector in the manufacturing industry—the product is complex, and its manufacturing process involves a very large number of actors contributing with specialized technologies (Chanaron & Lung, 1995). Global competition, customer pressure for better value for money,

safety restrictions and pollution problems push the automobile manufacturers to search continuously for better solutions in order simultaneously to reduce costs, improve productivity and improve quality.

Over the last 10 years a major tendency in the automobile sector has been a vertical disintegration leading to an increased importance of external supply due to an increased ratio of purchased parts in the total cost price of a finished vehicle. The Boston Consulting Group (BCG, 1991) estimated the rate of vertical integration at 56% (including parts divisions) in the European car manufacturing sector and at 36% in the Japanese. These figures relate to 1990–91 and were calculated as value added on turnover. In 1993, BCG estimated that the vertical integration rate had diminished by at least five points since 1991 (Brocquet, 1995). More recent survey data were not available at the time of study, but evidence from single companies (PSA and Renault public relations) indicates a continuous evolution towards vertical disintegration in 1996–98. For recently launched models the ratio of purchased parts on the total cost price of a vehicle varies from 65 to 75%. At the same time, the number of suppliers has decreased; from 1500 (PSA) and 900 (Renault) in 1988 to 800 (PSA) and 500 (Renault) in 1998. This increased importance of the component sector indicates that supplier performance becomes critical for the final quality and price of vehicles and for the productivity of the entire production process.

According to the French Vehicle Equipment Industry Federation, the French automotive component sector employed 108 800 people in 1997 and enjoyed a turnover of about 118 billion Francs.

In the French component industry, the Rhône-Alpes region, where the study was conducted, is the second most important region after the Paris region (Ile-de-France), both in terms of number of companies and number of employees (8800 in Rhône-Alpes, 19 700 in Ile-de-France out of a total of 108 800) (FIEV, 1997). In terms of the structure, size and activities of the companies, the Rhône-Alpes region can be considered as representative of the French situation as a whole.

Lean production and the lean enterprise

Lean production can be defined as an alternative integrated production model because it combines distinctive tools, methods and strategies in product development (Clark & Fujimoto, 1991; Karlsson & Åhlström, 1996), supply management (Lamming, 1993) and operations management (Abo *et al.*, 1994; Krafcik, 1988) into a coherent whole (Womack *et al.*, 1990; Womack & Jones, 1996). Lean production is 'lean' because "it uses less of everything compared with mass production—half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time" (Womack *et al.*, 1990, p. 13).

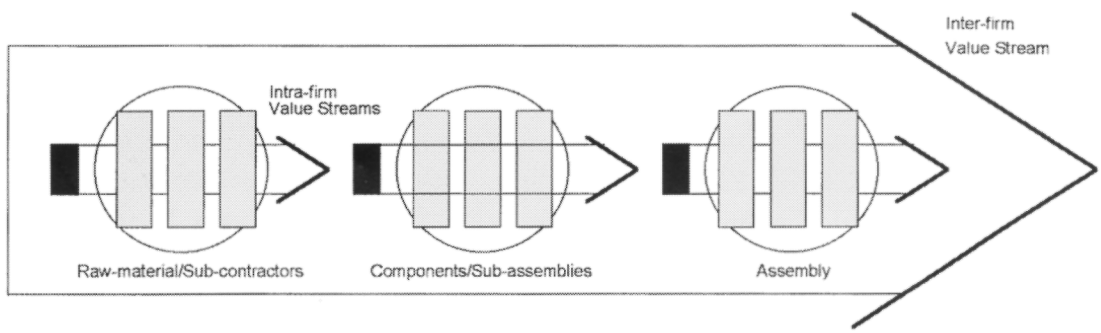
One of the cornerstones in the lean production model is a renewed approach towards quality management compared to the practices within traditional mass production (Levy, 1997). Core features of quality management within the lean production framework, as identified by Abo *et al.* (1994), Clark and Fujimoto (1991) and Womack *et al.* (1990) include:

- low inventory levels and just-in-time (JIT) delivery driving the detection of error sources;
- emphasis on successive quality control integrated in the production process conducted directly by workers;
- preventive maintenance where shop-floor workers have maintenance roles;
- statistical control, and fail-safe devices (Poka Yoke) in manual operations;

- standardized procedures at all levels and in all functions;
- design for manufacturing through integrating product and process engineering;
- small group activities, quality circles, proposition activities and company-wide information sharing.

More important than different methods and techniques, however, is the integrated approach to quality management that lean thinking emphasizes (Lamming, 1993; Womack & Jones, 1996). Quality should be a top management issue and continuous improvement efforts together with the zero error objective should be company-wide and extended over company limits in production chains. Recent trends include self-assessment through internal quality audits, and focus on administrative routines for quality improvement as a complement to quality improvement in direct design and manufacturing operations. The philosophy that should underpin the quality project in a lean company is that of a total quality management (TQM) approach which can be defined as simultaneously focusing on customer value, shareholder value and employee satisfaction (Kélada, 1994).

