Selected Paper
Number 65

Quality and Productivity: Implications for Management

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Versions of this paper have been given before GSB alumni groups, including the Alumni Association Board of Directors, as well as the Council on the Graduate School of Business and the Chicago chapter of the ASA.

Quality and Productivity

Introduction and Summary

When the potential contributions of statistics to management are recognized at all, they are viewed as limited and specialized. Some companies, however, are beginning to see that statistics can contribute broadly to management activities, both as a way of thinking about management problems and as a set of tools for more effective management. The key to this changing perspective lies in the blending of ideas about organizational behavior with an area of statistics known as statistical quality control. As a result, a new management philosophy often called "quality and productivity" is emerging. My aim is to explain the philosophy and to assess its practical implications both for businesses and for business schools.

The Deming Story and the Japanese Connection

Almost everyone is aware not only of the success of Japanese companies in a number of highly visible industries where Americans have traditionally been strong but of the increasing emphasis on quality by a number of large American companies. Relatively few people are familiar with the name of W. Edwards Deming, a statistician who is connected with both these developments. But managers in industries faced with Japanese competition-for example, automobile manufacturers and their suppliers-know Deming's name very well.

I myself had known Ed Deming for many years as a leading expert in the design of probability samples for business applications without being aware of his contributions since World War II in the area of statistics that is coming to be called “quality and productivity.” Only a few years ago did I learn that Deming had delivered a series of lectures on statistical quality control in Japan starting in 1950--including a talk to heads of many large companies-that have had a remarkable impact: the Japanese now give Deming a substantial share of the credit for their economic growth since 1750. The Deming Prize for outstanding contributions to quality is awarded annually in Japan and is eagerly sought by leading Japanese companies. Deming is the first American to be awarded the prestigious Emperor’s Second Order Medal of the Sacred Treasure. Another American awarded this medal, interestingly, is Joseph M. Juran, also an expert in quality control who helped the Japanese in the 1750s.

Statistical quality control is an American creation. The great pioneer was Walter Shewhart of Bell Laboratories, who made his contributions in the 1920s and 1730s. A young Ed Deming (he and Juran, now both in their 80s, show no signs of slowing down) worked with Shewhart in the late 1730s. In substantial measure due to Deming’s efforts, quality control made an important contribution to American production during World War II and in the immediate postwar years. But just as the Japanese began to bet heavily on quality control and to introduce statistical thinking into the mainstream of the management process, American interest began to subside. In American companies, quality control became increasingly a specialized function, like tax accounting, advertising, legal services, management information systerns, or management science. In Japan, statistical quality control developed into "total quality control" or, in Deming's nomenclature, "quality and productivity."

Reawakening of American interest in quality control can be dated from about 1980 when it had become apparent that Japanese companies were posing a serious competitive challenge to American companies in one industry after another. A number of American companies turned to Deming almost as Britain did to Churchill in 1940. Many sent managers at all levels to Deming's famous four-day seminars. Several companies, most notably the Ford Motor Company, hired Deming as a consultant and have continued to work with him. Many are now working with other quality control experts to try to implement ideas that Deming has advocated for more than a generation.

It is hard to assess the success so far attained in America, but some companies-for example, the Brunswick Corporation of Skokie, Illinois-have clearly done very well. When Jack Reichert took over as CEO of Brunswick in 1982, quality was high on his list of goals and objectives for the company: "Quality-we will either be the highest quality producer in every market we serve or we won't be in that business." Combined with the quality objective were two others: "people" (employees) and "serving customers." And these three are a compressed statement of Deming's philosophy. Reichert dropped earlier goals, such as a two-digit PE ratio and a high bond rating, as explicit company targets.

With important assists from Juran and a consulting group from GE, Reichert concentrated on creating the environment in which the quality objective could be achieved. The technical leader was Walter Breisch, whose organizational base, significantly, was in human resources. In less than two years, positive results were clear, including the results for divisions of the company in markets where the Japanese challenge was strongest. And as a by-product, the earlier goals of a two-digit PE ratio and a high bond rating have also been achieved.

