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A Quality Journey

Observations and Suggestions Regarding Continuous Process Improvement

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Introduction

In the early 1970s, Xerox had almost 100 percent of the copier market. By the late 1970s, the company's market share had shrunk to about 30 percent. Japanese firms -- including Fuji Xerox, 49 percent of which is owned by the American company -- had become able to sell a copier for the price that it took Xerox to produce one. Xerox's solution was to reduce costs through a company-wide quality improvement effort -- what has become commonly known as total quality management (TQM). Because Xerox began comparing its efforts with those of other companies, listening to its customers, working with suppliers, reducing defects and -- importantly -- training its employees in basic statistical methods, the company is no longer "circling the drain," but instead a recognized leader in quality, the winner, in fact, of a 1989 Malcolm Baldrige National Quality Award.

Many firms now have similar stories about how continuous process improvement programs and the use of statistical methods have cut costs while improving the quality of their products. The quality revolution that the American manufacturing sector has undergone during the last decade is, in fact, now spreading: to health care and other service organizations, to educational institutions, even to some government bodies.

As chairman of the graduate program in Quality Management and Productivity at the University of Iowa and a past president of the American Statistical Association, I have found this spread of the "quality word" encouraging. One of the central tenets of the quality philosophy, however, is that improvements can always be made. In academics, it is especially easy to lose sight of what is happening in industry and the rest of the "real world." So that I could better understand the current challenges facing continuous improvement programs and the role statisticians must play in meeting those challenges, I took a sabbatical during the fall semester of 1991 and embarked on a "quality journey." Of particular interest to me was

talking to those "customers" who use statistics students and discovering how universities and other educational institutions could better serve both them and the students who graduate from our programs.

My "quality journey" had me on the road continuously from early September through late November, then out again in December and January 1992. It convinced me that eleven weeks is too long for a man turning 67 to live out of a suitcase. The opportunities to learn that this trip provided me were, however, invaluable. In addition to touring Xerox's Rochester, New York, operations, I enjoyed the chance to discuss the Baldrige Award-winning efforts of Motorola with CEO emeritus Bob Galvin and others and see the Rochester, Minnesota, facilities that earned the award for IBM. I saw DuPont's continuous improvement program in action, observed what was happening at Kodak, Parke-Davis and AT&T Bell Laboratories, heard about BBN's statistical software development and attended a symposium for StorageTek suppliers.

I saw a variety of automobile industry operations, including Ford's Dearborn, Michigan, headquarters and its Romeo, Michigan, engine plant. I traveled with quality guru Ed Deming to General Motors' Lansing, Michigan, Oldsmobile factory, and toured its AC Rochester components facility in New York. I also observed first-hand the new Saturn operations in Tennessee.

In the area of health care, I saw Hewlett Packard's efforts producing medical products at its Andover, Massachusetts, plant and observed Baxter Healthcare Corporation's work manufacturing and distributing medical supplies. I made brief stops at the Hospital Corp. of America headquarters in Nashville, Tennessee and Meriter Hospital in Madison, Wisconsin, each of which is committed to using principles of TQM, as is the Mayo Clinic in Rochester, Minnesota, which I paid a longer visit. I also attended the National Forum on Quality Improvement in Health Care at the invitation of Don Berwick, a physician who authored the collection of excellent quality improvement case studies, **Curing Health Care**, with statistician Blan Godfrey and writer Jane Roesser.

Other gatherings on my schedule included Joseph Juran's IMPRO '91 seminars and the "Case Studies in Quality Improvement" meeting at the University of Wisconsin. I visited a number of other universities as well, including MIT, the University of Tennessee, the University of Waterloo in Ontario and Oakland University in Rochester, Michigan. I also heard about

the work of the Madison [Wisconsin] Area Quality Improvement Network (MAQIN), stopped at the Bureau of the Census, which is getting its third attempt at a quality improvement program off the ground, and observed the efforts in quality improvement being made at the National Institute of Standards and Technology, which administers the Baldrige Awards and is evaluating its own operations based on the award criteria.

The hospitality I encountered throughout the journey was wonderful and representatives of several of these organizations provided helpful comments on drafts of my initial impressions of their programs.

Confirming quality principles

The trip basically reinforced many of the principles that have become commonly accepted in discussions of quality. Most generally, the journey confirmed that quality companies are those that are concerned with and listen to people, including customers, employees and suppliers, as well as those in the society at large. They also study the processes by which value is added to products and services and work to continuously improve those processes to eliminate errors and waste.

Quality also requires the commitment of top-level management. At some companies successfully undergoing continuous improvement, there is almost an obsession about quality. The best example is perhaps Motorola, where Bob Galvin told me, "Quality is very personal." His sincere belief has rubbed off on a top team, including Richard Buetow, Paul Noakes, Gene Simpson and Bill Smith, each of whom describes the company's "Six Sigma Quality" program with conviction.

Pay attention to customers

Quality programs do, however, in a sense turn traditional organizational pyramids upside-down, even as they require the commitment of top management. Decisions about improvement of processes are ultimately based on what customers value and want. This is, of course, not a new idea: "The customer is always right" has long been a slogan of successful businesses. The quality movement has, however, re-emphasized this concept. The fact that IBM calls its continuous improvement program "Market-Driven Quality" indicates the importance placed on the customer there. At the Mayo Clinic, administrators describe their move from quality assurance to quality improvement as being an updating and extension of

founder William J. Mayo's statement: "The interest of the patient is the only interest to be considered."

One of the first accomplishments of the National Institute of Standards and Technology's efforts at total quality management has been to reduce the number of grievances made against it. Hewlett Packard's work creating medical imaging equipment is another good example of the role customers play in successful quality improvement programs. The company turned to those in the medical profession to determine what sort of performance they truly wanted from imaging equipment, and used their suggestions to define the metrics they would measure as they attempted to improve the quality of their products.

Perhaps the most extensive efforts to learn from customers that I have encountered I heard about after taking my quality journey, though. These were the steps taken by John Deere to get information from their excavating equipment customers. Purchasers are first of all asked if they want to be on a team of Deere customers. If they do, they are then called every two weeks to see how the equipment is operating. Deere representatives later visit them to check on the performance of the equipment in the field themselves. Finally, the customers are invited to the Deere plant and asked to participate as modifications in the machines are planned.

Organizations need to go to such extremes to discover what their customers truly find important about their products and services. Otherwise, deciding what processes need improvement is no more than educated guesswork. Few do make these efforts, though, even while paying lip service to the importance of the customer's opinions.