In 1994, the notion of the lean enterprise was introduced by Womack and Jones (1994). It was elaborated further by the same authors in 1996. In the lean enterprise, highly specialized companies, using state-of-the-art technology in their special core activity, form inter-firm value streams, where each participant, based on its internal value stream, adds a piece of value throughout the production chain—from raw material to distribution and sales of a finished product. The basic elements in the lean enterprise are: a refocus on a limited number of core activities within each firm; emphasis on transversal processes and project management, strong collaborative ties between firms with clear agreements on target costing, levels of process performance, rate of continuous improvement and cost reduction, consistent accounting systems; and formulas for splitting pain and gain. In addition, a particular career management within flat organizations focused on skill development more than on hierarchical advancement, and rotation of mid and senior managers between the company's operations, suppliers and foreign operations are central elements of this new industrial structure. Figure 1 is an illustration of the lean enterprise concept.



The Specialist Functions. They become 'schools', systematically summarizing current knowledge, searching for new knowledge, teaching it to their members, and dessiminating it in the transversal intra-firm value streams. Moreover, functions should develop guidelines for best practice in their specialised field, define long term partners, and rules for governing common problem solving processes with their counterparts up and down the value stream.

The process-management function. A new function which defines the rules for managing cross-functional teams and the continuous-flow production. It teaches team leaders in product development and production how to apply these rules, and it constantly searches for better approaches.

Figure 1. *The lean enterprise (adapted from Womack and Jones, 1994).*

The lean enterprise is in fact an extended part of the lean production model and it is presented as a new model for industrial organization applicable once single firms have applied lean techniques to their specific activities. As far as quality management is concerned, the lean enterprise concept emphasizes integrated management systems between companies in a defined value stream, something that is shared in Lamming's (1993) model of lean supply; customers and suppliers should jointly fix improvement plans, and performance measurements should be set up against commonly agreed criteria. Moreover, in the context of vertical disintegration and focus on core competencies, suppliers are expected to lead in quality management and control initiatives within their specific field of technology. Once common principles have been agreed upon within a value stream, the companies must practise mutual verification, with audits conducted jointly and in both directions, supplier–customer–supplier (Womack & Jones, 1994, 1996).

These integrated quality assurance systems are a reality in the European car industry today. The assemblers have their specific norms (Q1 of Ford is probably the most well known) that provide detailed guidelines on a wide range of items, e.g. quality policy and organization, design process, process engineering process, control and testing equipment, quality assurance of externally purchased parts, quality in running production (ppm), etc. System suppliers are also developing their own standards, and in addition there is the ISO 9000 normalization that is starting to reach a large number of suppliers, also among the small sub-contractors. Generally speaking, all French system suppliers, all specialist suppliers and an ever increasing number of sub-contractors are certified by assemblers and/or ISO 9000 (Deranlot, 1994).

Analysis frameworks for quality management

The quality literature was reviewed in search of a quality focused analysis framework to guide interviews and field observations. Saraph *et al.* (1989) identify eight critical factors of quality management in a business unit based on a comprehensive review of the quality management literature (Table 1). Based on their framework, Flynn *et al.* (1995) proposed a slightly different set of factors developed as a result of a survey of 75 US manufacturing plants, including Japanese-owned and world-class reputation plants (Table 1).

In order to develop a specific framework for the present study, these frameworks, explicitly developed for studying quality management in manufacturing companies under transition, were compiled with the lean production perspective on quality management (Table 2).

Table 1. *Factors for analysing quality management (Flynn* et al., *1995; Saraph* et al., *1989)*

Critical factors of quality management (Saraph *et al.*, 1989)	Quality infrastructure components and core quality practices (Flynn *et al.*, 1995)
The role of management leadership and quality policy	Top management support
Role of the Quality Department	Customer relationships
Training	Supplier relationships
Product/service design	Workforce management
Supplier quality management	Work attitudes
Process management	Product design process
Quality data and reporting	Process flow management
Employee relations	Statistical control
	Perceived quality market outcomes
	Competitive advantage

Table 2. *Compiled set of factors for analysing quality management within the lean production framework*

Analysis factors for quality management within the framework of lean production
1. Top management support, leadership and quality policy
2. Customer relationships
3. Product design process
4. Process flow management
5. Continuous improvement
6. Market outcomes

- The role of the Quality Department was not considered as a specified factor because lean production philosophy prescribes quality management integrated in design, procurement and production operations.
- Supplier relationships and supplier quality management were integrated in the process flow management factor.
- Training, workforce management and employee relations were included in a factor entitled continuous improvement because we wanted to relate these factors to a broader objective coherent with the lean principles.
- Work attitudes were not particularly assessed as the perspective is more operations-oriented than human resource-oriented.
- Quality data and statistical control features were regrouped under the process flow management factor.
- Perceived quality market outcomes and competitive advantage were regrouped under one factor—market outcomes.

