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# TOTAL QUALITY IN THE AUTOMOTIVE INDUSTRY: STRATEGIES, METHODS, PRACTICES

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# Total Quality Management in the Automotive Industry, an Overview

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**Abstract**

Due to the competitive struggle, that becomes more and more vigorous on the international markets, the producers are forced to reorientate their methods and optimization strategies, in order to improve their competitive power. The previous procedures and processes, that have been successfully applied on the former producer markets and marked by Taylor's Principle, are to be replaced by overlapping measures, that take all fields and eventualities into consideration, give utmost preference to the demands of market and customers, and include the know how of all personnel. Therefore, a Total Quality Management is the dictates of the hour.

## 1. Introduction

Total Quality Management evidently is a promising way for today's terms of competition in the automotive industry. What is the reason for this absolute and all-comprising approach to management? Have other methods failed, or has competition become so extremely vigorous, that the usual way of optimizing individual procedures and processes and the established methods are no longer sufficient for the successful management of an enterprise?

Worldwide, a predatory competition has been made for the last 10 years, and has led to many new approaches in management. Just remember the publications of PIMS on the growing influence of quality with regard to the return on investment figures, or the foundation of the ASI to include the whole subcontracting industry into the measures for improving the competitive power. Later, the introduction of Quality Circles seemed to be the key to success.

The very moment one concept has been introduced, an altogether difficult matter anyway, the next formula to success has been propagated as the ultimate remedy and introduced very often without the required comprehension - but faster than by the competitors. Very often - and incorrectly - the FMEA has been considered a substitute for the fault tree analysis.

Disputes on a completeness, that never had been laid claim to, or the accuracy of results, have been held, instead of discussing the real issue, i.e. talking about methods for identifying priorities, such as FMEA or short-time optimization methods according to Taguchi or Shainin. SPC is being revived, in order to calculate those peculiar Cpk values, no designer has ever insisted on being on a design drawing, if possible computer-aided - which in many cases means: no need to use your own brain.

The persons in charge for inspection and quality assurance have to watch the pillars, that have supported the system for decades, collapse. They do not understand this world anymore. Suddenly, the workers are responsible for the task they are assigned to. There are no longer AQL-values suitable for receiving tests, because today the determined limits of the error rates are within the ppm range, in order to reduce the current assets or because of logistic reasons. Due to the required variety of production and the frequent change of models, the former high-volume production with its economy of scale effect gradually disappears. Despite all efforts, the gradings in the **Power Initial Quality Survey** are very often not good enough, and the **MIT** expertise of the International Motor Vehicle Program shows efficiency figures for a sufficient competition power, that demand an approach to organization differing completely from the previous methods. Time seems to be ripe for another general and complete adaptation of the approaches and methods of management in the automotive industry to the current terms of competition and situation on the market.

Until about 20 years ago, there were - with just a few exceptions - only producer markets, the customer was glad to get a vehicle at all. The management and the quality management, too, aimed at achieving a maximum of units out of the investments that had been made, and at increasing the profits at a pre-determinable turnover by means of optimizing the costs. The management methods and means, that have been developed for that purpose in the course of many years, including the established cost calculation methods dating back to those times, and quality control by means of inspection and rework activities, are adequate only to a certain extent for today's markets dominated by predatory competition. Under the very sophisticated and complex conditions of the customer markets, the usual optimization of individual processes and procedures will not lead to durable improvements, too.

Nowadays, the customers can choose among several models in each price category, their preferences for one car make do not take the sales figures budgeted by the manufacturer into consideration. Thus, even the financial management, that has always been very accurate and precise, has to revise cost calculation and prognosticated profits subsequently due to quality criteria having not been taken into consideration, e.g. attractiveness to the customer. With regard to the above-mentioned item, it is all too well understandable, that T.Q.M. is of utmost concern to the automotive industry.

## 2. Quality management for the future world market

Until recently, the technically perfect solution to a problem has been the goal of our engineers. To make the invested capacities work at lowest possible costs has been the target of the company. Supply-without-trouble has been ensured by expensive test methods, the costs have been optimized by means of statistical quality control.

Many companies had been shocked, when it became apparent, that these proven methods no longer guaranteed the budgeted profits and the basis for cost calculation, namely the budgeted order volume. Suddenly, the success of a product has been determined by the customer, and not by the product which is considered good only by the producer. It is of little use to double one's efforts, if the criteria for the success of a product change so dramatically. The old thought patterns are no longer correct, thus new approaches are necessary.