Empower employees

A principle of the quality movement that perhaps is more opposed to traditional management philosophies is the notion of empowering employees, giving those "on the line" the authority to suggest improvements and actually make decisions about how to better serve customers. To do this successfully requires changing the paradigm of management. Leaders successful at quality improvement do not see their task as keeping workers in line and assigning blame when something goes

wrong, but rather serving as facilitators responsible for creating an environment in which workers are allowed to excel.

For example, at Hewlett-Packard's Andover plant, where worker suggestions brought about such things as numerous "recycle stations," I happened upon a meeting in which an engineer was discussing with operators of a particular machine a fire that had happened the previous evening. Although the fire had been caused by human error, I was impressed that the discussion was friendly, and that workers clearly felt free to speak up with suggestions about how the fire could have been avoided.

IBM Rochester's Gerry Falkowski perhaps explained the concept of employee empowerment better than anyone else I encountered on my journey. He described it as a process in which organizational leaders learn to change themselves. In a sense, they must "let go" their control of the workplace. Instead of this control, they need to exhibit respect and trust when dealing with their employees, who are in turn encouraged to take risks and make innovations. Lines of communication are opened up; teamwork, rather than antagonism, is fostered.

IBM Rochester, however, does more than talk about empowerment. Its efforts in this area have paid off. For example, the company used to have to undergo long, costly shut-downs while repair specialists prepared for and then fixed equipment in its "clean room," an area that must be kept 10 times cleaner than a hospital operating room since even minute particles could foul up the disks being worked on there. Then a man already working in the clean room suggested that he be trained to repair the equipment in it. No longer does the room need to shut-down while repair specialists put on "clean suits" and otherwise get ready to enter the room. The firm proudly showcases other employees who have made similar cost-saving suggestions. In one case, they claim the ideas of a woman working on the line reduced the costs of producing a particular unit from $80 to $2.

Provide training

IBM Rochester is, in some sense, particularly able to capitalize on employee empowerment, since its work force tends to be highly educated compared to the national average. Perhaps 50 percent of its line workers have at least one year of vocational or technical training beyond high school. Even so, the company engages in extensive training efforts.

Organizations with less educated workers must devote even more resources to training and otherwise provide the tools that will let employees perform in a way that merits the trust and respect they are given.

It is hard, in fact, to put too much emphasis on the role training and education play in quality organizations. At many of them, about five percent of employees' time is spent in these activities. Ford's ALPHA program provides the "cream of the crop" from various units with three years of training. After spending this time working on projects throughout the company, employees take their experiences back to their original unit. Kodak likewise gives special training to excellent employees who then become "Quality Improvement Facilitators" in their original divisions.

BBN, the maker of statistical software, especially emphasizes the notion of "information empowerment," which they describe (sadly, to an educator) as a way to compensate for the declining level of math and science education among American workers. In a nutshell, information empowerment means putting user-friendly computer programs and other tools in the hands of workers who must make decisions based on statistical methods, but might not otherwise have the ability to make the analyses these decisions require.

Modify organization and reward structures

In addition to changing management philosophy and providing training and other necessary tools, reducing organizational bureaucracy and offering proper rewards are other keys for employee empowerment. Bureaucracy leads to too many barriers between leaders and workers and also between different departments within an organization. Reducing the levels of management from 10 or more to about 5 or 6 and using more "cross-functional" teams were key steps in the turnaround at StorageTek, which has perhaps exhibited a greater rate of improvement than any other organization whose efforts I encountered. The firm, which makes such information storage products as disk arrays and tape libraries, filed for Chapter 11 protection in the early 1980s; quality of StorageTek products has now improved so much that representatives of the firm were asked to offer the keynote address at the Juran IMPRO '92 meeting. Baxter also reduced its layers of management in early 1990; workers there seemed to be in favor of the change.

Adequate rewards are simply a necessity to keep employees who have received the training needed to do quality work. Giving workers the opportunity to replace senior people in the organization in the long run provides motivation for them and also helps the firm maintain a "constancy of purpose" that "job-hopping" can counteract. Money, of course, is also a motivator. A worker whose regular salary is only, say, one percent of the compensation received by the corporate CEO is probably not going to have much desire to improve the company performance.

While bonuses and prizes can help spur individual initiative, there is some fear that they also foster competition and thus constrict teamwork. Some experts in continuous process improvement even question whether the presentation of Baldrige Awards really supports needed cooperation and information-sharing among organizations. The Madison Area Quality Improvement Network (MAQIN) -- a model for regional quality organizations that has, in the last five years, seen its staff grow to five full-time members, its membership increase by about 60 percent annually, and attendance at its annual three-day Hunter Conference grow to more than 800 -- urged the state of Wisconsin not to present "mini-Baldrige" awards to firms there, in part because it would have been too difficult to train examiners, but also due to fears of spurring competition. Instead a "Quality Recognition Process" was adopted that requires organizations to share information about their achievements.

On the other hand, some firms do put considerable emphasis on bonuses and prizes. "Baxter Quality Awards" are, in fact, patterned after the Baldrige Awards and are designed to get employees involved in Baxter's quality improvement program. IBM Rochester awards bonuses to cross-functional teams; sometimes these amount to $2,000 for each individual on the team. Some reward structure that strikes a balance between individual initiative and teamwork is probably ideal. Achieving such a balance was, in fact, a key concern expressed when I spoke with Bill Scherkenbach, a student of Ed Deming's who now serves as group director for statistical and process improvement methods at General Motors' Buick-Oldsmobile-Cadillac group.

Reform union-management antagonism

While the emphasis on employee empowerment in quality improvement programs is ultimately designed to improve the position of workers, it should be noted that labor unions founded on a tradition of worker-management antagonism can be hostile to the changes it creates. Before Deming's influence began to be felt at Ford in the early 1980s, unions there would not allow workers to plot points and keep other statistical measures associated with the company's quality control efforts. There is still some resistance to process improvement from "old-line" union workers who only want to "lay so many bricks" each day and are concerned about increasing productivity standards. They also fear the added responsibility that comes from having a voice in the production process; when something goes wrong, it is easier to say, "It's not my job to worry about that." For such workers, union acceptance of quality programs can seem like a case of labor "getting in bed with" management.

Most union workers at Ford and elsewhere, though, have come to accept quality improvement as a long-run necessity if they want their plants to stay open and their jobs to continue; workers I visited with reported that they actually enjoy keeping track of performance levels. In some cases, unions are now actually the driving force behind quality improvement efforts because they see it leads to happier employees. Job satisfaction is, of course, something organizations can and should measure as part of their continuous improvement program. One good metric to look at is absenteeism. At Kodak, for example, employees are absent only about 1.5 percent of the time, indicating they feel pretty good about the company for which they work.