Case study

Background of company

The case study was conducted in an automotive expert supplier firm located in the Rhône-Alpes region of France. In order to ensure the quality of our research, we used a criterion sample strategy (Miles & Huberman, 1994) for selecting the appropriate organization for the case study. The specific criteria used in selecting the supplier firm were as follows:

- should be a medium-sized supplier;
- should supply to at least three manufacturers (at least one should be international);
- should be a former 'off-the-shelf' supplier with a clear objective of being a partner in integrated component development and staying aligned with the car industry;
- should already have or should currently be implementing lean production principles;
- should have an explicit strategy for quality, R&D and organizational development;
- the supplier's components should provide a value adding function, largely depending on the supplier's own R&D efforts.

The supplier selected for this study is an international supplier firm producing all kinds of technical fastening devices for leading carmakers, such as Peugeot, Renault, Ford, General Motors and Volvo, among others. The supplier employs 600 people in France and 1600 world-wide (Europe outside France, the US and Japan). The case study was conducted in the main plant and head office, which is based in the south of France. In the early 1990s,

the supplier decided to restructure its operations following changing customer demands. The restructuring efforts were focused on introducing the concepts of lean production—in this case, from JIT to TQM to total integration of lean principles including integrated product development with main customers.

Methodology

Given our interest in studying the ongoing change process in the supplier's organization over an extended time period, a clinical perspective approach was used. According to Schein (1987), the clinical perspective is characterized by the fact that the researcher participates actively in observing organizational change, thus providing access to data that are usually not available. In our case, the primary author spent about 60 hours in total in the company between 1995 and 1996. Data were collected from three sources: semi-structured interviews, direct observation and content analysis of various documents.

Interviews were conducted with the Chief Executive Officer, the Directors for Quality, R&D, Production and Purchasing. Furthermore, chief engineers, process engineering managers, project managers, quality control personnel and design engineers were interviewed. In all, 20 semi-structured interviews were conducted based on the framework identified in Table 2. Direct observation is fundamental to understanding a specific setting in qualitative research (Silverman, 1993). The particular strength with real-time observations (during meetings, discussions, and of operational execution) is that the context in which data are collected and processes involving interlocking series of events become visible (Bryman, 1988). Interviews are important for receiving messages that managers want to give. Observations within the framework of a case study allow, then, for comparing discourse and practice; if there are differences their reasons could be sought. Concerning documents, quality manuals, customer files, performance indicator histories, job descriptions and project status records were used both as initial elements for understanding organization, systems and processes in the company and, as Silverman (1993) underlines, as elements or end products revealing the practices leading to their existence and actual form.

Data from initial interviews and observations were rapidly analysed in order to focus the topics or open up new ones, what Miles and Huberman (1994) call conceptually-driven sequential sampling. The analysis method followed the paradigm model developed by Strauss and Corbin (1990), which consists of grouping data through a cause–effect analysis. In order to ensure reliability and validity, key informants reviewed draft result reports.

Major findings

This section presents the research findings following the different factors identified in Table 2.

Top management support, leadership and quality policy

During interviews, all functional directors stressed the criticality and the importance of quality. They felt that it was very important for them to inspire people to do things they do not believe they can do. Top management practices for promoting quality included: (1) creating a strategic vision and clear quality values around customers—these values and vision were clearly stated in the quality manual and were promoted throughout the organization through talks and newsletters; (2) demonstrating personal commitment and involvement in quality by serving on quality improvement teams, personally visiting customers and participating in quality training seminars; (3) providing a quality working environment where employees

talk openly about problems, teamwork was encouraged and supported—for example through physical co-location of product and process engineering staff—and on-the-job training was provided on a regular basis; and (4) encouraging development of stronger customer relationships through an explicit strategy of letting R&D and quality personnel work directly on project platforms in customer firms, inviting customers to visit the plant and provide product and process engineering input especially concerning quality requirements, and encouraging direct contacts between the supplier's design technicians and their counterparts in customer firms to avoid distortion of technical information.

The responsibility for developing the company's integrated quality system, assessing its efficiency and ensuring its continuous evolution was delegated to a Quality Department headed by a functional manager at the director level.