The following items are to be considered decisive for the future:

> Today, a good product and a good service are taken for granted, the customers will only avail themselves of the most attractive offer. The customers become more and more fastidious, their demands, however, depend on the respective time and place. Professional marketing is becoming a major item.
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> There is more to a competitive product than only to function well. A great number of sometimes contradictory requirements are to be fullfilled better than by the competitors. For that reason, the complete know how of an enterprise has to be utilized from the very beginning of a project. On today's markets, there is no time for subsequent optimization activities. An overlapping quality management, a so-called TOTAL QUALITY MANAGEMENT, is an absolute must for that purpose.
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> These extremely complex optimization tasks are made even more difficult by limited financial resources, hardly calculable risks, and deadlines dictated by the market. New methods in Quality Engineering are necessary, if you wish to market the more attractive product before your competitors do. New methods and processes in quality engineering, the risk of which can be easily evaluated by the management, are to be selected and developed. Methods which can be applied easily and rest on a mathematically representative basis, must be developed, trained, and applied immediately.

All above-mentioned items are necessary to offer a more attractive product before the competitors do.

## 3. Complete change of the enterprise culture:

T.Q.M. is frequently recommended as the appropriate way to solve the afore-mentioned problems. What is behind it?

Just have a look at the sequential execution of orders, that dates back to the times of the producer markets. The project has been divided into separate project stages, which have been optimized only within their individual range of tasks. If you take today's demands of a worldwide predatory competition into consideration, and above all forthcoming terms, that will be even more vigorous, you soon will realize, that only a holistic, simultaneous approach is the right way to achieve your goals.

There are, however, many serious obstacles to overcome, before a concept can be translated into action. Some of these obstacles are:

**Taylorism:** The division of tasks, which is rushed to the extreme, leads to a point, at which the whole system of product development and execution of order is no longer transparent to the individual staff member. Thus, the staff members optimize only that part of the task that is assigned to them.

**Blame - System:** In order to avoid the risk of laying oneself open to the reproach of having made a mistake, the knowledge of individual staff members or a whole department is withheld from others as far as possible.

**Old quality conception:** Not the expectations of the customers have been the center of concern, but the formalistic execution of specifications that in most cases have rarely been questioned.

**Habit:** No one likes to give up methods that have been successful, and that everybody got used to during the past decades. Against their better judgement, people do not throw cherished habits overboard, until they reach a point at which they suffer severely.

**Wrong definition of terms:** It has been very convenient to obscure purposive concept approaches by wrong definitions of terms. Quality control has frequently been confused with inspection, quality assurance is repeatedly equated with making quality. Thus, the false opinion, quality can be effectively made by inspection, became even stronger.

**Lack of probability thinking:** Our engineers and managers have not been trained in probability thinking in the course of their education.

Very often there is a wide gap between realizing what is right, and doing what is right. Sometimes, the only way to immediate result is a company-wide, drastic introduction of T.Q.M., which the firms of consultants, of course, use various, often mysterious titles for. Whether a reorientation introduced by drastic measures will remain stable even under the severe stress caused by a setback in economy, or whether the staff will fall back into the old concept patterns, is yet to be seen. If the enterprise has enough time, it may be better to continuously adapt the strategies and methods to the changing challenges and conditions.

Three fundamental considerations are necessary, to guarantee the success of T.Q.M.:

All stages and fringe conditions in the course of product development and execution of orders are to be considered equally important.

The activities are to be exclusively focused on the needs of the external and internal customer.

All staff members shall be actively involved on the basis of a motivating teamwork, in order to mobilize and utilize the know how, that up to that point has been hidden in the enterprise.

From these basic considerations, adequate tasks and targets for all functions in the course of product development and execution of orders can be deduced. As soon as the targets are determined, the methods for cost and time saving processes and procedures for the individual tasks can be defined. Above all in quality engineering, so much has happened, that it will be difficult to keep pace with the progress having been made in this field, and aquire the necessary background knowledge.

## 4. Required methods of quality engineering

What then are the methods, processes, and procedures to aid the optimization of product design and manufacture for the future world market?

**QFD**

Any overall optimization must be based on an objectified evaluation of the customers'demands. By means of Quality Function Deployment it is possible to prepare a rated transition matrix deducing the engineering targets from the customers' expectations. The fulfillment of the customers' requirements can be made transparent with regard to their significance, even down to the levels of processing and quality assurance, which also is indispensable for all subsequent value-analysis activities, since the QFD indicates the actual value each characteristic item has to the customer.