In many other companies, the proponents and opponents of change (the latter often passive rather than active) are locked in a battle whose outcome is still not clear. But remember that the Japanese have a long head start and that Deming and others have warned that the needed transformation takes years rather than months to achieve.

Deming and the Japanese have expanded the purely statistical side of quality control into a broad management philosophy, a philosophy that appears on the surface to be only remotely related to statistics. Yet as Deming points out, only a statistician can fully understand it. For statistics to be applied effectively to management problems, the climate of an organization has to be favorable, and Deming's management philosophy is designed to create a favorable climate. A vivid presentation of this philosophy is to be found in Deming's 1982 book, which is titled, significantly, Quality, *Productivity, and Competitive Position.* (Other references, including Deming's most recent book, *Out of the Crisis,* are given at the end of this paper.)

But not everyone is persuaded by Deming. Some managers stoutly resist the Deming philosophy because of its points of conflict with established American management practice.

Some statisticians feel that, by extending his scope to management philosophy, Deming has departed too far from his technical role and become an advocate rather than a statistician. On this issue I am with Deming. Since I believe that statistics is important only to the extent it is effectively applied, I believe Deming has made an important contribution by drawing attention to the potential contributions of statistics to problems of management and by suggesting concretely how this potential can be realized. The concept of quality and productivity is not a one-man show: many statisticians and others, including engineers, have contributed to its modern development. But Deming is a pioneer in attempting to build a bridge from statistics to management and in working vigorously to make that bridge operational.

To my mind, the Japanese experience provides empirical evidence for the soundness of Deming's ideas. The Japanese seem to be using them, and the ideas seem to work. The second book by Ishikawa on my reading list at the end of this paper gives the Japanese perspective in great detail, and Ishikawa's formulation is remarkably parallel to Deming's.

Of course many factors other than management philosophy and reliance on statistics and statistical thinking have contributed to the Japanese success. For example, many say that cultural differences between Japan and the United States are mainly responsible. But the key evidence is that Japanese have duplicated their success in American plants staffed largely with American personnel, suggesting that there is little danger of spurious assignment of causation to a purely statistical association. The following quotation from an article about the NUMMI plant in Fremont, California, is especially pertinent:

> "... the Japanese are exporting, in highly developed form, ideas the seeds of which were sown by Americans-particularly statistician W. Edwards Deming, who after World War II tried to sell American manufacturers on an integrated statistical approach to quality involving cooperation between management and workers. Rebuffed in this country, he lectured. . in Japan, where he is now a minor national hero. So now these ideas-which at root are simply the universal tenets of good management-have returned in a form that is uniquely Japanese." ("New Toyota-GM Plant Is U.S. Model for Japanese Management," Science, July 18, 1986, p. 276.)

My only quarrel with this report arises in the last sentence's reference to "the universal tenets of good management." As has been pointed out forcefully by Brian Joiner, the Deming ideas conflict both philosophically and practically with the dominant American conception of good management, which is often summed up by the expression, "management by objectives" (MBO). Peter Scholtes has written that this management philosophy is American in origin and dates back to the period before the Civil War. The idea is that management sets objectives and uses sophisticated control techniques to monitor success in attaining these objectives. Employees at all levels in a company are rewarded when they meet their objectives and penalized when they do not.

Management by Objectives versus Continual Improvement

Deming makes two fundamental criticisms of management by objectives:

1. The objectives-such as targets for current earnings, dividend payout, rate of return on investment, sales growth, or market share-are usually short-sighted and arbitrary, even perverse. Attaining such objectives may even defeat the proper long-run goals of a business. Deming describes the long-run goals as constancy of purpose for the improvement of product and service. I believe that Deming is essentially saying that companies should try to maximize long-run profitability, without pretending to know specifically what that long-run maximum will turn out to be.

2. Management by objectives tends to create an organizational climate that is hostile to the rational pursuit of long-run profitability. It encourages an incentive structure that does not reward, and often punishes, the disinterested collection and evaluation of statistical evidence that can be a key to improving long-run profitability. If statistics suggests how improvement is possible, the finding is often interpreted as a criticism of current management, which may result in strong pressure to suppress or distort the evidence. At best, there is infighting within the organization about the appropriate assignment of credit and blame, and this confrontational atmosphere discourages further statistical study. Entrenched management positions thus limit the use of statistics in organizations. One consequence is the slanting of data to make performance look better than it really is. Another is an excessive reliance on intu-

itive judgment without trying to find and study relevant evidence.