Customer relationships

The qualification of the supplier company as an expert supplier stems from its relationship structure to its customers; the studied supplier gained around 50% of its turnover directly from carmakers. What is more important, however, is the fact that the supplier had developed a triangulation relationship mode (Söderquist, 1996) where joint development was conducted in common between the supplier studied, system suppliers that would integrate the components in its subassemblies, and the carmaker. Most important for the supplier's relationship strategy was to keep direct contact in terms of development intelligence, even if the physical component was to be delivered to a system supplier.

Electronic data interchange (EDI) systems were identified as another important factor in customer relationships. The use of EDI facilitated and speeded up the exchange of technical information and related feedback, which in turn played an important role in reducing engineering lead-time and improved quality of design and conformance to specifications. Integrated product development between suppliers and customers requires continuous information exchange, something that quickly paid off the EDI investment for the supplier studied through reduced coordination costs (fax, phone, travelling) and improved data reliability. After the successful introduction of EDI, design engineers and technicians were beginning to look for possibilities of extending the computer-aided system for data transfer to more qualitative information. The central idea was that computer-aided design (CAD) and EDI systems could be supplemented with more qualitative information beyond blueprints and material specifications and, moreover, allow for informal dialogue between design staff working on the same system in different supplier and customer firms. In this context, however, much attention must be paid to defining what information can be shared through network software and what needs to be protected, for example through selective access procedures.

Finally, a project organization, with project managers responsible for specific customers, ensured efficient and personalized customer contacts, something that was reinforced by participation of supplier engineers, design technicians and quality staff on project platforms in carmaker and system supplier design departments.

The importance of quality standards has increased over the years and they have played a central role in the tactical and operational preoccupations in all functions in the supplier firm studied. There is a simple explanation for this: the conformity between the quality standards and the reality is regularly assessed through severe auditing procedures, and the correction of detected failures in order to remain as a supplier to the auditing customer is given very little time. As a logical consequence of this, the quality standards were quoted by the managers interviewed as a critical benchmark for survival. The supplier was audited in

the Renault/PSA quality standard (first-class supplier), in the ISO 9001 standard and in more than 10 contractual certifications with system supplier customers. This can seem as a complex web of different standards, but the Renault/PSA standard is in fact a sector-specific extension based on the same ground structure as the ISO 9001 standard, and the system supplier standards differ only in terms of regulations specific for the subsystem or component technology in question.

The role of these quality standards was found to be of crucial importance for ensuring integration within a value stream in the sense predicted by the lean enterprise. Once the supplier is audited, the customer will dispose of a contractual guarantee that certain organizational, control and quality management principles are respected. This reduces considerably the need for frequent coordination efforts, as the companies in a defined value stream will follow similar rules of the game. The backlog of the quality standard system with its regular audits (3-year interval for the Renault/PSA standard) as perceived by the studied supplier was that quality targets and predicted organizational measures were often seen as too directive and bureaucratic. Negotiating common objectives, for example, in terms of price cuts, output rates, inventory levels, or development lead-time, were still more an exception than general practice. Moreover, heavy procedures hindering the supplier from taking the expected lead in terms of proposing quality and productivity improvements were sometimes met in the interaction with customers. For example, price reductions were predicted by all customers, but in some cases the process of validating a new product design allowing for a significant price reduction could take longer than the development lead-time allowed. In such a case, the supplier had no other choice than to squeeze its margins. Thus, the role that quality standards play as governance structures smoothing value streams seems still to be more in favour of the final assembler than of companies further down the stream. The positive impact is that quality standards oblige companies in the same value stream to confront their procedures and develop specific alignment capabilities to the value stream in question.

Product design process

The supplier company made specific efforts to integrate process engineering and manufacturing aspects in the design activities. This was realized through integration between design and manufacturing in the framework of a project organization and specific actions taken more punctually in order to promote learning between design and manufacturing personnel, for example, co-locating product and process engineering technicians in the same office. This helped the supplier in obtaining the following three advantages:

- A reduction of the development lead-time thanks to an important reduction of design modifications discovered late in a traditional sequential process.
- An improvement of the product quality (quality of realization) thanks to simplified designs made easier to manufacture and assemble.
- An improvement of the productivity in cross-functional communication (in terms of recognizing individual problems as common problems and speeding up feedback on the requests of one another) through the development of a common cognitive ground between product and process engineering.

In addition to the above, other key processes instituted by the supplier firm for achieving effective product design/development included: (1) addressing all product quality requirements in new product development projects early in the design process, taking into account cost and manufacturability through the constitution of an inter-functional project team; (2)

ensuring that quality is built into the products by using appropriate engineering tools such as calculation software, and statistical methods for prototype testing during the development process; (3) understanding customer needs and translating them into product design requirements through close interaction at the operational level (cf. above); (4) reviewing new product design thoroughly before the product is produced and sold by generalizing failure mode and effects analysis (FMEA); and (5) consulting direct manufacturing labour in the early design of products before they reach the plant.