Form partnerships with suppliers

The importance of suppliers in quality programs was dramatically demonstrated when Saturn, an organization designed around the principles of continuous improvement, was forced to recall some of its first cars due to defective seats and anti-freeze that had been supplied to the company. In retrospect, it seems that it should have been expected that it would take a while before a new operation such as this could create "perfect partnerships" with its suppliers and ensure the removal of all the "bugs" from their products. The public does not, however, readily distinguish the

cause of defects and because of these "bugs," Saturn got off to a rather rocky start despite otherwise exemplary efforts.

One of the pioneering companies in ensuring quality from suppliers was Ford. Through its widely imitated Q-101 program, the corporation created a worldwide set of standards that must be satisfied before a firm can win a "Q-One" Award and be a Ford supplier. These standards are applied "in-house" to other Ford operations as well as to other companies. It is Xerox, though, that now claims to have the best supplier base in the United States, getting only about 200 defective parts out of every million it purchases. (This is, however, still about twice as many defectives as the best Japanese companies encounter.) Suppliers here must also go through a certification process and are trained in statistical process control by statisticians within Xerox and from the Rochester Institute of Technology (R.I.T.). Usually, there is only one supplier for each part and there is no incoming inspection of parts from a certified supplier. Suppliers are also asked to participate in the design process, creating a true partnership.

Perhaps the most encouraging evidence of company-supplier partnership encountered during the quality journey was, however, StorageTek's two-day "Supplier Symposium." This was the 4th annual event of its kind, and it attracted about 500 people from approximately 75 companies. By putting on such a well-organized conference, StorageTek demonstrated that it is truly interested in teaching its suppliers the basic quality philosophy and statistical methods. It is hoped that such efforts help company suppliers achieve what is known as "just-in-time delivery," or deliveries arriving at precisely the moment they are needed, thus preventing either costly warehousing or costly delays.

Improve the process

At one particular workshop on engineering design at the StorageTek symposium, there was substantial effort being made to reduce the number of parts in a product. This is taking place throughout companies employing continuous improvement and is consistent with the quality principle of simplifying the process by which goods and services are produced as a means for reducing defects and waste.

The emphasis on optimizing processes has, in quality organizations, to a large extent replaced the notion of final inspection, which is largely a

wasteful activity since one "cannot inspect quality in." Xerox has, for example, now reduced the time it spends on final testing of a $150,000 copier from 24 hours to 8 hours, and is working to cut that time even more. Concentrating on processes also helps keep the focus of improvement efforts away from blaming individuals. "Process improvement" is, in fact, probably a good way to introduce continuous improvement efforts in fields in which there might be a defensive reaction to the notion of "quality improvement." Professionals such as physicians, for example, will usually maintain they are already doing "quality work." They tend to readily acknowledge, however, that the system in which they do their work could be greatly improved.

Ideally, it is a production process as a whole that should be optimized. Often, simplification in one particular area can cause difficulties in other areas. Perhaps most problematic for manufacturing companies are cases in which simplification in design and production ends up creating problems for the ultimate users of the products -- the customers. System engineers at General Motors, for example, emphasize that they consider drivers and cargoes as being parts of their automobile system. When creating cars, they keep considerations like insurability and serviceability in the forefront of their minds; the ease with which customers will be able to change tires or use their vehicles to buy groceries becomes a high priority for certain types of automobiles.

To the extent that components of a system can be isolated, quality companies have engaged in "benchmarking" as a means to try to optimize these components. Benchmarking involves examining the processes at other organizations, both within and outside a particular company's industry, determining what organization does best at each system component and then using the achievements of these organizations as goals to reach and exceed. Xerox, again, was a leader in benchmarking, starting its quality improvement efforts by touring Japanese companies and studying their efforts. To improve its warehousing and distribution processes, for example, Xerox examined the efforts of the catalog retail firm L.L. Bean. Successful benchmarking, of course, requires that other organizations are willing to share information -- the sort of cooperation that could be discouraged by aggressive pursuit of Baldrige or other awards. Motorola's

Bob Galvin displayed what was perhaps the ideal attitude, issuing the commandment: "Thou shall steal (non-proprietary) ideas shamelessly."

Motorola also is notable for setting perhaps the most aggressive "quality" goals: Its "Six Sigma Quality" program, the title of which comes from the mathematical symbol used to represent a standard deviation, was designed to reduce the rate of defects in Motorola products to 3.4 per million by the beginning of 1992. The company did not make it, ending 1991 at a rate of 40 defects per million. The organization did, however, manage to reduce its manufacturing defect rate 150 times during the five-year period starting in January 1987. Motorola's new goals are to reduce defects 10 times every two years and to reduce "cycle time" -- that is, the time it takes a process from start to finish -- in all parts of the company by 10 times in the next five years.

Reducing cycle time is, in fact, seen by many companies as a necessary step to take to keep up with customer desires. Motorola has already managed to significantly cut the amount of time it takes to develop new products and reduced its "patents cycle" from two years to 90 days. IBM Rochester's regular product development cycle of five years was cut in half when the new AS/400 family of mid-range computers was created. Concentrating on reducing manufacturing cycle time also helps eliminate waste and cut costs. Hewlett Packard, through its continuous improvement program, now manages to produce in four hours a printed board circuit that previously required six weeks to complete. Service organizations can also think about cutting cycle time as a way to better satisfy customers. One of the first achievements of Meriter Hospitals quality improvement program was to reduce outpatient registration time.

Think about society

Perhaps one of the happiest results of the concern with quality is that it has brought with it a re-awakening of corporate concern about society. "System thinking" has led to a realization that individual organizations are not somehow independent from the community, nation and planet on which they operate. This was clearly a belief of many of the individuals who founded the companies now engaged in quality improvement efforts -- Kodak founder George Eastman's work developing Rochester, New York, and the duPont family's concern with the Delaware region spring

immediately to mind. It seems throughout too much of the 20th century, though, manufacturing and other large corporations were operating solely for short-term profits, with little regard for their effects on anyone besides top management and stockholders.

Now, however, ethical behavior is a major concern of such figures as Bob Galvin. Quality companies are more and more beginning to realize that long-term profits depend upon being part of a society that produces well-educated and healthy workers and customers. StorageTek executives, for example, were clearly concerned about reading and numerical skills of the U.S. labor force; they estimated that the average American worker operates at about an eighth-grade level, while the average Japanese worker performs about four grades higher. To combat this difference, StorageTek has gotten involved with elementary and secondary schools, as well as the University of Colorado. Xerox is also involved in elementary and secondary schools in addition to its work with the University of Rochester and R.I.T.

