Total Quality Management as a Tool for Organizational Change

The case of Motorola

by

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Content

1. Introduction

1.1 Background and aim

Most Western corporations are facing an immediate need to transform the way their businesses are run, in order to meet the quality, lead time and product development demands of the 1990s. There are several examples of companies which are trying to respond to the increasing competition, primarily from Japanese companies, with piecemeal changes. Possibly they are reluctant to accept that the rules of the game have changed, that improvements on a massive scale are needed just to survive. At the same time, other companies are beginning to understand that this type of change is needed but do not know how it can be accomplished. This is often due to different barriers in the organization related to the company's culture, history and other specific conditions, wich could cause a resistance to a change process. Further barriers could include the lack of strong leaders or of role models for a major change process.

How can such major transformations take place? Do we have any companies that can demonstrate ways of achieving them? Are there any Western "success stories" to tell?

One identified case, which can illustrate such a transformation process, is the US electronics and radio-communication company Motorola, the first winner of the Malcolm Baldrige National Quality Award in 1988. In the late 1980s and early 1990s, Motorola showed a tremendous change towards world competitive quality levels, production costs and lead times, as an effect of a company-wide quality program.

The aim of this paper is to analyze the relevance of total quality management[1] as a tool for increasing external and internal capability to achieve greater customer satisfaction and competitiveness. The experiences and results achieved at Motorola will be examined.

1.2 Methodology

The primary means of data collection for this study has been 21 in-depth interviews conducted in 1991 at all levels within Motorola, including the present and the former CEOs, general managers at sector and group level, managers at top levels in all different functional areas including personnel and finance, and development engineers. However, no interviews have been conducted with the workers on the shop floor. In addition to the interviews, we have supplemented our findings with secondary source information, in the form of internally written articles, documents and videos, as well as interviews published in trade journals.

The quality change program in Motorola will be examined and presented in the following sequence: the motive for the program, when and how it was implemented, critical incidents and important actors during the process, content of the program, and methods used for organizational change.

It is important to note that a change process, in this case a quality program, does not start from zero. There is always a particular history of each company which influences the way that is being selected and what path

[1].In this paper "total quality management" (TQM) is used interchangeably with "total quality control" (TQC) or "company-wide-quality-control" (CWQC). This means that our use of TQC is in the wider Japanese sense including the involvement of all persons, also the shop-floor workers, in the quality activities and responsibilities, and not in the more narrow sense of limiting the responsibilities to the quality specialists, as defined by Feigenbaum (1961).

the change process takes (Moss Kanter 1983). Hence, a comment is included which describes the influence of the history of the company on the change process.

In this paper we have chosen to analyze the quality change programs according to a model of organizational change developed in Alänge (1991). The influence of the change activities is analyzed on four levels: technical, social, political and cultural.

1.3 Our model of change

The model below provides a picture of four different dimensions: the technical, the social, the political and the cultural. For a successful outcome of a process of organizational change, it is essential to consider these four dimensions simultaneously.

This view is based on Tichy's (1983) notion of the importance of simultaneously solving three organizational dilemmas: the technical design problem, the political allocation problem and the cultural/ideological mix problem. The **technical design** refers to the organization's production output and how its social and technical resources can be arranged to fulfill the demands on output.[2]

Most production organizations are built up by **technical systems**, i.e. machines and equipment, which set some of the boundaries for what it is possible to change in the organization. In particular, the work tasks and work organization on the shop floor level, i.e. for blue-collar workers, may be very dependent on the machine configuration. However, white-collar workers can also be

[2]. Tichy (1983) includes the deployment of financial resources into the technical design area. In our model, the financial resources are seen as means for investments in and control of the technical and social systems, i.e. the financial resources have a political dimension as well.

dependent on hardware investments and configurations, e.g. in terms of available scientific instruments and computer terminals.

The **social system** refers to the human resources in the organization and how they and the organization are structured. This system can operate according to a more explicit means, and can be adjusted through changes in, for example, strategy and goal formulation and communication, formal organization charts, selecting and developing skills, fitting people to roles, defining their responsibilities, specifying performance criteria and measuring performance, developing information and planning systems, and fostering the development of information networks.

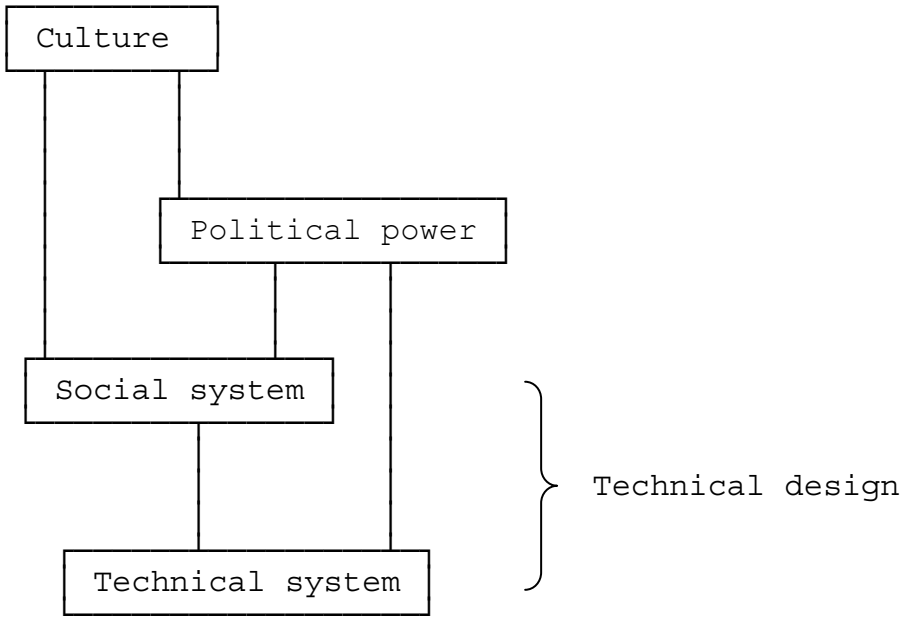

Figure 1. A model of organizational change components

The **political system** concerns the task of allocating power and resources in an organization. The concepts and language are less formal or explicit, and often less obvious, than is the case for the technical design

problem. Performance appraisals, compensation programs and career decisions are often reflections of this system area. Management of the internal power structures is another area, concerning who gets information and is involved in the planning and mission-setting processes, distribution of power across the role structures, the balancing of power across different functions within the company, and who is not involved, etc.