Several performance indicators related to development of new products also existed. For example, the number of new products released and the turnover generated by new products compared to total turnover—measurements that were dispatched per customer, per product family and per type of output, i.e. only prototypes or mass production launch. These performance indicators were in line with a strategy of maintaining and reinforcing expertise in product development. The adoption of quality standards has resulted in around 300 written procedures for the overall functioning of the unit studied. These procedures have helped the company to reconfigure its organizational processes (production flow groups, integrated CAD office, customer-dedicated design teams, interfunctional product development project groups, *ad hoc* teams for specific more long-term R&D project, and so on). The respect and efficiency of the procedures were internally audited by quality assurance staff on a yearly basis. In the mean while more limited audits were realized, especially with system supplier customers, for example on a specific production line with a new customer or in connection with the development of new tools for a new product.

Process flow management

Effective process flow management was treated as extremely important by the management of the surveyed company, because of its direct impact on quality performance through reduction of process variance. Several steps have been instituted by the company to ensure that the quality of realization of products meet rigid customer specifications. These include: (1) use of electronic detection and signalling devices for ensuring foolproofing of manufacturing processes; (2) emphasizing scheduled preventive maintenance, in order to avoid equipment breakdown; (3) utilizing simple quality tools and techniques such as mistake-proof systems—Poka Yoke, Pareto and Ishikawa charts; (4) utilizing advanced statistical methods such as statistical process control (SPC) (control charts and continuous calculation of capability in some critical processes) for identifying significant variations in processes and outputs, determining root causes, making corrections and verifying results; (5) using integrated software that manages quality parameters for heat treatment, plastic injection and assembly machine operations; (6) using the Weibull distribution for the purpose of reliability testing; (7) employing proper procedures for traceability of errors; (8) analysing a variety of quality indicators and measurements for continuously improving processes for achieving better quality, cycle time and overall performance of operations; and (9) conducting regular internal quality audits and receiving external quality audits (cf. the section on customer relations).

In order to ensure quality of purchased parts, the company studied has developed its own auditing process for qualifying its suppliers. The company has two main categories of suppliers: suppliers of raw material and chemicals for surface and heat treatment; and suppliers of plastic moulds and mechanical commodities (such as simple screw-cut parts). In the first category, consisting mainly of large and medium-sized companies, the suppliers must be ISO certificated, be able to present a total traceability of delivered goods, to propose technical assistance in case of material failure, and to advise concerning the application of

the material to help the company choose the right material for every different application. Traceability was a crucial element for the company's operations: if a carmaker has a complaint and it is found to concern the raw material, the company must ensure that it can track the problem to its final source, even if it is situated outside the company in a supplier's process.

In the second category, consisting mainly of small companies, a particularly interesting state-of-the-art example in managing supplier quality concerned a training programme allowing for supplier technicians to come and work in a 'model' workshop created for supplier training purposes. Their suppliers were able to experiment with SMED techniques, preventive maintenance, operation of fool-proof devices, SPC and KANBAN. External consultants were also hired by the supplier to help committed suppliers to develop their quality management, organizational structure and accounting systems. This assistance was generally organized as a step-by-step programme over one or several years.

For all of its suppliers, the company studied has developed a partnership approach to procurement with parallel (two to three suppliers) or single sourcing in each category of purchased goods with the objective of achieving quantity discounts, stable quality and more personalized service. In accordance with lean principles, the selection of suppliers was based on quality levels, quality assurance, price stability and technical assistance more than only the lowest price at the moment. More than its own customers, the company emphasized that price decreases should be due to real decreases in costs, not just to a temporary commercial action.

Continuous improvement

There was a great awareness concerning the importance of continuous improvement activities at the management level in the company studied. Special quality indicators exist in the company that measure the development lead time, the manufacturing lead time, quality of purchased parts, the number of internal non-conformities and the number of customer complaint claims. Pareto charts were developed on a weekly/monthly basis to depict the performance of the company against these indicators. These indicators, with their Pareto charts, were analysed by the management team and the information along with recommendations disseminated to all concerned functional areas. In addition, these measures were used by the quality manager and other functional managers for preparing the annual quality improvement plan. The objective of this plan was to set benchmarks (specific targets) to improve the overall quality assurance system, i.e. organization and functioning, manufacturing processes and products. Regular meetings with functional managers and supervisors were conducted by top management of the company to ensure that these benchmarks had been achieved.

In addition, formal supports existed in all functional areas, for example in the product development/design area, weekly design meetings where the product development manager met with project managers and design technicians, and procedures for the course of events in projects existed. The latter corresponded to the quality standards that require detailed instructions for customer need analysis, feasibility reviews, production launch reviews and reviews of qualification (intervening after pre-series production and complete testing and control of the final product). An explicit objective with these reviews was to identify problems, propose solutions and generalize these experiences to parallel and forthcoming projects, thus realizing continuous improvement.