Sincere concern about safety and the environment was also repeatedly heard. This is true even (perhaps especially) at a company like DuPont, which has had an outstanding safety record, but admits to having caused environmental problems. Both Hewlett-Packard and IBM Rochester presented changes from chloroflourocarbon (CFC) cleansers to water as part of their continuous improvement efforts. Of course, preventing environmental and health problems aren't strictly altruistic gestures. Ignoring these areas can create real costs for an organizations. By serving society, quality organizations are also serving themselves.

Saturn's quality culture

Serving society is a part of the mission for the new Saturn operations. It is, of course, too early to tell how well the company will do in this area. Generally, however, the company seemed to be as good as any I visited in creating a "quality culture."

Of course, the structure of Saturn's operation demands that top management is involved in continuous improvement efforts and that employee empowerment is a top consideration. The company is organized around "Quality Councils," and the Saturn president and union president jointly serve as leader of the top one. They also meet at least once a month with each of four Functional Quality Councils, which respectively deal with

customers and sales, manufacturing, resources and engineering. These two officials even teach some of the introductory courses on the quality culture. The management structure is quite "flat," with line workers making many of their own decisions as part of a "quality team" of six to 15 people. When additions to a quality team are needed, current team members participate in the interviewing.

It is, all in all, a highly motivated work force inclined towards risk-taking; perhaps 85 percent chose to leave their jobs at other General Motors plants to work at Saturn. Saturn management does, however, strive to ensure that these workers have the tools and knowledge they need to produce quality cars. Workers are required to spend 5 percent of their time -- the equivalent of more than two weeks per year -- in one of more than 20 courses. They take a pre-test and a post-test for each course. Good pre-tests allow workers to "pass out" of a course and thus save wasted training. The post-tests, however, require them to study what they are presented. Team members also take turns serving as the "quality champion" in their group, a position for which special training is received. Clearly a lot of effort was put into planning and creating materials for the training programs, which range from 45-minute videos to three-day seminars. After initial help from faculty members at the University of Tennessee, courses are now for the most part taught by persons within the Saturn operation and include lots of statistics. When on the job, workers are asked to plot points and keep other statistical measures. They are rewarded through salaries; there are no time clocks at Saturn. Nevertheless, people have tended to work longer than expected.

Saturn was initiated after a huge benchmarking effort that continues. The company makes only a few models of cars (design work was actually done in Detroit) and concentrates on making them well. Respect for statistical methods -- an important aspect of quality programs -- is also evident here; statistician Phil Ross serves as a "trouble shooter," and is used to help resolve quality issues in many parts of the plant. In addition, it should be noted also that Saturn looks not only at automobile production, but also such activities as training and human resources as processes, and strives to continually improve them. The company does not get involved in activities and businesses that are not seen as being part of its mission. Saturn, for example, hires outside firms for housekeeping, security and food

services. There is, all in all, a definite commitment to quality at Saturn. Unless those of us championing the principles of quality management have been completely off-base, the company should eventually become known for making very good cars.

Quality does not happen overnight

It is true that there have been some initial glitches at Saturn. Problems with suppliers were mentioned earlier. People there also kidded about producing "Mary Kay" cars: In one instance, they had been painting cars red, then tried to switch to white. The red paint did not, however, get turned off entirely and pink cars resulted.

Such events do not, however, contradict quality principles. In fact, they simply confirm the one principle that was absolutely proved on my journey: Quality does not happen overnight. Even though some companies have made great strides, there is still a long way to go. Those who lead organizations with continuous process improvement programs readily admit this. While speaking at the StorageTek supplier symposium to company executives who knew something about the quality philosophy, I asked those in attendance to subjectively rate their continuous improvement efforts on a scale from 1 to 5. Even though StorageTek officials -- their customers -- were in attendance and could see how they rated themselves, the median score given was 2.25. Those I spoke to who had just finished attending a three-week course in quality improvement and basic statistical methods at the University of Tennessee gave their companies -- which had enough interest in quality to fund their training -- a median score of 1.25. One individual wanted to give his firm a zero. Even after I told him the lowest rating he could get was a one, he insisted that his company was at zero.

I personally would not rate a typical U.S. company much higher than 1.25, although most of those firms I encountered on my journey I would put in the 3.25-4.25 range. Even at these good companies, there is unevenness and too much non-value added activity. Because it is easier to "fire" another company than it is to make real change in one's own organization, some companies remain much tougher on external suppliers than they are on other divisions of their own firm. An official at one company with a very developed quality improvement program confided to me that 25 percent of the work done there still was on activities that did nothing to improve the

company's products or services. I told that figure to an official at another organization, also with an organization-wide policy of continuous improvement, and he said the percentage of non-value added activities was even greater there.

I hate to pick on any one company, but the situation at General Motor's AC Rochester components plant is, I think, instructive. The factory is led by Ron McCoy, a strong Deming supporter and former leader in the Iowa Quality Coalition who was extremely successful at a Sioux City, Iowa, plant of about 300 employees. After arriving in Rochester two years ago, he started a Deming Users group composed of representatives from the 10 largest companies in the area. Under his direction, the plant, which changed from making carburetors to fuel injection systems and components during the last decade, is an extremely clean, smoke-free environment. Machine operators take their own measurements and presumably suggest actions when things get out of control.

There does, however, seem to be wasted effort: Parts come from suppliers in different trays than the ones used in the factory, so unloading and re-loading must take place. The sheer number of different fuel injection models produced would also seem to lead to extra costs; it would probably make more sense to make a few very good models that could fit all General Motors cars. McCoy's biggest obstacle, however, is a union agreement that created a "job bank" for hourly employees whose jobs would otherwise be eliminated by new technology. Because of the change from carburetion to fuel injection, about 600 of the AC Rochester plant's 3,300 hourly employees were in the job bank at the time of my visit. Some were being retrained, but others were being paid by General Motors simply to do work for community service organizations or stay home. The United Way of Greater Rochester alone was benefitting from the efforts of almost 100 hourly employees from the AC Rochester plant. Throughout General Motors, perhaps 6 percent of the work force was in these job banks. The cost of paying these people with little value added in return simply must be passed on to the customer. In the long run, this benefits nobody; if the plant cannot be competitive, it will not long survive.

"Job security without a method to reemploy does present a dilemma," states McCoy. "A company must have employee participation to build quality and reduce cost, but the company must also insure the employees

that they will not suffer personal loss if they participate. In today's competitive environment, there is no easy answer."