The **cultural/ideological area** concerns the range of values, objectives, beliefs and interpretations of past and current events which are held by the organizational members. Decisions to change corporate culture are not always made explicitly; instead they are often made implicitly, intuitively, and by trial and error. Often, this area concerns the development of a culture aligned with mission and strategy, where values and philosophies have a coherent influence. It is mostly developed through symbolic events, the communication of "success stories", by communicating and clarifying key values, by role-modeling in key persons, through the development of subcultures, by selection of people and management of rewards to reinforce the key values, and by fostering friendship and affective networks to shape and reinforce the culture.

Resistance to a change process can occur in these different dimensions, as follows.

First, the technological system itself can create barriers to change; e.g. an operator may be tied to the continuous monitoring of a machine, thereby limiting the technical autonomy and judgement of individuals.

Second, on the social level, an individual might resist change due to a number of reasons including: habit, fear of the unknown, lack of skills, unpredictability, and "sunk costs".

Third, on the political level, resistance to change may occur because of conflicts around the allocation of resources and power in the organization. For individuals the resistance can be due to need for power, overdependence on others, competition for power; and on the organizational level, due to threats to powerful coalitions, resource limitations and "sunk costs".

Fourth, resistance to change may be due to cultural issues, including: selective perception (cultural filters), values and beliefs, conformity to norms, and climate for change.

In section 3, the framework of the above four-dimensional model is used to analyze the Motorola approach of using total quality management as a means of organizational change. The influence of the Motorola change activities on the technical, social, political and cultural levels is analyzed.

2. A quality change process

2.1 Introduction

Motorola is the major US manufacturer of two-way radios, cellular radios, semiconductors and integrated circuits, and a major supplier of government electronics and information systems. Motorola's generic strategy can be classified as cost leadership in combination with differentiation through innovative features and with very high product quality. Motorola has experienced strong growth during the 1980s, from US$ 8.3 billion in 1988, and US$ 9.6 billion in 1989, to more than US$ 11 billion in 1990. It is a global company, in such a way that its production takes place in many different parts of the world and, of its market, more than 50% is outside the

USA. It is also a very research- intensive corporation and R&D/sales was 8.1% in 1989. Motorola was the first winner of the Malcolm Baldrige National Quality Award in 1988.

2.2 Motives for change

In the late 1970s and early 1980s, Motorola found itself being forced out of areas where it traditionally had been among the leading manufacturers in the world, by Japanese suppliers of better and/or cheaper products. The bow-out started with consumer products such as car radios and television sets, but continued with Motorola being forced to abandon its dynamic random-access memories (DRAMs) manufacturing in 1985/86. The latter constituted an important negative break into the core of Motorola's high-technology domain. In addition, a need of accelerated improvement became apparent through benchmarking efforts[3] made throughout the company, combined with projections of what the customer expectation would become in the years ahead.

This negative trend, of being forced to abandon product areas, became a strong driving impetus for radical improvement in the early 1980s. Motorola used all available ways to become more competitive, including: lobbying in Washington to obtain protection, entering into R&D consortium for semiconductors, and forging strategic alliances with a major Japanese competitor, Toshiba, in order to receive new competitive DRAM technology in exchange for Motorola's world-class microprocessor technology, in 1988. Motorola also decided on a strategy to try to beat the Japanese on their home

[3]. Benchmarking means a systematic comparison with the best-practice company for each specific process, e.g. invoicing or product development (which means that different companies are chosen for comparison and that they do not have to be in the same industry).

market, and to learn from the Japanese by cutting down the NIH barriers through a TQC way of working adapted to the Motorola context.

In 1982, Motorola developed a new pager with considerably higher quality levels than earlier generations in order to enter the Japanese market. In this connection, Motorola made the very important finding that there was a strong positive relationship between higher quality and lower cost, which contradicted earlier truths in US industry. Thus, it provided Motorola with internal indications of the promising route of TQC.[4]

2.3 When, how, and the purpose

According to the "official" history of the quality improvement process at Motorola, it all began in 1979, when a National Sales Manager, Art Sundry, stood up at an upper management meeting and declared: "our customers say that our quality levels really stink". This comment initiated a process at Motorola, which led the CEO and his executives to start touring around the world to visit other companies. What they found in Japan, plants with 1000 times better quality performance, convinced them that something must be done. But how?

In 1980, one of the senior business managers became the Motorola Director of Quality. This indicated a change, putting quality in focus, when a high executive was

[4].In the case of pagers, Motorola now has a 30% market share on the Japanese market, attributed to a very competitive quality level, with very high product reliability (MTBF of more than 150 years). The market share is a direct result of a clause in the contract with NTT, indicating that the supplier with the highest reliability also should have the largest market share. This was a clause introduced by Motorola. However, at least part of the reason for the start of this success stems from Washington putting pressure on Japan to import electronics goods from the USA.
"What won the day for Motorola was not its reputation for first-rate customer service and technical support. It wasn't even the outstanding quality of its products and design expertise. .... What made the difference? Resolute and protracted pressure from Washington." (Business Week, November 1989)

selected to become a corporate champion for quality as a complement to the efforts made by the CEO office.

In the early 1980s different programs were introduced, e.g. the Tool Management Factory and the Manufacturing Technology Centre, but the result of these in terms of quality performance was not impressive.

In 1981, the first firm step towards a quality revolution was taken by establishing goals for quality improvement, which exceeded earlier thinking about what could be accomplished. The Operating and Policy Committee approved a five-year goal of a ten-fold improvement in quality, regardless of how quality was measured. Several difficulties arose because of problems of comparison between different parts of the organization; e.g. managers' bonuses were based on quality, but nobody could approve or disapprove because the results were not comparable, and when different divisions met it was "a tower of Babel" because a common language of communication, as regards quality improvement, was missing. Nevertheless, this phase, between 1981 and 1986, gave promising results in terms of quality improvement. By 1986 most divisions met the goal, which in 1981 had been seen by many as impossible to meet. Hence, the project provided indications that quite considerable improvements were possible. But it was not enough; a major jump in improvement was still required, because benchmarking had shown that Motorola's competitors were sometimes 100 times better, even though not in exactly the same products. This finding became the strongest impetus for radical change in 1987.