Based on the guiding visions of top management, one of the main roles of the quality director and his team was to develop the coordination and teamwork animation skills of project managers. This focus was aimed at completing the transition towards a project

organization once formal procedures had been implemented. In this context, the project managers and team leaders needed to focus on making operational staff participate more actively in formal meetings through a development of a more open and less directive meeting climate. In the supplier company studied, informal communication channels were very efficient for quickly obtaining information or resolving a problem—there was a great deal of spontaneous interaction between different functional participants—but people were not yet accustomed to continuing this open and frank style of interacting within more formal structures such as weekly design reviews and quality progress groups in the presence of their hierarchical superiors.

Market outcomes

The introduction of lean production principles, and in particular the consequent adoption and development of integrated quality management, has had several positive impacts for the company over a period marked by important restructuring of the auto component sector and elimination of a large number of medium-sized suppliers. In terms of turnover, the company achieved an increase of 27% between 1990 and 1995, both through the conquest of new markets and through increased business with existing customers. A core feature of the supplier's strategy was to maintain and reinforce its role as an expert supplier. The success of this strategy is visible in at least two important market outcomes:

- the company gained an introduction to the Japanese market through a sales unit and with delivery of specific components from France;
- the company succeeded in positioning itself as a development consultant for its customers, being able to provide a total cost analysis and process development advice in order to accompany the development and introduction of new products.

This success is undoubtedly due to an in-depth understanding of the value-creating principles that characterize the automotive component sector: high and stable quality of delivered goods; strong alignment to and anticipation of customer needs; strong focus on product and process innovation; and an active participation in optimizing value streams through supplier selection and management.

Results from the case study

The company studied provides a relevant example of a supplier undergoing transition driven by the outsourcing tendencies in the automotive sector. The central role that engineering played in the company's strategy and the emphasis on direct customer contacts in terms of development intelligence were some of the most distinctive answers to this trend. Integrated problem-solving in engineering, generalized use of EDI in new product development, adoption of quality standards in relation to customers and parallel or single sourcing based on a partnership approach towards its suppliers were all signs of integration within an inter-firm value stream as predicted in the model of the lean enterprise. In the internal organization of the supplier, integration between design and manufacturing through a project organization and co-location of different functional staff reflected a strategic emphasis also on internal value streams.

Concerning the core features of lean quality management identified in the literature, the supplier company had applied all of them with success. This confirms that adoption and adaptation of lean techniques by a single company operating in an integrated manner with its customers and suppliers is not only possible to achieve, but also beneficial for strategic

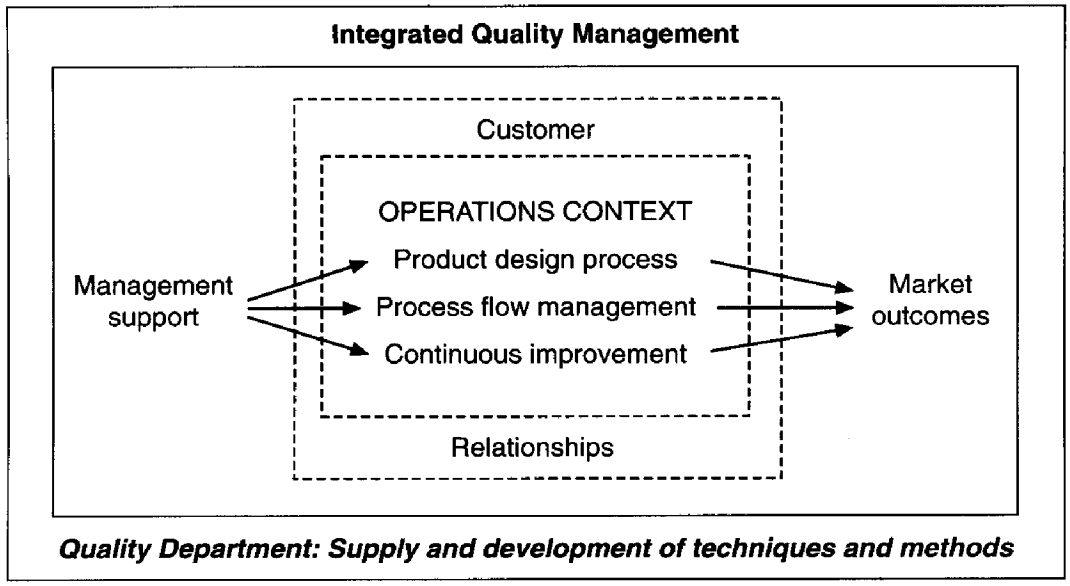


Figure 2. *A framework for integrated quality management in a supplier firm.*

positioning. The supplier had succeeded in confirming its position as an expert within its specific technical area.