Generally speaking, laying off workers (or, to keep up with the current term, "downsizing") should not be the first option looked at when trying to optimize processes. A community or society with lots of people who want to work but can't find jobs tends not to be a quality environment. Furthermore, an organization can lose lots of talent by cutting back its work force. When DuPont, for example, recently cut back its work force, three excellent statisticians -- Don Marquardt, Ron Snee and Jim Lucas -- chose to retire early; they were important parts of its continuous improvement efforts. Presenting lay-offs as part of a process improvement effort also creates a link in people's minds between quality programs and recessionary times; it can make quality improvement seem like a short-term fix with which people are likely to become disenchanted before long-term goals can be achieved. At some point, however, the goal of eliminating wasted effort might indeed require downsizing. If this is the case, organizations must be allowed to make those needed cuts.

Improving the use of statisticians

Of course, as a statistician, the area in which I saw the most room for improvement in quality programs I encountered was in the use of statisticians and statistical methods. While certainly all workers do not need to have doctorates in statistics for a continuous improvement program to succeed, they should appreciate elements of the scientific method in problem-solving and be able to use data to make basic decisions. In the words of the University of Chicago's Harry Roberts: "TQM comprises much more than statistics, but without statistics, TQM can be a lot of smoke and mirrors."

There are, however, barriers that organizations (including such quality environments as Xerox, AT&T and the National Institute of Standards and Technology) must overcome to get even engineers and scientists to see the need for statistical methods. The only use some seem to have for statisticians is to get them to "sprinkle holy water" on their data. I regret to say that the lack of respect shown statisticians is, in some respects, the fault of the statisticians (and their instructors) who have emphasized

becoming experts in "technical skills" more than "people skills." When making presentations, for example, many will forget the "KISS" principle: "Keep It Simple, Statistician." Instead of just presenting the result and offering advice based on the findings, statisticians will attempt to "show off" their statistical "know how," even when managers and executives cannot be expected to understand the details behind the findings.

Teaching statistical thinking

It is, perhaps, this lack of people skills that also prevents statisticians from having the role in training that they ideally should have. It is, for example, probably best to have a statistician (or at least someone who has demonstrated competence using statistical methods) teach what are know as the "seven basic statistical tools" -- flow diagrams, cause-and-effect charts, Pareto charts, histograms, run charts, scatterplots and Shewhart control charts -- to all employees. Some organizations have had success with self-paced courses; Xerox's New Build Operations plant, for example, has a 16-hour self-paced course in statistical methods that most salaried employees take. Having a "master teacher," as Deming suggests, is, however, generally a good way to avoid the information distortion that often can result from "trickle-down teaching," or having one level of trainers train another, who train another, and so on until the front-line employees are reached.

It is also probably preferable to have "in-house" people be such master teachers. While outside experts can sometimes get people started in a new direction, the field of quality consultants also includes a number of "hacks" and charlatans. Even good outside consultants, however, would not have enough knowledge of the organization's activities to know exactly what training is needed at a particular time. Training that does not cover the *right topics* in the *right amount* at just the *right time* tends to be a waste -- a no-value added activity for both the employees and the instructors.

Getting relevant data

In addition to training, statisticians should serve the vital role of ensuring that quality data is being used in continuous improvement programs. It is vital to use metrics that measure well the areas in which improvement is sought. In some organizations, much more data could be collected.

At the National Forum of Quality Improvement in Health Care, many metrics that could be used more to improve service in health care institutions were discussed. Data could, for example, be gathered on such items as the rate of errors in billing and in the admission process; the number of incorrect scheduling times and delays or cancellations in operations; the waiting time in clinical departments and the emergency room; the length of stay for various problems; the number of late food trays and bed sores; the rates of infection and errors in medication; the turn-around time for lab reports, medication orders and X-rays; the cost-effectiveness of different competing treatments; C-section rates; and also the mortality rates for certain surgeries.

Certainly, in many cases, hospitals are already keeping records of such items. Generally, however, health care organizations are somewhat behind major manufacturing companies with their quality improvement programs. One exception is the Mayo Clinic, which has used many total quality management techniques for years. I was particularly impressed with how Mayo, which is administered by physicians, takes a "system approach" to its operations. While on the subject of continuous improvement programs at hospitals, I might also mention the efforts of the University of Iowa Hospitals and Clinics, where I have spoken with many doctors, nurses and administrators. Iowa now has six trained quality facilitators in the hospital area, one of whom is assigned to each of the hospital's improvement projects. By the end of 1992, there will be about 12 such improvement projects under consideration.

It should probably also be noted that, in some cases, manufacturing companies could take more measurements as well -- particularly on the "business side" of the organization. IBM Rochester was one operation that clearly made good use of surveys to determine the major complaints of customers. People at AT&T also suggested some "capture-recapture" surveys that could be used to estimate the number of complaints in each category.

In the words of Bob Galvin, "You cannot have too much relevant data." There can, however, be much wasted effort collecting irrelevant data "just-in-case" it is needed. In several organizations I visited, data is gathered that is simply "reported to the file," where it sits forever. Data

that is truly worth collecting should be statistically summarized and stored so it can be used in an appropriate manner.

Using advanced statistical methods

While changing the culture of an organization and using the basic seven statistical tools can get most of the "low-hanging apples" that need to be "picked" for quality to improve, eventually advanced statistical techniques will be needed to design the experiments that can create continual improvement. Statisticians ideally should be helping foster an environment in which engineers and scientists can and do engage in this sort of experimentation.

Walter Liggett of the National Institute of Standards and Technology noted that he worked in Japan for a year and engineers there "experiment, experiment, experiment." This is in part due to the influence of Genichi Taguchi, the Japanese engineer who popularized using design of experiments. While most American statisticians recognize that there are often designs better than those Taguchi suggested, because of the popularity of his name, many, such as Robert Arnold at Hewlett Packard and Phil Ross at Saturn, teach the so-called "Taguchi methods." I believe they are correct to do so, as long as they note the positives and negatives in both his and other systems.

Perhaps the best use of advanced statistical methods came in companies, such as AT&T, Kodak, DuPont and Baxter, that had research groups involving statisticians. I was impressed by how large some of the data sets these companies worked with were. Good solutions to important problems using response surfaces, in particular, were found at Baxter and DuPont. At DuPont's Medical Products Glasgow plant, I saw an engineer -- with the help of Tom Short and Paul Schiffelbeim -- use design of experiments to help establish a response surface that solved a problem concerning the peel strength of a plastic container. At Kodak, Chuck Heckler made good use of multivariate techniques involving partial least squares and principal components (one in which p = 105 measurements were reduced to 15). Since most engineers (and maybe statisticians as well) have a hard time understanding more than five factor designs, Kodak's Craig Van Nostrand had "sewed" several together to create "Frankenstein designs." I remember one: $3^{4-2}4^{2-1}5^{2-1}$ = 180 experiments.

Many of these statistical research groups will "charge" other company divisions for their services as if they were an outside consulting firm. This helps demonstrate the value of what they do and also makes it easy to add statisticians if there is a big demand for their statistical services. (Of course, a lack of demand would lead to cuts.)