In 1987, the CEO and the Operating and Policy Committee established even tougher goals for quality improvement over the next five years. However, they would hardly have succeeded in increasing the rate of change, if they had not at the same time found the "magic tool" for

organizational change, "management by uniform measurements". This consisted in the creation of a single metric for quality, i.e. a common language which made it possible for everyone to compare his quality performance with other departments or groups at Motorola. In addition, it provided top management with a tool to follow up and assess improvements in one section in relation to other sections. The common metric was Total Defects per Unit, where a defect was anything which caused customer dissatisfaction, a customer was the next person in the process, and a unit was any unit of work. To make all different work processes comparable, Motorola introduced the procedure of comparing defects found in relation to the number of opportunities that existed to make errors, for each specific process.

This common metric was first used by the Communications Sector in 1985 and it was fully adopted by that Sector in 1986. It contributed to such a startling improvement in the Communications Sector that the same metric was adopted by the whole corporation in January 1987. Motorola's goals for the next five years were set to improve 10 times by 1989, 100 times by 1991, and to achieve Six Sigma Capability by 1992. In Motorola, Six Sigma capability meant a maximum of 3.4 defects per million opportunities of error.[5]

In combination with the introduction of this unifying metric for measuring defects, Motorola changed from measuring a large number of quality- and productivity-related variables to measuring a few, selected in order to directly contribute to change. The basis for this was the overriding goal of Total Customer Satisfaction, introduced in mid-1987, which was accompanied by five key operational initiatives. The first was the above-mentioned Six Sigma Quality goal, and the remaining four

[5]. That is, six sigma adjusted for a deviation of process mean of 1.5 sigma to one side.

were: total cycle time reduction, product and manufacturing leadership, profit improvement, and participative management. Of the latter four, cycle time reduction was the most operational for inducing improvements, since it was directly measureable and could easily be used for comparisons.

However, the main vehicle for transforming the company since 1987 has been the Six Sigma Quality Program, whose key ingredients (according to Smith 1988) are: (1) A superordinate goal of "Total Customer Satisfaction"; (2) common, uniform quality metrics for all areas of the business; (3) identical improvement-rate goals for all areas of the business, based on uniform metrics; (4) goal-directed incentives for both management and employees; (5) coordinated training in "why" and "how" to achieve the goal.[6]

2.4 Content of the quality program

At Motorola it was acknowledged that aggressive quality goals had to be accompanied by training. During the 1980s, Motorola's corporate training function has put an increasing percentage of its resources into quality. In 1985 37%, in 1986 43% and in 1987 73% of the total training was devoted to quality. In 1987, Motorola spent 2.4% of the corporate payroll on training. It was a demand that 40% of this training, for each Motorolan, was required to be directly devoted to quality-related matters.

The considerable increase in the amount of quality-related training in 1987 reflected the new set of even tougher goals, including the Six Sigma capability by

[6]. In addition to the above goals, Motorola introduced a short-term impetus in Jan. 1987, the goal to correct all such defects that the customer would take notice of by March 31, 1987.

1992. Before this date, several courses had been developed, but these new goals placed a demand on a major shift in training intensity and coverage. Without intensive training of all categories of Motorolans, and not least the training of the total engineering workforce, in design for manufacturing and simultaneous engineering, the new goals would have remained paper goals.

In March 1987, a new course was launched, "Design for Manufacturing". It had a predecessor with the same name, but that one had been a very general course, which did not provide the practical guidelines needed. The new course was not a tool box, but it provided the necessary understanding of the "miracle link" between defects per unit and cycle time, of the Six Sigma benchmarking, of the capability index, of the relationship between latent defects and total defects in products, as well as of the relationship between the design process and defects per unit. In short, it taught the engineers how to design a product virtually defect-free.

There was an instant need for training of all Motorola engineers in "Design for Manufacturing", because of the aggressive quality goals introduced in January 1987. By using the regular Motorola training, at most 80 persons could be trained per week, which was very far from the demand for training. The solution became to train engineering managers to become instructors in this specific course. For a start, eight Motorolans were trained during one week to become the teachers of the engineering managers. These eight were split up in four teams with two teachers in each, who in one week each could train 8 engineering managers. The result was that after 2 weeks Motorola had 32 engineering manager instructors, after 3 weeks 64 instructors, and so on. These instructors, the engineering managers who came from the line organization, trained their own subordinates in

a 2-day course in "Design for Manufacturing". The result was that Motorola accomplished the massive training of all their 15,000 engineers in only eight months' time.

Besides being a very rapid way of introducing the knowledge needed on a massive scale, this form of training had several additional advantages. As the instructor was the line manager, the focus of the course automatically became the use of the new knowledge in the everyday work. In addition, the line managers had the advantage, as compared to ordinary trainers, of being able to relate the problems to their own and their subordinates' product area. In relation to earlier case instructions, this was a considerable improvement. The managers' implementation of the knowledge became more thorough as well, depending on the way they themselves learned; i.e. to teach is also to reinforce the learning.

Other areas of Motorola have also benefitted from this thorough training of engineering managers, through the promotion from this group of instructors into positions of product managers and senior product managers. This means that Motorola today has a number of product managers with hands-on experience of "Design for Manufacturing".

This course, and a course in basic problem-solving, are the only mandatory courses for the Motorola engineers. All other courses can be taken free of choice. Motorola today has a set of 100 courses provided by the Motorola University. Included are courses in statistical process control, design for manufacturability, understanding Six Sigma capability for persons outside direct production and design functions, benchmarking and robust design. Motorola has developed quality-related training programs for all levels within the company, including the senior executives, all line and support managers as well as supervisors and workers.

In addition, Motorola's suppliers have been invited to, and are required to, attend the training courses at Motorola University in Six Sigma and statistical process control. Motorola itself has concluded that Total Customer Satisfaction and world-class competitiveness would not be possible without first-class suppliers, but the requirement for the suppliers to take the courses does not originate from the company. It comes from Motorola's advisory council, Partnership for Growth, which was founded in 1982 and consists of suppliers and Motorola. However, since a year ago this council has turned the question around by asking how Motorola can become a World-Class Customer to its suppliers; i.e. the council today provides an equal focus on what Motorola has to change.