**FMEA**

Among the many established methods serving to evaluate each item of risk still to be dealt with in the course of the proposed solution or the planned manufacture process, the FMEA (Failure Mode and Effect Analysis) has proved to be highly suitable for the current terms of competition, since by means of this method, and with the assistance of those persons representing the know how, the existing risk priorities can be detected. The ranking of these risks determines the sequence of activities.

**DoE**

The so-called Design of Experiments (DoE) is a highly efficient method to pick out the optimum solution from all the possible solutions to the requirements that sometimes are very contradictory.

In such a case, the practical application of mathematical-statistical methods is subjected to a severe test, since the problem areas to be optimized are not as clearly defined and limited as is required for the suggested mathematical optimization methods.
For this reason, it is highly recommended to include as many factors relevant for the optimization as possible, and present them by means of catchy visualization techniques, such as the so-called **Ishikawa Diagram**. With the assistance of the personnel experienced in the relevant fields, the parameters which the optimization activities will be based upon, can be selected. To cover the problem areas completely usually is too time- and cost- consuming. Thus, this process of selecting the experimental parameters before the actual planning and designing of the statistical experiment very often plays a more important role in obtaining an accurate result than the particular method applied in the DoE.

In the practical application of the extremely great number of mathematical-statistical methods, however, one encounters a series of obstacles difficult to overcome. The roots of these obstacles can mainly be found in our educational system. Hardly any of our development engineers has been trained in probability thinking. Many times the chance to win the jackpot marks the people's way of thinking to a much higher extent than the representative data for a particular case which have been acquired in a sober, statistical manner. If a solution to a problem happens to work, this is almost always interpreted as a representative confirmation; if it does not work, it is regarded the exception to the rule which can be done away with by means of simply performing another experiment. Since reality does not work this way, the engineer becomes insecure and eventually believes that the design of sophisticated experiments had better be left to a mathematician. This, however, will usually not yield the desired results, either, since due to the lack of data acquired and analyzed for a particular problem, the mathematician is faced with insuperable problems, when trying to evaluate the extremely complex problem area.

Consequently, the development and planning engineers need to make up for their lack of knowledge in the field of mathematical-statistical experimental methodology, and their lack of experience in putting the concepts into practice. Thus, it comes as no surprise, that the engineer tends to cling to simple methodological "recipes", all the more, if they once proved to be surprisingly effective. This may explain the enthusiasm some people showed in advocating the Taguchi orthogonal table methods, some others the Shainin methods, which sometimes culminates in philosophical battles and arguments with orthodox mathematicians. In any case, the choice of the mathematical-statistical method should depend on the particular problem to be dealt with.

If the products or processes, that are to be optimized, already exist, the approach to the solution should be based upon Shainin's proposals. In such a case, the existing reality is used as a first test series for the pre-evaluation.

If the new products or processes do not exist yet, and if it is difficult to comprehend the interactions, it is highly recommended to have the possible cause-and-effect chains determined by teams, present them by means of the Ishikawa diagram, and perform FMEA studies before designing detailed experiments.

If many, independent optimization parameters seem to be relevant, or if the design and manufacture processes are to be optimized at the same time, the Taguchi orthogonal-table-methods for designing experiments should be considered; an alternative for designing experiments is the genetic algorithm, which, however, is even more difficult to comprehend by an engineer not specialized in this field.

The target, the experiment is designed for, is to be considered as well: is it designed to find the best solution, or to guarantee sufficient robustness against varying influencing variables, or is it to prove conformance to a particular requirement with a high level of confidence. Furthermore, designs of experiments for verifying and assuring reliability and durability requirements gradually gain significance. The time and financial recources, however, are not provided to an extent the mathematicion would consider adequate.
When TQM is introduced, only the selective application of the whole instrumentarium available for overlapping, simultaneous optimization will lead to the desired results.

## 5. Participation of personnel

If T.Q.M. is introduced, the participation of the personnel will be of utmost significance. The industrialized countries of the Western world with their emphasis on individual performance and success, lack, however, tradition and understanding to such an approach. Since Taylor's times, planning and performing have been systematically separated, and now all of a sudden the persons carrying out a task are supposed to take part in the brain-storming. They even may question the solutions of the well-paid planning engineers, and are called upon continuously thinking about improvements that will contribute to the advantage-in-efficiency, that is so significant today. The phenomenon we face in this context, is the fact that despite computer-aided FMEA very trivial mistakes keep on being made. Having a closer look at it, we often find out, that the personnel responsible for the daily execution of the concepts was not involved in the FMEA, but - as usual - only the departments and engineers entrusted with developing and planning the concepts.