While it should be clear that I thought Motorola's quality operations were generally very admirable, the study of the use of advanced statistical techniques at its Six Sigma Research Institute was not what I expected. Funding, some of which came from other companies, seemed to be minimal, making it difficult for the fine statisticians working there. I did, however, get an explanation of how the "six sigma" name translates to 3.4 defects per million. One would think that if $\mu \pm 6\sigma$ is within specifications, there should be less than 2 defects per billion. Motorola, however, allows for μ to shift as much as 1.5σ from the target, so it could be 4.5σ from one specification limit and 7.5σ from the other. This does result in 3.4 defects per million. (The C_{pk}, incidentally, would be at least 1.5.) While not translating defects per million into sigma might seem easier, as a statistician, I am delighted with the fact that Motorola found the term "sigma" appealing.

Ford Romeo's respect for statistics

The operation that perhaps most impressed me with the way it had generally integrated its statisticians into its overall efforts was probably Ford's extremely clean 4.7-liter engine plant at Romeo. Ford's Romeo plant is, in fact, in many ways an exemplary quality operation. It appeared very much to be a democratic organization, with no special privileges for management such as reserved parking. All employees wore "uniforms" -- there were no neckties -- and ate in the same place.

The problems being worked on at the Romeo plant also seemed to be designed to increase customer satisfaction. Because of the annoyance car owners experience when fan belts break, they were trying to improve the fan belt mountings and angles in a way that would make them last at least 100,000 miles. Efforts had also been made to work with suppliers on packaging, so that repackaging of incoming items was unnecessary. There was also no need for incoming inspection, since suppliers had been certified

as makers of quality products. Instead, the parts would simply be delivered to the appropriate team, which would report even one defect back to the supplier. Thought had been devoted to the manufacturing process as well, and only one size of bearing was used here, rather than the five sizes that are commonly used elsewhere in the industry.

There is a total of about 850 employees at Ford Romeo. None have doctorates in statistics, but three of them have master's degrees in the subject. (At many organizations I encountered on my journey, there is less than one statistician for every 1,000 employees.) The employees were divided into roughly 20 teams and a statistician was assigned to almost all of these teams. As I walked around with the two statisticians, Dick Rockey and Karen Jacobsen, who served as my hosts, they were greeted in a friendly way by the other employees. It was clear that the statisticians are respected here.

Most employees have taken some basic statistical training. The statisticians teach a basic quality culture course on the ideas of Deming, Juran and others and a course on the seven basic statistical tools. They also conduct two-hour one-on-one refresher courses on basic statistical ideas for key persons, using data from that person's department.

There was, in fact, a great deal of data collected. Statisticians were involved in deciding what and how to measure, and how best to summarize the findings. Many of the measurements were taken automatically, and summaries could be called up on computer terminals known as "white phones" that were throughout the plant. Control was exercised over the environment under which the measurements were taken. In one case, the robot taking measurements was mounted on a slab separated from the floor so that it was in the proper position and would not be influenced by the temperature of the room. There were substantial statistical efforts to reduce variability by going "upstream" in the process. In particular, they were trying to make parts more robust, not only to environmental changes but also to the variability in other parts.

In most cases, the statisticians worked with engineers to create realistic specifications. This, of course, is critical in computing meaningful values of C_{pk}, a statistic used a lot in industry. At Ford's Romeo plant, C_{pk}, computed only when the process is in statistical control, is required to be at least 2 or the process is investigated. In one instance I saw, the C_{pk}

value was not computed because the process was "out of control." Actually, the parts were well within specifications, but, because of wear, there had been a drift of the mean, resulting in relatively low R values, an unusually small estimate of the standard deviation and thus tight control limits. Accordingly, they constructed a special rule suggesting a tool change if the mean would get about four standard deviations from the appropriate specifications.

Even here at Ford Romeo, though, they were using many univariate tests when there were opportunities to use some multivariate tests. This situation was, however, at least recognized by the statisticians there and they were exploring the use of multivariate statistics in certain situations in the future.

Improving statistical education for quality programs

Centers and institutes

Perhaps the greatest efforts to improve the use of statistics and statisticians in continuous improvement efforts are taking place at universities with special programs dealing with quality concerns. Many of these programs, such as MIT's five-year-old Leaders in Manufacturing, have had great support from industry. The Institute for Improvement in Quality and Productivity at the University of Waterloo has had enough support from the Southern Ontario industries to employ about five full-time people, including the director. Oakland University's Applied Statistics Program has established strong relationships with both Ford and General Motors, each of which is headquartered about an hour's drive away.

The recession has, however, caused fear that there will be a reduction in this kind of support in the next few years. Instead, more is needed, especially support that would provide the internships that are such super experiences for students. Oakland University now provides excellent training for its master's students through up to 16 half-time internships at Ford. One of the strongest elements of MIT's program is that students -- usually with undergraduate engineering degrees -- trying to earn full-time two-year double master's degrees in engineering and business do six-month internships at one of the companies involved, which results in a thesis that must be acceptable to both the engineering and business colleges.

Such institutes also provide excellent opportunities for academic research in quality improvement, which is, of course, why they are connected with universities. At the Center for Quality and Productivity Improvement at the University of Wisconsin, for example, strong relationships have been established with groups such as AT&T Bell Laboratories. Waterloo's Department of Statistics and Actuarial Science faculty members also have done some excellent research in statistical methods associated with quality improvement, in addition to teaching courses and consulting for the institute there.

The program that is perhaps closest to being in an ideal situation, though, is the Institutes for Productivity through Quality at the University of Tennessee. Tennessee has a fine set of eight courses that they can offer to industry, including the Three-Week Institute, which covers such topics as basic statistics, Shewhart control charts, components of variance, statistical tolerancing and correlation. Also of statistical interest is the Design of Experiments Institute, which also is three weeks long. For each of these two courses, participants alternate a week at Tennessee with a month at their organization, where they are expected to work on projects. Tennessee faculty members practice what they preach and are always striving to improve the courses.

There could, however, be problems associated with such institutes. For example, since frequently those faculty members participating in institute activities would earn extra financial rewards, there could be jealousies and barriers created between participating and non-participating members of the departments involved. Ideally, work at an institute should be considered part of the "team activity" of a statistics department, which some individuals are assigned to because they are better at it, while others may be better at research, advising and teaching courses for regular students. If institute duties are thus considered part of faculty members' regular loads, then money they earn through an institute could properly be used to help cover their regular salaries.