The existence of a wide variety of training courses is only the first step; what really matters according to the TQC philosophy is what is implemented in practice. The Motorola approach can be revealed by the following words of Bill Smith: "Naturally, all the tools for quality improvement have been common knowledge for many years. The key to a successful quality improvement process is not the tools themselves, but rather in the pervasive use of these tools within everyday conduct of business."

2.5 Actors

If we look at the change process from an actor's point of view, there are several important inputs made by different individuals during the action. Of course, the role of the then CEO, Bob Galvin, immediately comes forward; but in the "official" Motorola success story, other actors are also emphasized, partly to communicate the message of general change. In the following section, some of the critical roles in the implementation of a

major organizational change project will be discussed. In Table 1, a set of seven important roles is presented.[7]

Table 1. Actors - critical roles

Initiator	-	"our customers think our quality levels really stink"
Change agent	-	teacher, idea man; background outside Motorola
Communicator	-	on top level, brings the new ideas in and elevates them; change agent mentor
Diffusor	-	implemented the new ideas immediately in his spin-off unit
Brutal action man	-	a forceful businessman, frustrated, looking for a solution
Process mentor	-	top management, personal involvement, credibility, environment creator; a "listener and role model"
Continuator	-	new CEO, continued top level support; background includes quality - measure!!

One important point is that the awareness of the need for major change to meet strong Japanese competition existed long before some of the important tools for change were developed. Furthermore, although the CEO had been extremely important in creating an environment conducive to training and change, many of the ideas needed initially grew and were nurtured outside the CEO office.

[7]. These roles have all been generated empirically, in order to describe the change process from an actor's point of view. Some of the categories applied, such as the 'change agent' and the 'mentor', can be found in earlier literature, e.g. Rogers (1983), but the use in this study does not necessarily correspond fully to earlier use.

Several of the new quality approaches were developed within the Communications Sector; they were first tested there, and later implemented on a wider basis within the whole corporation. Hence, Bob Galvin, as the former CEO, primarily saw himself as a listener, who was sensitive to good ideas and had the ability of amplifying and adding value to the ideas, and then forcefully communicating them throughout the corporation once their potential had been proven; i.e. he was the **process mentor**.

The role of the **initiator** was to bring up the question of quality on the agenda, and Motorola from then on used this specific occasion, Art Sundry's comment that "our quality stinks", to communicate the message of a need for major quality improvement.

In the mid 1980's, Bill Smith, the quality manager at the Communications Sector who joined Motorola in 1978, had insights into Juran's teaching, experience from working in Armand Feigenbaum's consultancy company, and knowledge of Japanese practices. He became the **change agent** coming up with ideas about how to proceed. It was Bill Smith who originally wrote a relatively technical paper focusing on latent defects and arguing for six sigma quality. This paper was presented at a seminar in September 1984.

At the September seminar, a knowledgeable top manager grasped the idea and became the mentor of the change agent, and arranged for a presentation for the top management within the Communications Sector in December 1984. In January 1985, the decision was taken to start measuring defects within the Communications Sector. In addition, this top manager took it upon his shoulders to communicate the new ideas in understandable ways. He became the **communicator** of the new concept, and his function was to amplify Bill Smith's six sigma into SIX SIGMA. By the assistance of Bill Smith, he developed easily communicated graphs illustrating processes of 4, 5

and up to 6.3 sigma. The 6.3-sigma process concerns the function of normal aeroplanes, i.e. the message was clear; it is possible to attain the 6-sigma level. Later on, in 1989, he became the corporate director of quality and could continue to get his message through.

The **diffusor**, the head of the cellular division, attended the initial top management meeting at Communications Sector, when Bill Smith presented his ideas. Within 3 weeks after the meeting, the cellular division was spun off and moved to a new location, but the communicator brought the ideas there and implemented them immediately. The starting point was to give the engineers involved in developing the new cellular telephone the message that, unless the total defect estimate for the new product generation had been lowered by one quarter, the product wouldn't be authorized. The result was that the engineers themselves turned to Bill Smith to get assistance in finding the methods. The way to succeed was by applying the principles of fewer parts (from 1500 to 750, from 11 circuit boards to two) and simpler manufacturing (from 27 steps to 18). It should be added that, except for the head of the cellular division, there were more individuals within Motorola who took a similar role of diffusing the new ideas into other sectors of the company.[8]

Without fully understanding the statistical intricacies, the corporate director of quality, who was eagerly looking for a way of increasing the rate of change, adopted the 6-sigma concept as a device of change, once it was fully established that it worked in the Communications Sector. One reason for this was that the

[8]. Although Table 1 provides a set of seven actors or individuals who were of importance for the Motorola change process, these seven critical roles can possibly be found among more individuals within Motorola, depending on the unit of analysis. For example, there are surely more individuals who performed the role of diffusor for their respective work units, and even the role of change agent can be found at different levels of Motorola. Bob Galvin expressed this in a video presentation by referring to "the Bill Smiths of Motorola" (Fischer & Galvin 1991).

concept of Six Sigma had some distinct advantages as a tool for change. It was an absolute quantitative measure, and the figure/word combination, both starting with an "s", was easy to remember and communicate. As a forceful businessman and manager, he cleared the way in the rest of the organization and brought the new concept out into the organization. His function could best be characterized as being a **brutal action man** who got things moving on a wider scale.

As the seventh role we have added the **continuator**, meaning the role of the new CEO to continue with the same focus on the quality change process. This new CEO has a long history of participating in the quality program, including having a position as a quality manager during some time, and being involved in taking decisions during the early introduction of Six Sigma at Communications Sector in 1985. To ensure that the same focus was kept although the CEO was replaced, the new CEO to come was selected 1.5 years ahead of the actual switch of position, which gave the old and the new CEO considerable time to make a smooth transition. This is definitely not a typical procedure for changes of CEOs in US corporations, whereas Japanese companies show a similar pattern, keeping the former top managers as working senior advisors for several years after their retirement. The point to be made is, though, that this is a normal procedure for Motorola, e.g. in the case of change of corporate chief financial officer, in order to bring about a greater continuity.