The Deming alternative to management by objectives has many names, but I like to call it "continual improvement of processes." Like management by objectives, continual improvement of processes entails the formulation of objectives; but the process of setting and attaining objectives is radically different, as we shall see.

A process is any collection of activities by which specific things get done. Specific business examples are the manufacture of an expansion board for microcomputers, processing of consumer complaints, sending out the checks for a company payroll, or treating patients in the emergency room of a hospital. Notice that a process is not necessarily a manufacturing process. Deming's ideas apply to all areas of a company as well as to service industries like banking or health care.

Companies can be thought of as interrelated collections of specific processes. Deming espouses the continuing attempt to improve processes, and hence overall company performance, and to use statistics effectively in doing so. Statistics is seen as a set of tools and a way of thinking that are useful in improving processes. (Statistics, of course, can play other roles; for example, it is a tool of inquiry in basic scientific research, and it facilitates management tasks, such as forecasting, that are not directly related to process improvement .)

To avoid a possible misunderstanding, I hasten to add that Deming does not advocate a simultaneous attempt to improve all processes at once. Priorities must be set by the "Pareto principle," which means that one aims first at processes for which improvement will make the greatest contribution to overall company profitability.

Since I have found that many people best understand the contrast between management by objectives and continual improvement of processes in personal terms, I turn next to a discussion of personal processes. (If you don't find this helpful, or if my main illustrative example doesn't appeal to you, skip ahead to the next section, "Business Processes.")

Personal Processes

The idea of a process applies at the personal level. Examples are typing, cooking, learning accounting, or managing high blood pressure. I will use illustrations from running, an activity that I personally enjoy and am familiar with. As with many other human activities, common beliefs about ways of improving running performance have little foundation in statistical evaluation of evidence; rather, they are mostly folklore-that is, opinion related to evidence loosely if at all.

High quality in running means fast running. Consider a 64-year-old woman (her name is Algene Williams) who had just been through carotid artery surgery and was told by her physician to take up some form of physical exercise. Since her husband was a runner, she decided that jogging would be a good activity. She began jogging, liked it, and found that she was gradually able to extend her distance and increase the pace. So she began to enter races. In three years she was able to beat her husband, himself an excellent athlete. Now she is 71 and has set a number of national age group records, steadily improving during her six years of running. This is "continual improvement."

Management by objectives would have

required the 64-year-old Algene Williams to set up a plan. The plan might have taken the form of a training schedule, summarized by total miles run per week and elaborated in detailed specifications of daily workouts. It might have indicated how training intensity should be increased through time or reduced as particular races drew near. The plan might also have included specific racing times to be achieved by specified dates. It would have provided for monitoring departures of actual performance from the targets set by the plan, and Algene would have been held responsible for her disappointing races or failure to achieve the targeted training mileage.

A major problem with such plans is that they tend to be formulated in the absence of statistical evidence of the capabilities of the runner in question. Very few females of any age have the natural ability of Algene Williams. Another problem is that the goals themselves may be poorly expressed. For example, total weekly mileage is not necessarily a predictor of race performance; many runners successfully pursue the goal of increased weekly training mileage, but then race slower rather than faster, or get injured and do not race at all. Still another problem is that the plan gives no guidance, beyond slogans and folklore, as to how it is to be carried out. Finally, conformity to the plan does not necessarily imply the best performance. Algene could have sand-bagged by just barely meeting planned racing performances when in fact she could have done much better.

Algene approached running by an unconscious application of statistical principles. She trained, observed how things were going, "listened to her body signals," and modified her training accordingly. In the process, of course, she set interim objectives, but these were based on evidence as to what was attainable. She gradually improved. She had no specific numerical target in mind other than to improve on recent performances as her physical condition permitted. In the beginning Algene had no idea what a high level of performance she would eventually achieve.