There is also the question of whether work in an institute or center should count for promotion and tenure within the university. If part of a faculty members' regular load, clearly it should. Young faculty members at Oakland University have, however, been denied promotion and tenure a number of times, no matter how good they have been for the institute there.

Until the reward system at universities is changed, such non-tenured faculty members must be "protected" from institute activities other than research related to quality improvement.

In addition, there is a great deal of stress placed on institute directors, who must find financial commitments, respond to the demands of those supporting industries, satisfy the requirements of the university and at the same time work to keep good faculty members. During the last year, in fact, three of the institutes I visited had directors resigned their positions: Bill Hill of Wisconsin, Harvey Arnold of Oakland and Jock MacKay of Waterloo.

In this time of industrial downsizing, such institutes might do well to find directors from industry. There would seem to be a few excellent candidates who are between the ages of 50 and 60 and have established outstanding research records. Of course, getting a director from industry would not always work out. Bill Hill, who became director at Wisconsin following the retirement of George Box and death of Bill Hunter, would have seemed such a perfect candidate. His resignation leaves only two outstanding but non-tenured assistant professors as center mainstays there.

Redesigning university curricula

While such institutions and centers can make great headway in quality improvement research and help those already working in industry, it is still up to traditional colleges and universities to provide training for the bulk of those individuals who will be bringing statistical expertise to quality improvement efforts. I had super discussions about university curricula with many persons I met on my journey, including Carl Munro of DuPont, Ron McCoy at the AC Rochester plant and Jeff Hooper of AT&T. There was generally dissatisfaction with the education students were receiving from statistics departments. Most of the criticism was similar to that of Art Fornari, a plant manager at Xerox, who offered this challenge: "Teach the real world."

A particular criticism of university statistics programs was that students rarely take part in projects from the beginning to the end. They never get to see the messy part of deciding what to measure and how to measure it. They never deal with the problem of missing data, nor do they usually make final presentations once the data has been analyzed.

Students need to get involved in experiments. Even simple experiments that involve changing a number of factors, such as making the paper helicopters with the longest hang time or projectiles that shoot farthest from toy catapults, can be extremely useful teaching devices.

Students need to do more of the sort of consulting activity advocated by Doug Zahn of Florida State University and Jim Boen of the University of Minnesota. More effort should also be devoted to arranging internships. These activities would presumably not only expose students to projects, but also help them develop their "people skills." As I visited various organizations, communication skills -- speaking, report-writing and even body language -- were continually stressed. Most often, a B student skilled in these areas does better than does the A student who is not. It seems universities sometimes pretend that all of its doctoral students will teach at Berkeley. While one can hope a few will, it is good to remember that most will serve either at liberal arts colleges or in business or government work. Mentoring must therefore be done in "people skills" as well as technical skills and research.

Another way in which universities could better teach the "real world" would be to put more emphasis on computers and computer research and prepare students more for the huge and messy data sets they could confront in industry. More attention could also be paid to statistical graphics, such as "S" from AT&T Bell Laboratories. Survey techniques could also be stressed more. How many programs really prepare students for running blind external surveys such as IBM uses to compare its products with competitors, or the sampling of internal measurements the company uses to ensure customers' expectations are being met? What book explains that a survey with a dollar enclosed is much more likely to be returned than one without one?

Ideally, universities will move from method-oriented courses to problem-oriented ones as much as possible. After talking with those in the field, I suggest the following first-year curriculum for incoming master's students who have had a little probability and statistics (they would know, for instance, that a sample mean has an approximate normal distribution) and want to be professional statisticians: a probability/mathematical statistics sequence; applied statistics courses (regression and design of experiments, listing the positives and negatives of the "Taguchi methods" in

the latter); "appreciation of statistical thinking" courses; and, if possible, an internship for the summer.

While the first two sequences are rather standard courses that most departments offer, the "appreciation of statistical thinking" courses would be more novel. Almost everyone I talked to, though, wanted something like this. The University of Iowa plans to begin presenting a modification of such a course in the fall of 1993. The first two sequences would be corequisites to allow some integration of what is being taught in the other courses. Topics, presented in roughly this order, would include collecting data (sampling surveys, design of experiments); understanding variation (time sequences, etc.); the quality culture (philosophies of Deming, Juran and others); the concept of quality teams; the basic seven statistical tools; variability concepts such as common and special causes; the scientific method; the importance of prediction; more graphical methods (Q-Q, plots, digidots, back-to-back stem-and-leaf displays, etc.); communication and people skills; working on projects from beginning to the end; case studies of important problems; time series (exponential weighted moving averages); use of computers and appropriate software; basic multivariate analysis; messy and large data sets; more on regression (response surfaces, problems in nonlinear regression, etc.); topics in reliability; non-normal data (particularly discrete type with support like {1,2,3,4,5}); and basic stochastic processes.

Using quality management in universities

Of course, ideally universities should teach total quality management in part by using it. Many universities, including MIT, Wisconsin, Purdue, Michigan, Clemson and Georgia Tech, have, in fact, started quality improvement programs, usually during the last five years. Frequently the concentration has been on the administrative side. Oregon State, for example, is working on improvements in such areas as its physical plant and registration.

Incentives are now building to use total quality management to improve what goes on in the classrooms as well. The University Challenge, which was first proposed by Motorola's Bob Galvin, but later was also supported by Xerox, IBM, Milliken and Procter and Gamble, was an attempt to improve colleges of business and engineering. Each of the participating

organizations invited 50 engineering and 50 business faculty members to their companies to participate in a week-long course earlier this year for the purposes of teaching them the principles of total quality management. Although the initial reviews of these programs have been mixed, business faculty members seem to have generally responded well to them.

Universities looking for inspiration in starting total quality management programs could look at the activity at smaller universities and colleges, as well as elementary and secondary schools, where some efforts are generally farther along, perhaps in part because faculty members at these schools do not face the same sort of research pressure as do those at large universities. Samford University in Birmingham, Alabama, and Fox Valley Technical College in Appleton, Wisconsin, stand out among many small institutes of higher learning engaging in such efforts.

Mt. Edgecumbe in Sitka, Alaska, is probably the high school best known for instituting total quality management. David Langford, with the support of superintendent Larrae Rocheleau, started the program after hearing Deming speak. The customers there -- students -- engaged in discussions about how to improve classwork, then a quality team composed of administrators, teachers, students and parents started making changes. One decision reached was to go from seven 50-minute periods to four 90-minute periods each day to allow more in-depth study and activities.

Such activities not only should be studied, they need to be encouraged. Industry and government must help improve the education and training average workers get before leaving school so that they are prepared for the "high tech" positions that must replace the jobs now shifting to workers in other countries. Instituting total quality management would help lift pre-college education from its current mediocre state. University statistics departments could pitch in as well. A lab course featuring the American Statistical Association's quantitative literacy material could, for example, be offered to those studying math education.