Moreover, a truly integrated approach towards quality management as proposed in the literature was confirmed. To summarize these findings, we propose a framework for integrated quality management in a supplier firm operating in the lean production context (Fig. 2). In this framework, quality management is seen as a resource, enabling a supplier company to create competitive advantage and achieve positive market outcomes.

A strong focus on quality management in all functions, with a delegation of the responsibility for quality to the functional heads, provided the basic building blocks for integrated quality management in the company studied. Customer relationships, including the application of quality standards, condition how quality will be managed in the operations context of product design, process flow and continuous improvement. As the case study demonstrates, a consistent approach to quality at the management level in customer relationships and in operations can become a resource enabling the achievement of competitive advantage and positive market outcomes. The role of the Quality Department is that of a support function providing assistance at both the strategic and operational levels.

Conclusions and managerial implications

By means of a case study, this paper illustrates how a medium-sized French automobile supplier has successfully incorporated the critical elements of quality in its quest for achieving lean production. The practices of the supplier firm in six critical areas, identified from the literature, were examined in detail. We have highlighted numerous points in the day-to-day management and application of lean production, especially lean quality principles. The study allows us to conclude that successful adaptation and application of lean quality management seems to be a reality in the car industry today, and that an integrated approach to quality including management support, customer relationships and operations can create competitive advantage for automotive suppliers. However, this exploratory research needs to be followed by a quantitative assessment of the state-of-the-art in lean quality management in the

European manufacturing industry, and a wider elaboration and testing of the proposed model.

Based on the present findings, we suggest the following managerial implications concerning management support, customer relationships and operations context (cf. Fig. 2).

(1) *Management support.* The importance of top management support in terms of a consequent deployment of guiding visions for quality improvements and personal commitment to quality teams was a decisive factor for establishing favourable conditions for the company's quality culture. It is important to emphasize the notion 'support' in top management's relation to quality. The success of the company's quality programmes was due to a three-level deployment strategy of top management:

- Quality objectives and their reason for being in the company were explicitly communicated to employees. This was done through memoranda, notes, information meetings on the part of general management, training, etc.
- The top-down information diffusion approach was complemented by a bottom-up return of information where management ensured a comprehensive analysis of operational situations based on feedback from employees.
- A key to successful deployment of quality objectives was for management to prove the seriousness of communicated guiding visions through concrete interventions in the organization—taking into account employee feedback. For example, the co-location of product and process engineering technicians materialized the objective of improving quality of realization through design for manufacturing.

Through this consistent strategy of deployment, the company studied had succeeded in mastering what is still a major problem in many companies: employees often do not agree that management have a strong commitment to quality and they relate this to a perceived lack of communication (Yavas, 1995).

(2) *Customer relationships.* Concerning customer relationships, a strategy of maintaining and developing further the company's position as an expert supplier passed through close personalized contacts at the engineering level, a generalization of EDI in the specification process and the development of transmission systems for qualitative information. Managerial literature and practice is unfortunately rich in examples where the results from the introduction of new information technology has been below expectations (Corso & Paolucci, 1997). The successful implementation and use of these tools in the company studied was due to the fact that their development was directly related to improving the quality of design in integrated component development with easily measurable quality indicators for benchmarking progress.

The contractual guarantee offered by quality standards that certain quality management principles are fulfilled make them important coordination mechanisms within value streams. However, the power of carmakers is still perceived as too strong: improvement targets are imposed rather than negotiated jointly. Integrated quality management might be one way of strongly emphasizing a supplier's capability of being a reliable, dedicated and lean partner in integrated development—leading to the possibility of reinforcing positions in joint negotiations.

(3) *Operations context.* Based on managerial support and conditioned by the specificities of customer relationships, the company's product development process featured several key processes for achieving effective product design. Support in terms of co-location between product and process engineering enabling true integration of different professional perspectives has already been discussed. Enabling operational

design technicians to visit customers and establish direct relationships with their customer colleagues was another important factor for speeding up design lead-time and quality of conformance. Also, process flow management was characterized by integration and consistency through the use of a wide range of quality prevention and control tools in the manufacturing process, and training and implication of suppliers in order to build a smooth value stream. Particularly efficient for this was the 'model' workshop set up by the supplier. Not only did it contribute to lifting the technical and managerial performance of suppliers, but it also played an important role in establishing personalized contacts and a common way of thinking about how subcomponents should best be designed and manufactured in relation to final customers' needs.

(4) *The role of the quality function.* The role of the quality function was that of a support function developing tools, methods and best practice in terms of quality management. Its essential role was to disseminate continuously appropriate quality management tools and methods to the operational functions—to be an expert support structure adapted to operational needs for creating customer value. This confirms the theories of the lean enterprise with its matrix organization of specialist functions and value streams, and proves their efficiency for managing in complex and strongly integrated production chains.