As a runner-statistician I might have been able to help her to analyze her past training and racing performance with the aim of making even more rapid improvement, but I think my contribution would have been modest. Algene is her own intuitive statistician, and a good one.

The running illustration has one weakness. An individual's running performance appears to have little relationship to technique, equipment, or special diet (beyond the restraint in caloric intake needed to keep weight low enough to achieve a "lean and mean" appearance). Running performance depends mainly on training, but most of the effects of training are felt only after long lags, which makes difficult the task of statistical study. As a result, the potential contribution of statistics is less dramatic in running than in sports like swimming or golf where technique is important and where apparently minor variations in stroke mechanics can have immediate and major effects on performance. It is then possible to carry out statistically designed experiments to learn efficiently and relatively quickly how to improve technique and thus performance.

Even in running, however, statistical thinking is useful. Let me give two examples.

1. As a college middle-distance runner in the early 1940s--at best slightly above average in natural ability-I learned through informal but careful observation of my performance that, other things being equal, I ran faster races when I sustained approximately the same pace throughout the race-"even splits," in the jargon. The prevalent coaching advice at the time (which has by no means disappeared) was essentially management by objectives: "Go out fast (with a numerical target for the first quarter mile of the race), ease off in the middle of the race (again with specific targets), and sprint at the end."

Many other people have made the same intuitive statistical observation that I did. Over my adult lifetime, the doctrine of even splits has almost become running folklore. It has been noted, for example, that almost all outstanding performances at all distances beyond the sprints (where the first few yards are necessarily slower) have been achieved by holding a nearly constant pace. Many believe that Dave Wottle's dramatic win in the 800 meters at the 1972 Olympics is an exception because he went from last to first place in the final 200 meters. The fact is that Wottle's times for each 200 meters were virtually identical; the rest of the field slowed markedly in the last 200 meters.

2. The current running folklore is that one should drink lots of water during distance races in hot weather. Up to a point, the folklore is sound: it is better to drink lots of water than to do nothing about cooling the body. But by experimentation I have discovered another way of cooling the body that, for me at least, is superior. Instead of drinking water, I dowse myself with it. The cooling effect is immediate; the side effects

of sluggishness and mild nausea are absent. My informal statistical experimentation suggests a significant and substantial performance improvement. Only in races at the marathon distance in very hot weather do I supplement the dowsing with a little drinking. Friends bold enough to try my approach have had similar results.

These examples suggest that statistical thinking provides a way to improve processes by making good use of actual data on performance to predict from past experience. There are also specific statistical tools to help, and many uses of statistics are more systematic than the ones I have sketched. For example, statistically designed experiments are powerful tools for process improvement because they reduce the ambiguity of causal interpretations of data. Control charts are useful for assessing past performance and maintaining surveillance of current performance. Many other statistical tools, some of them extremely simple (such as Ishikawa's cause-and-effect diagram), are also available. It is a mistake to think that only high-powered statistical techniques, known only to statistical specialists, are needed to achieve process improvement.

At times, of course, high-powered techniques are necessary, and there is an important consulting role for highly trained statisticians who can help less-trained people. But often the simple techniques suffice to get the job done.

Business Processes

We have seen that a business organization can be viewed as a collection of interrelated processes and that there is no real distinction between processes in manufacturing and in other areas of business, such as finance, marketing, purchasing, accounting, engineering, and research and development. Improved performance of a business is achievable by improving the component processes. Potentially, statistics provides a systematic and powerful approach to the improvement of processes in all areas of business as well as in nonbusiness organizations such as schools, government agencies, nursing homes, or churches.

Deming believes that piecemeal or episodic application of statistical methods is virtually doomed to failure. At best, it will only slightly prolong the life of a sick organization. Exhortation and slogans, like arbitrary targets and goals, are worse than useless. Complete dedication of top management-and through top management, the entire organization-to continual process improvement is essential.

Deming's Contributions

Deming's fundamental contribution is his perception of the intimate connection between the potential role of statistical methods in management and the organizational environment needed for effective application of statistical methods. This connection distinguishes him both from statisticians who have tried to use statistics effectively in business and from writers on management theory such as Peters and Waterman, authors of *In* Search *of Excellence,* even though their "eight basic principles to stay on top of the heap" strikingly parallel Deming's philosophy.