Efforts at the University of Iowa

I chaired the department of statistics for 18 years after it was established in 1965, and I agreed to take over again (beginning fall of 1992) only if my faculty members were willing to try total quality management. While I have been talking about total quality management for some time,

this is truthfully my first experience putting the continuous improvement philosophy into practice on an organizational level.

Running a department using the principles of total quality management means change -- really a major transformation -- from standard academic practice. Department members must learn to look at themselves as a team willing to take assignments -- in administration, in teaching, in research and in consulting -- based upon their strengths. They will need to rally around a department mission, aim or vision, which may be something as simple as striving for continuous quality improvement in teaching, research and service.

There must be a focus on the customers of the statistics department, which includes parents, state taxpayers and future employers, including other schools, businesses and government organizations. More efforts must be made by university faculty members to reach out to colleagues in the statistical profession and other fields, college and high school teachers (the suppliers for university statistics departments), those in business and government and the public generally. Our main customers -- the students themselves -- must, however, particularly become a focus. It must be asked: Are they getting what is best for them at this department? Attempts must be made to find out more about the whole student and what his or her needs are.

One struggle of instituting total quality management at a university department is that it requires getting administration to reconsider its reward structure for faculty members. Activities suggested above take time, and the present reward structure simply does not place much weight on them. The reward structure simply must encourage a better balance among research, teaching and service. Unfortunately, when questions of tenure, promotion and raises now arise, the greatest emphasis is put on research the individual has done. Research is clearly necessary; fellow scholars are among the customers that statistics departments need to be serving. It must be questioned, however, if the current system, which requires that young faculty members in particular get practically anything they can published, really serves those in the community of scholars or simply lowers the average of the quality of articles and books that are published.

Instituting quality management in teaching

Reorganizing a department structure and university reward system around total quality management principles will not, however, be sufficient to create continuous improvement in statistics programs. Quality improvement techniques must also be applied to what takes place within the statistics classrooms. Teaching methods must be improved; video-taping instructors and especially teaching assistants, for example, can help demonstrate to them how they appear to their students. Courses must be planned with a mission in mind; instructors need to focus on what students will need to remember a year after the course is over.

Teachers usually underestimate difficulties students are having and overestimate their understanding. One way to try to correct this is to form "quality improvement teams" made up of students. Iowa actually has already used such teams for some of its large statistics lecture courses. These teams, consisting of six to eight student volunteers, meet once a week with the course instructor. The very good suggestions that have resulted since the team concept jelled range from the position of the instructor relative to the overhead projector to distributing surveys about the difficulty of various topics in the course. One such study uncovered that students were having difficulty with computer instructions; accordingly, the instructors prepared a more detailed handout. It is hoped that after the "appreciation of statistical thinking" courses develop, students who have taken these classes will be active members of quality teams in graduate courses to help instructors improve those classes as well.

In my own classes, I have tried to improve my teaching by using a version of the "minute paper" suggested by Fred Mosteller of Harvard. I hand out six to eight slips of papers to students more or less at random at the beginning of each class period. Each student selected is then asked to record during the last minute of class what they think was the most important thing discussed that period, what was the "muddiest" topic to them, what they want to know more about and any other thing that would help me in my teaching (if, for example, I was blocking the board or spitting on the front row). Once trust is built with students and they realize the instructor cares about them and they won't be penalized for their comments, some very helpful suggestions result. Often I realize I did not do a good job explaining certain topics and I return to them at the beginning of the next period. It is a great immediate feedback device -- clearly much

better than an evaluation at the end of the semester -- that improves communication between the instructor and students.

Instructors can also encourage students to improve their performance, so that teacher-student meetings are not "non-value added" activities. While I encourage students to come and see me, I do ask them to plot and grade the number of study hours that they have spent on my course between sessions. They must show me this run chart before we talk.

Starting quality improvement

The quality improvement steps being taken at Iowa will not, of course, work for every statistics department, just as a particular company's efforts must be adapted by other organizations to fit their particular needs, leaders and culture. If I had to select one guide to follow, it would be Joiner Associates' **Team Handbook**, for which Peter Scholtes was the major author. This guide stresses Deming's ideas, including his philosophy about understanding variation and optimizing systems, his 14 points, the basic seven statistical tools and using a scientific approach based on data. There is not, however, any particular book or "quality guru" that is unequivocally the best source on continuous improvement efforts. Being a statistician probably makes me lean toward Deming, but other approaches suit those with different inclinations.

It was, in fact, Juran's IMPRO '91, especially two days following the meeting in which Joseph Juran and Blan Godfrey reviewed Juran's excellent guide for getting started on continuous improvement programs, **Making Quality Happen**, that inspired me to sketch my own outline for beginning total quality management:

The first step is to *decide*. Form a vision to be world-class in a very competitive market. Recognize that this will no doubt require change and a new organizational paradigm.

Next, one must *prepare*. Identify external and internal customers and obtain feedback from them. Educate top management and a quality council, perhaps by employing a tested quality professional. Define the mission and aim, and stick with these in the long run. Train a few quality facilitators. Keep no secrets; announce the quality improvement plan to the organization.

Then, make a *start*. Do a small pilot project or two, having an appropriate leader, quality facilitator and team with each. Learn from them and then tackle one or two real important projects that have a good chance of success.

From here, one can *expand*. Involve more people in total quality management training, presenting the right topics in the right amount at the right time. Tackle more projects with adequate leaders, facilitators and teams. Don't be discouraged about the lack of quick results because the time it takes for real improvement is usually underestimated. Find ways to keep the momentum going.

Personal quality improvement

Someone seeking immediate results in a quality improvement program might think about her or his personal life, keeping in mind Bob Galvin's comment about quality being "very personal." People can establish visions, aims, missions for themselves. They can immediately start collecting personal data and discover what "defects" regularly impede them from moving toward their vision. They can then work to continually reduce these personal defects.

I picked up this idea of a "personal quality checklist" from Harry Roberts, who claims it originated with Bernie Segesketter of AT&T. I record seven things on that list that I should or should not do each day. I plot the total defects each week. While I still record defects -- mostly I eat too much or the wrong things -- I have indeed improved since beginning early in 1992. At that time, I had 12 to 18 defects per week, now I am down to 0 to 6.

The real important thing about the personal quality checklist is that it reminds me to strive for improvement each day: Continue to have a vision; earn trust; have integrity and keep promises; work to empower others; become a listener (something that is hard for me to do); and be a leader. In other words, it reminds me that even though my trip to organizations practicing continuous process improvement long ago finished, my own quality journey is far from over.