References

ABO, T. *et al.* (1994) *Hybrid Factory, The Japanese Production System in the United States* (New York, Oxford University Press).

BCG (1991) *The Competitive Challenge Facing the European Automotive Components Industry* (Brussels, Boston Consulting Group for the European Commission).

BROCQUET, C. (1995) L'avenir des équipementiers automobiles (The future for the automotive suppliers) *Etudes Economiques, Equip'Auto 95*, special edition.

BRYMAN, A. (1988) *Quantity and Quality in Social Research* (London, Unwin Hyman).

CHANARON, J.J. & LUNG, Y. (1995) *Economie de l'automobile* (Economy of the automobile) (Paris, La Découverte).

CLARK, K. & FUJIMOTO, T. (1991) *Product Development Performance. Strategy, Organisation and Management in the World Auto Industry* (Boston, MA, Harvard Business School Press).

COOPER, R. (1996) Lean enterprises and the confrontation strategy, *Academy of Management Executive*, X, pp. 28–39.

CORSO, M. & PAOLUCCI, E. (1997) The ambiguous role of IT in determining knowledge specialisation and architectural innovation capabilities in product development, *Proceedings from The 4th International Product Development Management Conference* (EIASM, Stockholm School of Economics), pp. 211–223.

CUSUMANO, M.A. & TAKEISHI, A. (1991) Supplier relations and management: a survey of Japanese, Japanese-transplant and US auto plants, *Strategic Management Journal*, 32, pp. 563–585.

DERANLOT, M. (1994) L'industrie automobile française dans son contexte européen (The French automobile industry in its European context), Consultant Report, Paris, DATAR.

FIEV (1997) *Facts and Figures 1997* (Paris, The French Vehicle Equipment Industry Federation).

FLYNN, B., SCHROEDER, R. & SAKAKIBARA, S. (1995) The impact of quality management practices on performance and competitive advantage, *Decision Sciences*, 26, pp. 659–691.

HELPER, S. (1991) How much has really changed between US automakers and their suppliers?, *Sloan Management Review*, 32, pp. 15–28.

HELPER, S. & SAKO, M. (1995) Supplier relations in Japan and the United States: Are they converging?, *Sloan Management Review*, 36, pp. 77–84.

KARLSSON, C. & ÅHLSTRÖM, P. (1996) The difficult path to lean product development, *Journal of Product Innovation Management*, 13, pp. 283–295.

KÉLADA, J. (1994) Pas de reengineering sans qualité totale (No reengineering without total quality), *L'Expansion Management Review*, 73, pp. 60–65.

KRAFCIK, J. (1988) Triumph for the lean production system, *Sloan Management Review*, 30, pp. 41–52.

LAIGLE, L. (1994) Les grands étapes de délégation des activités auprès des fournisseurs: de la sous-traitance classique au co-développement (The big steps in delegating activities to suppliers: from classical subcontracting to joint development), GERPISA, Working Paper 4/11/94.

LAMMING, R. (1993) *Beyond Partnership, Strategies for Innovation and Lean Supply* (Hertfordshire, Prentice-Hall International).

LEVY, D.L. (1997) Lean production in an international supply chain, *Sloan Management Review*, 38, pp. 94–102.

MILES, M.B. & HUBERMAN, A.M. (1994) *Qualitative Data Analyses, An Expanded Sourcebook* (Thousand Oaks, CA, Sage).

SARAPH, J., BENSON, G. & SCHROEDER, R. (1989) An instrument for measuring the critical factors of quality management, *Decision Sciences*, 20, pp. 810–829.

SCHEIN, E.H. (1987) *The Clinical Perspective in Fieldwork* (Newbury Park, Sage).

SILVERMAN, D. (1993) *Interpreting Qualitative Data, Methods for Analysing Talk, Text and Interaction* (London, Sage).

SÖDERQUIST, K. (1996) Car component suppliers face new design demands, *Logistics Technology International*, pp. 56–59.

STRAUSS, A. & CORBIN, J. (1990) *Basics of Qualitative Research, Grounded Theory Procedures and Techniques* (Newbury Park, CA, Sage).

WOMACK, J.P. & JONES, D.T. (1994) From lean production to the lean enterprise, *Harvard Business Review*, 72, pp. 93–105.

WOMACK, J.P. & JONES, D.T. (1996) *Lean Thinking* (New York, Simon & Schuster).

WOMACK, J.P., JONES, D.T. & ROOS, D. (1990) *The Machine That Changed the World* (New York, Rawson Associates).

YAVAS, B.F. (1995) Employee perceptions of quality: survey results, *International Journal of Quality and Reliability Management*, 12, pp. 8–17.