The Role of Statistics. Deming's stress on statistical methods can be viewed as a significant updating and revision of the scientific management philosophy founded by Frederick C. Taylor. Taylor saw scientific method as a powerful tool for improving processes. But since Taylor's career ended at about the time the career of the great statistician, Ronald A. Fisher, was beginning, Taylor did not know very much about efficient implementation of scientific method, which has been the central contribution of Fisher and the other statisticians (including Shewhart) who have shaped the development of modern statistics. Taylor's scientific study of metal cutting, which extended over much of his career, could have been accomplished in much less time had he known of the ideas of statistical experimentation that Fisher would introduce. By advocating statistics in particular rather than scientific method in general, Deming has played from a stronger position than Taylor's.

Deming's advocacy of involving all employees in the improvement of processes, which is necessary for the effective use of statistics, is antithetical to Taylor's conception of management, which assigns process improvement to specialists. Although this aspect of Deming's philosophy harmonizes with modern developments in behavioral science and organizational behavior (see, for example, Peters and Waterman), Deming apparently reached his insights mainly from personal experience.

As Brian Joiner puts it, scientific method (that is, statistics) cannot be successfully applied in an organization unless the organization is dedicated as "all one team" to the application of statistics to improvement of all processes. Many of Deming's famous "14 Points" of management philosophy deal with one aspect or another of "all one team." Perhaps his key point is "Drive out fear," by which is meant the fear of disapproval, even

Further Insights and Proposals by Deming

Productivity. It is natural for both businessmen and economists to regard quality and productivity as competing goals: higher quality is typically achievable only by increasing costs. For Deming, almost exactly the opposite is true: better quality means better economic results and better business practice. In my judgment, this conclusion is not axiomatic but is widely applicable, for the following reasons.

1. The delayed costs of poor quality-even though not typically measured by accounting systems-are very high. Consider for example the cost to an automobile company of recalling a large numbers of cars to fix a serious quality problem that poses a safety hazard. In addition to the maintenance work (which can fit under category 2 below), there is the disenchantment of customers and potential customers, which hurts future sales. In a private communication, Deming has pointed out that one example of delayed costs is amortization of automated equipment that either does not work at all or turns out defective product.

2. Within a company, a large but invisible component of total cost is "rework" in one form or another--that is, activity that would have been unnecessary if the process had been correctly implemented in the first place. Some examples would be: readjusting a poorly aligned car door, answering consumer complaints, looking for lost items, straightening out the consequences of an incorrect invoice. Tim Fuller of Hewlett-Packard calls such activities "complexity." Fuller has done sampling studies-confirmed

by studies by some of my students in their own companies-suggesting that complexity takes up a very high fraction of the time of managers and workers. Management by objectives may make a company seem to be more productive in the short run but may in fact create needless complexity leading to poorer productivity in the long run. A deadline for shipment of the product may be mer, for example, but subsequent problems with quality, along with consequent consumer disenchantment, may more than offset the promptness of shipment. Hardware and software products for personal computers provide many recent examples.

3. William Golomski points out that in many instances quality improvement is free. By this he means that if foremen and workers are encouraged to aim at continual process improvement, they achieve better quality as a by-product of their normal duties. This is another favorable by-product of “all one team.”

4. A company may reach a point at which further quality improvements of an existing process are uneconomic. At the same time, however, investment in basic process enhancement may pay off economically as a component of a company’s capital budget.

5. The search for continual improvement of quality may serve the very practical purpose of preventing backsliding from high quality levels already achieved.

6. The same statistical tools used to improve quality for given cost can be used to reduce cost for given quality.’

In. Statistics can be thought of as a general tool for improving processes, a tool that can, at least to a degree, be used effectively by everyone in a company. (Statistics is too important to be left to the statisticians!) And statistics, in this sense, does not necessarily require the most sophisticated techniques. For example, simple graphic tools have high value: Pareto charts, cause-and-effect diagrams, flow-charts, checklists, scatter plots, control charts, simple tables, and cross tabulations. Statistical tools of experimental design, though ingenious in conception, can often be implemented by simple arithmetic. The central requirements are reliance on data rather than on hunch and opinion unsupported by data, and application of statistical concepts in obtaining and analyzing appropriate data.