The above-described roles were all important for implementing change in Motorola, but the quality of the individual assuming the specific role is also of immense importance. A Motorola employee presents this view of the top management at Motorola:
"Most important of all is the role of top management. Motorola is singularly blessed because those at the very

top are leaders, not just managers; visionaries, not just bureaucrats; inspirers, not just controllers." (Bhote 1989)

2.6 Methods of accomplishing change

The Motorola way of accomplishing major change throughout the company consists of a wide variety of activities and measures, with the same intention of giving a strong message of the goals of defect-free production, short lead times and total customer satisfaction.

In order to make the personnel aware of the challenge, i.e. unfreeze in the terminology of Kurt Lewin (1947), a great number of examples from the major competitors in Japan was brought in as stories. These stories had the function of establishing an awareness of the extent of the challenge. One example is the story about the Japanese TV manufacturer who had only one single test at the end of the line, on and off. No advanced measurement equipment, just this simple test if the TV worked or not. The manufacturing process was under such control that virtually no variation in quality existed once it worked. However, if the television did not work, the first step was to call for the CEO to personally visit the shop floor and solve the problem. This of course provided a very strong signal to the Motorolans: it is possible to have virtually zero-defect production.

In combination with these examples brought in from competitors, the leaders of the company set examples. Especially the former CEO, Bob Galvin, was involved in all steps and initiated the broad-band activities. It was Bob Galvin who presented every Motorolan with the challenge of comparing him/herself and competing with his/her "counterpart" in their Japanese competitor

company, just as Bob Galvin had to stand up to the qualities of Mr Morita of Sony Corporation.

Other well-known "success stories" have been widely used in order to get the message through to every employee. One was about how Bob Galvin in 1986 set the stage by saying that the Operating Policy Committee had the wrong agenda, and insisted on putting quality as the first point. When this change had been made, the quality matters had been discussed and the financial performance was the next point, Bob Galvin got up and left. This was of course an extremely strong way of setting the stage, especially as he made a habit of leaving after the quality discussion and before operations are discussed. In addition, the Motorola way of turning this into a story that is told over and over, makes it diffuse all through the organization and become an essential tool of change.

Another visible action which stresses the importance of quality is that the CEO also chaired the Operations and Policy Committee eight times a year only to talk about quality.

In addition, when a new CEO was to be appointed, a senior manager with specific quality experience was selected from a group of many capable managers.

To show the importance of defect-free production, Motorola used a special method of communicating the message to the workers in the production of fixed-parts printed circuit boards. For each circuit board having one of four types of major defects: wrong weld, wrong part, missing part or reversed part, the order was to throw all defective circuit boards into a special basket. The employees initially thought that this was only another management gimmick, and they were convinced that another group of employees later repaired the faulty products.

However, such was not the case, as Motorola was aware of the fact that a repaired product always has a higher probability of failure, and with the new quality levels applied, this was not acceptable any more. Even more important was to give the employees a strong signal about the need for defect-free production; hence, the management went out to the specific work area and broke the defective circuit boards into pieces, to make sure that the workers got a strong visible message.

The "bandit line" at the pager factory in Florida is yet another example of the Motorola way of communicating a visible message through the organization. This production line was designed as an experimental greenhouse, with the intention to make use of all the best ideas and equipment that existed in the world. Even the name in itself, "bandit", refers to the intention of "stealing" and adopting all good ideas, i.e. it was a war against the Not Invented Here (NIH) syndrome. In the factory signs had been put up indicating that NIH was forbidden; others read "steal every idea you can", and every visitor could see a big sign saying "Don't leave here without leaving a good idea behind". The experiences and the knowledge developed from the bandit line contributed to excellent improvement results in the pager factory. The lead time from order to shipment to customer decreased from 40 days in the early 1980s to one hour and 30 minutes in 1985/86. This lead time is today down even further, to one hour and 10 minutes.

In Motorola, a very consistent picture exists of what happened during the process leading to the Six Sigma program. This story is shared by Motorolans at all different levels within the company; see e.g. the introduction above, which starts with Art Sundry's comment that "our quality levels stink". Motorola is using these kind of stories both internally and externally, in order to communicate the message to bring

about change as well as a new view of the high-quality company. Motorola is using these descriptions of the company history, where the more important events are emphasized, over and over again. In our 21 interviews at all levels within the Motorola organization, it was amazing how consistent the stories were about what had taken place. This was of course reinforced by the Malcolm Baldrige National Quality Award requirement, for the winners, of diffusing experiences through speeches and articles throughout US society. The success stories of the 1988 winner, Motorola, have been presented in hundreds of speeches and in a considerable number of interviews and articles. The Award can be seen as the frame for a change program and the Six Sigma goal as its vehicle.

It should also underline that Motorola, even after achieving considerable success in increasing quality levels, has still tried to establish a strong feeling for the need of change and continuous improvement among its employees. This is not expressed in direct crisis terminology, but Motorola stresses that it is a matter of survival.

"With lower cost, we will be more competitive. We can reduce prices and achieve a higher share of the market. We can invest more in new product development and marketing programs. We can share more profits! It's a WIN-WIN situation for everyone - but more than that, it is a competitive necessity. You know from your personal experience that competitors from all over the world are becoming more competent at an increasingly rapid rate. It is no understatement to say that achieving Six Sigma performance throughout Motorola is truly a matter of survival." (Weisz video tape, 1988).

In addition, Motorola's way of presenting its SPC courses is different, as compared to the common practice in

Swedish companies, where the focus is normally on process control. "It explains SPC as a set of problem-solving tools applied within a problem-solving strategy to implement Total Quality Improvement. Continuous improvement toward zero defects in products and components is the objective."

According to a senior manager, Motorola needs American management instruments to measure and compete. Measurement is used only to accomplish change. In comparison, Japanese teams do not use this kind of measurements because they have a strong culture of improvement. Motorola has not yet reached that stage, and hence there is a need for measurement.

Motorola's basic view on measurement is that only what matters for the customer should be measured, i.e. to concentrate only on the important measures. It should be pointed out that Motorola's definition of Total Customer Satisfaction includes total employee satisfaction. Furthermore, there is an optimal number of measurements, because the less you measure, the less opportunity to manage and control.