It is extremely painful to realize, that better results are achieved by consulting the personnel on the shop floor in time, than by having the work done only by the "departments in charge". The usual ambition to be successful as an individual person or department, however, becomes irrelevant as soon as a competitor is able to offer and sell a more attractive vehicle or component in the respective price segment.

Therefore, TQM can be successfully introduced only if the so-called Blame System is replaced by a completely open and frank exchange of information within the company. The suppliers, of course, have to be included in this process, as well. All levels of the hierarchy must be involved in this exchange, in order to ensure that the information reaches those persons, who due to their knowledge in a specific field are able to realize which step will lead to the small but crucial advantage over the other competitors.

Today, a leading position on the market can only be achieved by replacing basically good products, procedures, manufacture processes, etc., by even better ones. This is the basic philosophy of **KAIZEN**. When taking the full participation of people seriously, one has to take into consideration that human beings do make mistakes.

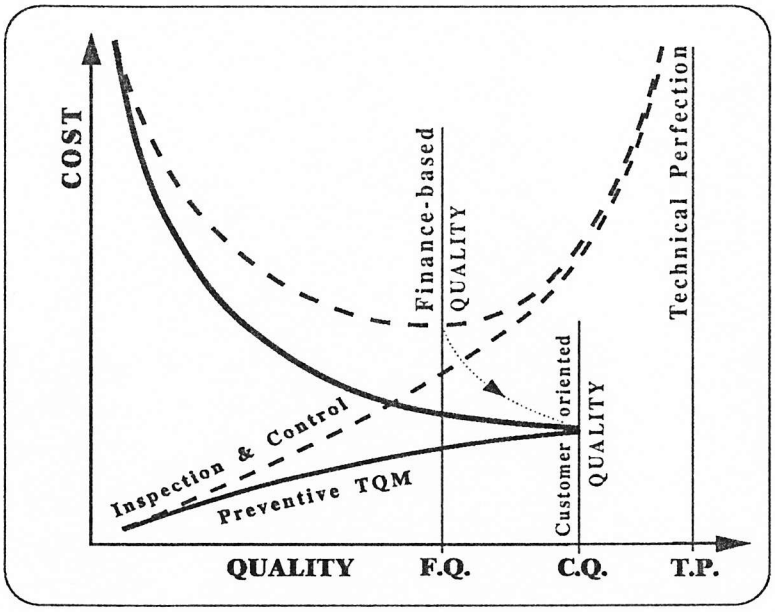
**Poka Joke** represents a method for systematically reducing the risk of human errors.

While in the early 80s the introduction of the **worker self control** gave rise to long discussions, the **teamwork** aimed at in many fields can today hardly be achieved without any **autonomous checking** and process-oriented quality control and its documentation. There are, of course, a few pre-requisites necessary, particularly with regard to the qualification of personnel and adequate **Audit**-feedback.

In the MIT/IMPV study, a production on a high technological level, which offers virtually no buffers, stocks and reserves according to our understanding (**LEAN PRODUCTION**), is considered to be the most efficient, provided it is controlled and continuously improved by mature and highly motivated personnel.

A so-called **TOTAL PRODUCTIVE MAINTENANCE** is being aimed at. The staff members are motivated by means of some psychologically very efficient methods to autonomously achieve excellent efficiency and availability at their workplaces, in order to present it as "shiny show room" to customers or potential clients.

Thus, **TQM** is an approach to management intended to achieve an excellent competitive power with regard to the overall attractiveness on the consumer market by utilizing the whole range of resources, not only the methodical and technical ones, but also the knowledge and creativity of the personnel.




In this manner, the connotations that usually go with the term **QUALITY** can be liberated from the merely technical definition of perfection (T.P.) on the one hand, and from the static, finance-based approaches (F.Q.) on the other hand, and be led towards a customer-oriented understanding of the term QUALITY. By applying the preventive patterns, methods, and techniques of **TOTAL QUALITY MANAGEMENT**, the customers' demands on a product of a particular price segment can be satisfied less expensively and faster than before. This is an indispensible condition for achieving a leading position on today's predatory markets.

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