The difficulty in using statistics successfully lies less in the need for sophisticated theory or heavy computation than in defining and measuring important quality characteristics, resisting pressures for meeting deadlines at the expense of obtaining vital information, and organizing and analyzing information collected routinely but then often ignored. Balancing these obstacles to the use of statistics is the realization that we need never take poor quality for granted, and that statistical attacks on poor quality offer hope even when poor quality seems incurable.

In the historical development of quality control, inspection of the final product by specialists was initially the most important activity, and it still plays a limited role. But final inspection does nothing to improve processes. As Deming puts it, the idea of inspection is that "you burn the toast and I'll scrape it." The inspection function is essential, but Deming's aim is for as much inspection as possible to be done by workers as a part of their normal job responsibilities rather than later by inspectors. Ongoing statistical process control (perhaps better described as "process surveillance") can greatly reduce dependence on final inspection.

Process control receives much more emphasis than final inspection in the quality and productivity approach. Increasingly, experimental designs for the improvement of processes-including the process of product design-have become important. In part because of the leadership of Genichi Taguchi, Japanese companies have gone in for experimentation on a very large scale. Perhaps the leading contributor in recent years to the statistical methodology of experimentation has been George Box of the University of Wisconsin.

There are also statistical techniques that contribute indirectly rather than directly to process improvement. For example, good statistical forecasting of sales, prices of raw materials, or broad economic forces may contribute to the improvement of many processes. And techniques of management science, such as linear programming, can be used in certain circumstances to optimize process performance.

Deming stresses that workers should not be blamed for system faults over which they have little or no control. Many quality problems are inherent in the system. Management's responsibility is to improve the system rather than to blame the workers. Workers should be encouraged to contribute to process improvement, not reprimanded for calling problems to the attention of management. One of Deming's famous "14 Points" is, "Remove barriers that stand between the hourly worker and his pride of workmanship." (As an educator, I see-and, I fear, partly share-the tendency to blame students for poor performance when the system confronted by students for a large part of their lives may be the major contributor.)

In Deming's view, the elusive quality of leadership is essential to good management. Managers must not be slick technocrats setting up and relying on computerized control systems; rather, they must combine the roles of teacher and coach. Pursuit of the goal of "all one team" requires much more than the basic disciplines and tools of management traditionally taught in business schools, such as accounting, economics, statistics, and management science. Behavioral science also comes to the fore. Most important, managers at all levels must be dedicated, really dedicated, to improvement of quality.

Education and training for everyone in the organization are strongly stressed in the Deming philosophy. Workers need constructive supervision that will inform them of what their jobs are, rather than leaving this function to happenstance "learning on the job." Middle and top managers need training in quality and productivity.

Technical education-including, in particular, statistics-is not for a few specialists alone but, to the extent practicable, for all members of the organization. The company time allocated to statistical education for individual workers and foremen in Japan is often more than the total time spent by American M.B.A. students on required statistics courses. An American innovation is the ParaStatistician training program being pioneered by Joiner Associates, Inc. This program ties statistical training to applications on the job, also an essential feature of the Japanese approach to education and training.

The Marketing Emphasis. The customer—ultimate or intermediate, inside or outside the company-is supremely important. Quality is ultimately defined by reference to consumer preferences. Since pleasing the customer is of the highest priority, marketing and production are central to the business firm. By contrast, finance is seen as a peripheral support activity.

Accurate information about customers, customer preferences, and customer experience with the product or service is essential. Obtaining this information is one of the most important contributions of statistics.

Not only does the marketing emphasis guide all activities of a company, but marketing processes are susceptible to improvement by statistical tools, including the use of sampling. Processing consumer inquiries or complaints is one good example. Servicing the product after sale is another. Based on my own experience, marketing is another area in which simple statistical tools may have the highest payoff. Thus simple consumer surveys, based on well-designed questionnaires, may be needed more often than some of the high-powered statistical techniques recommended by specialists in marketing research.