Motorola has increasingly been sending out very strong signals to the managers on different levels that they have to follow and support the new way of management, or else they must leave their position. For example, if the metric shows a high level of defects or a plateau in the improvement pace, the reason is investigated. If the group of senior managers, who conduct the regular operations reviews, find that the reason for the poor performance has to do with a manager's commitment, the manager will be replaced and possibly moved to a staff assignment. In the opposite case, of a good result in terms of a low level of defects, then the outcome may be a higher salary and an offering of a better job.

The same kinds of strong managerial signals are provided in other areas of management performance, which are considered as important for Motorola. For example, the goal of participative management within and cooperation between organizations implies that, if a manager can establish good cooperation with his subordinates and other organizations, then he will be rewarded. On the other hand, if a condition of poor cooperation evolves, then the manager is moved from his position.

Motorola aims at involving all employees, including the shop floor workers, in the change process. For this purpose, Motorola has formed TCS teams (Total Customer Satisfaction teams), which are a form of quality control circles. In 1990, a total of 2,000 teams existed at Motorola, 1,200 of them in the Communications Sector. During 1991 the latter number has increased to around 2,000 teams in the Communications sector alone, and in early 1992 there were about 3,500, and they averaged 8 to 10 members each. The TCS teams are formed by individuals from different departments and levels. The problem that they focus on is approved by management through the guidance of the "five key initiatives": lowering defects, shorter lead time, product leadership (doing the right things), profit improvement, and participative management and cooperation. The TCS teams are free to use any tools, which is a difference in relation to the Japanese QC circles, where a more standardized way of working with approved tools is being enforced. The TCS teams are building on the American tradition of setting targets to solve something essential and then getting there, regardless of the tools used. According to Bill Smith (1991), the difference between a Japanese QC circle working on a "Kaizen type" of continuous improvement and the TCS teams is that the Motorola goal is "aggressive" continuous improvement.

2.7 Barriers to change and how to break them down

Initially, the Motorola way of measuring defects per unit (in relation to the opportunities of making an error) met some resistance within the organization. Motorola had developed this way of measuring in order to permit comparisons of quality levels and improvements in products with different complexity. For example, to compare the total number of errors in a pager containing 130 parts directly with an EMX containing 150,000 parts would have been hard, if the adjustment by the opportunity of making an error had not been introduced. Still, the opponents claimed that the opportunities of error were not comparable and opted for a never-changing standard of comparison.

The most severe resistance to the Six Sigma program came from the statisticians in the organization, especially from those with a Ph.D., and less so from the M.Sc. They considered the defect-per- unit measurements to be less accurate and pointed to a considerable error in measurement, at least 5-10%.

The Motorola way of tackling this resistance was to recognize that a perfect standard of comparison did not exist, and that the Motorola way of measuring defects and opportunities would never be totally perfect. But if the goal is a 68% reduction of defects per year, then a 5% error in measurement does not really mean very much. On a time scale it would mean an error in measurement of quality improvement by one month. Furthermore, the definition of a defect itself is based on the notion of meeting customer satisfaction, and hence this measure is also changing from day to day, because customer expectations change. Nevertheless, what is important is that it works as a management tool for change and quality improvement, by making comparisons possible and by working in a common language. By making this purpose

clear, the Motorolans in general started supporting the Six Sigma efforts, and the Ph.D. statisticians joined as well, once they understood that it was a concept and a banner for change. In addition, Motorola today de-emphasizes the general comparisons based on opportunity of error, and focuses on continually reducing and comparing defects of "like" processes.

Early on, there was also resistance from the middle-level supervisors, the traditional "problem solvers", who had gotten their promotion because they could work around problems, e.g. know how to get parts if these were not available. The solution to this resistance was to involve them in the Six Sigma process of change, because here are always problems, waiting to be solved.

2.8 The history of the corporation - implications

A radical change of direction in a company never starts out from a vacuum; there is always an earlier history which can hinder or facilitate the transition. In the case of Motorola changing in the direction of TQC, a number of factors helped.

First, the top management had a belief in change and in continued education and training of the human resources. These beliefs and the practical promotion from top management are cornerstones in a transition. Second, for several years Motorola had promoted a program of increased employee participation on all different levels, including the work in small problem-solving groups, which is another cornerstone of TQC. In addition, Motorola had a strong culture based on people's values, where respect for the individual is an essential ingredient, which is another contributing factor to the possibility of unleashing the potential of all employees. Third, Motorola already had some of the characteristics which

are typical of a Japanese company but not at all of a US firm, as regards its relation to its employees. Motorola had a policy of never firing employees, and after 10 years of employment it is almost impossible to fire an employee; i.e. the groundwork for "life-time employment" existed, which is of importance when major investments in development of the human resources are needed. The Motorola family feeling was furthermore reinforced by employees typically having other relatives working for Motorola, and by institutions like the Profit Sharing Plan, which had been operating since 1947.

On the barrier side, within Motorola there was a long history of success and a belief in being the best in its fields of business. However, according to customers, this also had such implications as that Motorola was known to treat its customers in an arrogant way, not listening to their complaints and suggestions. Hence, a major change was needed if the goal of Total Customer Satisfaction would be possible to reach.

3. Is Quality Used as a Tool for Change?

In this section, the Motorola way of using quality as a tool for organizational change will be analysed. This is done within the framework of the model for change presented in section 1.3. The model emphasizes the importance of considering four different levels in an organization simultaneously, the technical, social, political and cultural levels, in order to accomplish a successful change process.

3.1 Technical dimension

The technical dimension refers to the physical technical system, i.e. the machinery and equipment, and to other

special resources developed within the organization, which are related to the operations. A research institute, with knowledge resources and all equipment needed for research, is one example of such a special resource. The present setup and possible investments in hardware define some of the boundaries for what it is possible to change on other levels in an organization. In the same manner, the availability of knowledge resources limits what it is possible to do and at what pace.

For Motorola, its "in-house" semiconductor manufacturing capability provides a distinct advantage in a number of ways. Most important is probably a timing advantage. This means that, for example, the cellular division can obtain knowledge earlier than competitors of new semiconductor technology being developed, and it can therefore incorporate this technology in new product developments ahead of competitors. Also, it is probably possible to be first among customers to receive deliveries of the new semiconductor components. In addition, the possibilities to obtain components with the right characteristics for robust designs should at least not be less, when the manufacturing capability is in-house. However, the initial decision to invest in semiconductor fabrication was made already in 1949, and can be seen as part of a historic process leading to the company of today. The existence of this capability provides Motorola with a distinct advantage on the technical level, which enforces its possibilities to successfully introduce one part of the quality program, i.e. robust design principles.