Single Sources of Supply. Another of Deming's 14 Points is to "end the practice of awarding business on the basis of the price tag. Instead, depend on meaningful measures of quality, along with price." For statistical reasons that cannot be developed here, there may be great potential gains in quality if a company can buy from a single supplier with whom a close, long-term working relationship can be established. The Ford Motor Company has made substantial progress in reducing multiplicity of suppliers, and the same has been done by many large Japanese companies.

Importance for American Management. Deming and other apostles of quality and productivity see the loss of American competitive position in a number of industries as a national crisis. Here I think they exaggerate. The American economy as a whole continues to perform relatively well in international comparisons. For one thing, in the United States, government regulation and restrictive trade practices appear to be a less serious threat to good economic health than in many foreign countries. Even in manufacturing, the overall American picture is not as bleak as painted.*

Moreover, economic competition does not lead to winners and losers in the same sense as in military competition. The theory of comparative advantage suggests that the faster growth of productivity in one country than in another does not doom the slower country to economic disaster. So long as growth is positive in both countries, both can have improving standards of living. My greatest concern here is that expanded protectionism may erode the scope of comparative advantage.

But for many American industries and companies, the crisis is real. Essentially, a superior technology of management is now available. Any company risks bankruptcy by ignoring the new technology while its competitors are taking advantage of it.

Some Implications for Business Schools. The developments in quality and productivity have caught American business schools off-guard, even more off-guard than American businesses. The academic emphasis of business schools has been on finance. Marketing has received much less attention, and, as William Wecker has pointed out, production is the sick man of the business school world. Business schools still teach little statistical quality control, and general business statistics courses pay little attention to the tools of statistical quality control. The few centers for quality and productivity in American universities do not tend to be found in business schools.

But things may be changing. At a recent conference on "Making Statistics More Effective in Schools of Business" attended by about 130 statisticians interested in business statistics, quality and productivity was a leading theme. There was general consensus that basic courses in statistics should emphasize applications of simple statistical ideas to practical business problems, even before formal mathematical treatment of statistical theory.

I began developing a course on quality and productivity at the Graduate School of Business in 1982. I believe this was the first such offering at Chicago since the late 1940s, when former Dean W. Allen Wallis, a wartime associate of Deming's, taught a quality control course in our evening M.B.A. program. I have a copy of Wallis's notes and have benefited from them in my recent course development. My students at Chicago and I are both enjoying my new course in quality and productivity. The idea of statistics as a tool for improving processes seems to present the subject in a very congenial light for business students.

In some of our elementary statistics courses, ideas of statistical process control and experimentation have been given central billing for many years. Several of our faculty members in business statistics are getting into research on problems arising in quality and productivity. An informal seminar involving faculty members from several fields in the school was organized recently by statistics and management science professors. An M.B.A. concentration in production and quality control has been approved by the faculty. Interest in quality and productivity among M.B.A. students shows evidence of increasing.

It remains to be seen, however, whether Chicago and other business schools will fully develop the new ideas. Enthusiastic statisticians alone cannot do so. As Dean James Hickman of the business school at Wisconsin has pointed out, the main implication of quality and productivity for business school curricula is that statisticians must work with faculty trained in the behavioral sciences, in fields such as organizational development. (The training course for ParaStatisticians pioneered by Joiner Associates, Inc., is jointly taught by statisticians and behavioral scientists.)

In a recent talk, “Pride and Prejudice,“’ Professor John E. Jeuck developed the theme that business schools have done well in teaching the tools used by specialists but less well in identifying and teaching management skills. What is taught about management is more folklore than science. The quality and productivity approach, on the other hand, is much closer to science than to folklore. A better technology of management is on the market, and business schools would be well advised to consider it carefully.

Footnotes

1. For a similar treatment of the issues raised in this section, see Arthur M. Schneiderman, "Optimum Quality Costs and Zero Defects: Are They Contradictory Concepts," *Quality Progress,* November 1986, pp. 28-31, which came to my attention during the preparation of this paper.
2. See, for example, "U.S. Manufacturing? It's Alive and Well," in "The Outlook," *Wall Street Journal,* 23 December 1985.
3. Published as *Selected Paper No. 64.*