Apart from the "hardware" side, the technical dimension also refers to investments in "software". In order to further strengthen the Six Sigma process, Motorola created the Six Sigma Research Institute. Its purpose is to research and develop advanced statistical engineering tools (e.g. Six Sigma Research Institute is one of the leaders in chaos theory development), research and

develop advanced application methodologies, and rapidly transfer the technology to different parts of Motorola. This "think tank" on advanced methodologies is part of the support structure for change that Motorola has created, by both developing instruments and ways of communicating them. Most recently IBM and DEC, two companies which have adopted the Motorola Six Sigma approach, also joined as shareholders of the Six Sigma Research Institute.

Another part of the support structure is the Motorola University, which provides courses for Motorola as well as for suppliers and other companies. Motorola has also assisted universities in developing their curricula, as a long-term change strategy. The most recent plan is to heavily support one general university, where 100 professors, not only in quality statistics or management or in engineering disciplines, but from a variety of disciplines, will go to Motorola and spend some time in order to make a major impact on this university.

3.2 Social dimension

In contrast to the capital and other production-factor investments that are linked to the technical dimension, the social dimension refers to the human resources and the structure and management of these resources in an organization. Included in this dimension are also strategies, goals and their process for formulation, as well as the method of selecting, developing, rewarding and dismissing these human resources. The social dimension is changed mainly through formal means, starting from the strategy and goal formulation.

The increased competition, demands on lead time and on quality levels, as well as the increase in technical complexity, have all worked as stimuli for new forms of

social organization. There is a need for shortening the development times and improving the contacts between persons involved during different steps. Hence, concurrent engineering has become an absolute requirement and it means that the team-player comes into focus, which requires a new reward system. Multi-disciplinary teams have become the solution. In Motorola this development started in the cellular business, with its less formalized way of management. Later, it has been diffused into other sectors with a more traditional way of working, partly by the movement of people with this kind of experience.

Motorola uses a contract book to guide and control each development project. This contract book provides very specific rules on the resources to be used, the development time and the results required. During the course of the project, there are frequent follow-up meetings, to make sure that the engineers are on the right track and pace.

Motorola exerted tremendous efforts in order to give all their engineers similar training. For example, in a mandatory course, 15,000 engineers (100%) received training in design for manufacturing in 8 months. This effort could be compared to its similar-sized Swedish competitor Ericsson's quality project in 1983-86 (the EQ project), which in some form reached a total of 15,000 persons during 3 years' time. Motorola has put more emphasis on training than most other companies in the US or in Europe. Motorola also has a very clear focus in its training activities, i.e. they should be "doing-directed".

Motorola is in the process of cutting away middle-manager layers within the organization. The number of hierarchies has been reduced from 14 to 9. This step provides possibilities of simpler information flow and improved

communication, and the hidden human buffers (i.e. waste) more easily come up to the surface.

Motorola installed a highly positioned general manager as a full- time corporate quality director, to support the CEO and his office, who also put very great effort into quality.

The Motorola way of using a uniform metric, combined with identical goals for each possible process and job, is the major factor behind Motorola's pace of positive change. This factor not only influences the social dimension, in terms of providing a very clear guideline for the work. It also has a direct effect on both the political and the cultural dimension, as will be described in the following sections. As the Motorola way of "Management by Uniform Measurements" has such considerable merits, by being one tool which influences three different change levels, it has now also been adopted by giants such as IBM.

3.3 Political dimension

The political dimension concerns the task of allocating power and resources in an organization. The concepts and language regarding the political dimension are less formal and may not be as clear to follow as is the case with the technical and social dimensions.

One of the most profound means of changing the power structure in an organization is through the succession order. Motorola's way of selecting the CEO, 1-2 years in advance and letting the new CEO work side by side with the retiring CEO, promotes stability. First, it secures a continuation of policy, which can be contrasted to the more common procedure in other US firms, where each new

CEO has to implement his own new ideas.[9] Second, the risk is lower of losing the no. 2 or 3 candidates for the CEO position to a competitor, which is very common in other US firms, where a number of very competent candidates fight and only one person is the winner. This succession focus has provided Motorola with a strength to carry through its TQC change project. Such a project must have a long-term commitment to be successful.

The way of selecting top people in Motorola is also a way of securing political power across different functional specialities, giving quality a dominating position ("quality first"). This was done through the succession on the top level, but the promotion and reward structure also provides a way of choosing which persons to promote on other managerial levels. The uniform-metric system is one contributing means to evaluate managers, in order to promote those whose department shows the improvements needed, and to move those managers aside who do not stand up to the right level of leadership or commitment to the Six Sigma quality goal. On this level the Motorola way is politically mechanistic, while on other levels Motorola has promoted a more organic policy of participative management.

In Motorola, the policy and key goals are set by the top management and communicated downwards. The participation comes on other levels. For example, in the case of product development, the short-term goals on a more practical level are developed through close interaction between the development team and the management. The Motorola way of measuring all work processes, in terms of their "defects per unit" result, is one of the most powerful stimuli of change in Motorola. The goal of Six Sigma capability by 1992 is the same for the whole company, and it has been set by the top management. On

[9]. Such was the case in Florida Power & Light, the first non-Japanese winner of the Deming Quality Prize, which after a shift of CEO lost its focus on TQC.

the other hand, the way in which the calculations are made, of defects per unit in relation to the number of opportunities for error, is essentially a question for each level concerned. Thus, the Motorola approach of "Management by Uniform Measurements" is being influenced on different levels. Besides being a general instrument of communication and comparison on all different levels, it is also a most essential top management instrument for balancing the power across groups and departments within the whole corporation.

Motorola has formed a large number of TCS teams, which is an example of the strategy of participative management, i.e. political influence on the shop floor level. These teams have freedom in such respects as that they can choose their team members and select the problems and the tools to use to solve the problems. The only requirement is that the TCS team identifies which one or more of the five key initiatives[10] that will be improved as a result of their project. This is a key point for the successful empowerment of the employees and it is based on the notion that management understands that the improvement of anyone of the key initiatives contributes to a better business. Of this follows, that management must support the team in its choice of improvement project, even if management thinks that it is not the most important issue to work on. Hence, this is one step that Motorola has taken towards empowerment and better use of the capabilities and inputs from all employee levels, i.e. it is a consistent part of a TQC approach.

[10]. Motorola's five key initiatives are: the six sigma goal of defect reduction, total cycle time reduction, product and manufacturing leadership, profit improvement, and participative management.

3.4 Cultural dimension

The cultural dimension concerns the values, beliefs and interpretations of past and current events held by the individuals in the organization.

Motorola consistently communicates its values and beliefs through all available media and channels. In short, Motorola has used TQC as a tool for making a major change of its corporate culture.

To increase the motivation for change, Motorola has put the focus on an external enemy, the Japanese competitors. Motorola used this outside enemy in a very consistent way, starting from benchmarkings and continuing by the CEO sending out the message that every individual had to compete with his counterpart in the Japanese competitor companies. Furthermore, Motorola communicated the message from the standpoint of its importance for Motorola's survival. One of the senior Motorolans expressed it in this way: "If we hadn't had the Japanese, we would have had to invent them."

In the cultural dimension, Motorola has done a thorough job in transforming itself into a company with a customer focus. Total Customer Satisfaction has been the guiding principle since its introduction in 1987. Motorola has used an array of means to communicate the message and transform the Motorola culture. Symbolic gestures have been made, and later communicated through interviews, articles, speeches, etc., to become part of the company history. One example of these symbolic gestures is when the CEO puts quality on top of the agenda for the meetings with the Operating and Policy Committee, leaving the meetings after this matter has been finished and discussion about operating results is to begin. The message is clear for everyone, not least for other senior managers: quality is number one for the CEO and for

Motorola. Other examples are the top managers visiting customers regularly (the message is customer focus), and the "bandit line" in the pager factory, i.e. steal every good idea you can find and implement it (the message is to break down all NIH walls). Yet another example is the little plastic card every Motorolan is supposed to carry with him all the time, with the key beliefs, the key goals, the key initiatives printed on one side, and the most fundamental message printed on the other side: everyone's overriding responsibility is "Total Customer Satisfaction".

These are all symbolic actions, which are communicated out into the Motorola organization in a consistent way, in order to work as a tool for changing the culture. They have been further reinforced by the way of rewarding and promoting people; the most outstanding example is the promotion of the new CEO, George Fischer, with a quality background, but this is also a more general trend throughout the organization.

According to the Japanese model, in addition to top management's real involvement, the use of "success stories" has been one of the most important means of diffusing TQC (Shiba 1989). Motorola has also used this means, in the same consistent way: for example, by communicating the improvement of quality and leadtime in the case of pagers, and the result in terms of a 30% share of the Japanese market.

Motorola has throughout used a "visible" and explicit way of communicating what it wants its culture to become. Since the uniform metric was introduced, a directly comparable quantitative measure of quality level has also been available, and has greatly helped in convincing Motorolans of the need for change and the possibility of changing.

By being the first winner of the Malcolm Baldrige National Award in 1988, Motorola has an obligation to communicate what it knows about quality to the rest of US industry. In order to communicate the Motorola Story outside of Motorola, a very consistent way of describing all changes and measures had to be developed. However, these thorough descriptions made for the external world also further reinforce the change process and the development of the new culture at Motorola. Throughout Motorola this is visible, and there are few companies that can show such a consistent way of describing their history and critical events, which is a clear indication of the pervasive strength the Motorola TQC approach has had all through the organization.

3.5 Quality - a tool for change

The answer is definitely YES to the question raised at the beginning of this section. Quality is used as a tool for change. Furthermore, it is used in a very consistent and thorough way, simultaneously influencing all four dimensions: the technical, social, political and cultural. There are variations between different units and sections of the large Motorola organization in how far the total quality approach has reached. But as a whole, it is impressive to see how greatly the message of total customer satisfaction and defect-free production has pervaded the organization and made Motorolans change their way of thinking and acting.

4. Management implications

What is meant by total quality control (TQC) or total quality management (TQM)? TQC or TQM stands for good management, which makes it possible for a corporation to benefit from the full resources of all individuals in the organization. There are some general truths in the above concepts, such as: the importance of a customer focus, the importance of top management involvement, the importance of involving all personnel, and the importance of clear communication.

There is also an accompanying set of quality tools and methods available for a company to choose from. This set or "tool box", has continuously been developed and new tools have been added. What really matters for the outcome of the TQC process is, however, that the strategy and tools selected are really implemented. Here we find a general weakness in Western industry. Many of the tools have been known for a very long time, but the potential benefits have not been reached. This is a main difference from Japanese industry, where one major strength is that the tools selected are also implemented and used.

In Japan, the tool box has been developed gradually. Starting from a focus on production and continuous improvement, TQC is now largely a matter of research and development, in order to better satisfy the customer. However, in Japan, JUSE has made a prescription of what tools are suitable for Japanese industry. This has a major advantage in terms of a wider diffusion of TQC into the industry in general. However, on the negative side, this way of prescribing the tools and the way of working may also be a bit rigid. Of course, the most successful large Japanese corporations do not stop at using the prescribed method and tools. They break new ground, which will later be incorporated in the JUSE prescriptions for wider diffusion.

In a similar way, Motorola has been breaking new ground: first, by benchmarking, identifying and analyzing what Japanese and other excellent companies were doing. The next step was to incorporate all good ideas from Japan or from other parts of the world into Motorola's own practice. Finally came essential ingredients based on Motorola's own history, and from the cultural context where the company is working. The essential lesson is that, once Motorola decided on using a TQC way of working, including their own Six Sigma process, it used all efforts to implement and make the ideas work.

Hence, an important management implication is that when a company decides on using TQC as a framework for change, and selects a specific set of ingredients and tools, it must implement this in a consistent way. To be successful, it needs a major change in ways of doing things, which requires a major effort and a focus on TQC. As TQC by definition implies a total commitment, half-hearted approaches rarely give a promising result. In that case, the company may be wiser to select another stimulus of change, which it can focus upon and implement thoroughly.

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