

ASQ Statistics Division Newsletter

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Contents

- [Ten Division Members Named Fellows](#)
- [Statistical Education of Engineers Urged For Quality & Productivity Improvement](#)
- [OUTGOING CHAIRMAN'S MESSAGE - 1983-84: A Banner Year for Division](#)
John Ramberg
- [INCOMING CHAIRMAN'S MESSAGE: How Can We Serve You?](#)
Bill Mead
- ['HOW-TO' SERIES NOW CONTAINS SEVEN VOLUMES](#)
- [Wescott Laboratory Dedicated at RIT](#)
- [SQC QUESTIONS, QUERIES, AND QUANDARIES: Two-Stage Nested Designs](#)
- [COUNCILOR SPOTLIGHT: James R. King- Region 1](#)
- [Fall Technical Conference: October 25-26](#)
- [Papers to be Presented at FTC](#)
- [1984-85 Statistics Division Officers](#)

Ten Division Members Named Fellows

Then members of the Statistics Division were honored as fellows of ASQC at the 38th annual Quality Congress in Chicago. Included in this distinguished group is the Division's founding chairman, William G. Hunter.

A list of the ten, along with their citations, follows.

EDWARD M. BAKER--Ford Motor Company

For his work in the field of employee involvement in product quality, and for his unique contributions to inspector motivation and performance, using the concepts of signal detection theory.

ROBERT F. BECHHOFFER--Cornell University

In recognition for his outstanding work on statistical theory, design analysis, and interpretation of experiments and for innovative research in the area of statistical ranking and selection.

ROGER W. BERGER--Iowa State University

For continuing efforts to promote the teaching of quality control in universities, services to sections, divisions, and national technical committees and applications of microcomputers to quality control.

FRANK J. CORCORAN--Singer-Kearfott

For distinguished service to the Society, both locally and nationally, and for promotion of principles of quality costs.

JAMES DEMETRIOU--ITT Avionics

For his many years of outstanding contributions and leadership in promoting the quality control profession through his section activities, teaching, speaking, and interest in the advancement of individual Society members.

RAYFORD E. FELDKAMP--McElrath & Associates

For significant contributions to the Society expressed through leadership at section, division, and national technical committees and for professional competence in promotion of quality and quality management to industry.

WILLIAM G. HUNTER--University of Wisconsin

For distinguished service to the Society as teacher at university level and a renowned international consultant and lecturer on practical methods for improving quality and productivity.

WILLIAM J. LATZKO--W. J. Latzko, Consultant

For his distinguished and unique accomplishments in the advancement of quality control technology and concepts in banking and other financial organizations.

MELVIN L. TURNER--Rockwell International

For continuous and outstanding leadership, dedication, and service to ASQC at section, region, and Society levels; for significant contributions and promotion of reliability and quality engineering educational programs in industry and ASQC; and for the successful implementation of statistical quality control on a world-wide basis in the automotive industry.

JOHN J. WARGO--Jacobs Manufacturing Co.

For contributions to the advancement promotion of the Society through teaching and speaking activities and leadership service at section, regional, and divisional levels of ASQC and for service to government and industry standards.

Statistical Education of Engineers Urged For Quality & Productivity Improvement

American industry can regain its competitive edge over foreign competition by educating its engineers to properly use statistical methods. Such was the consensus of 43 statisticians and engineers from leading universities and American companies who met in Iowa City Iowa, on July 23-25, to discuss ways to meet the quality and productivity challenges of the 1980's.

The subjects of quality, productivity, and competitive position of American industry have been widely reported in the popular press, television, and trade journals. The Japanese have been highly successful in using statistical process and quality control methods to achieve advantages in many product lines. Many of these methods were developed in the United States but, until recently, have not received widespread attention in university and company education programs.

Organized by Dr. Robert V. Hogg from the Department of Statistics and Actuarial Science at the University of Iowa, the conference focused on ways of teaching statistical methods to university engineering students and company engineers. According to Hogg, "We have used these two-and-one-half days of rigorous discussion and workshop sessions to identify the critical areas where statistical education can have the greatest impact on quality and productivity."

Industries represented at the conference included electronics, communications, automotive, oil, and steel. This unique meeting was supported by the University of Iowa, the American Statistical Association, the Statistics Division of ASQC, RCA, Motorola, and the Ellis Ott Foundation.

OUTGOING CHAIRMAN'S MESSAGE 1983-84: A Banner Year for Division

by John Ramberg

1983-84 has been a banner year for the Statistics Division and the quality profession. Highlights of the division's fifth year include:

- Record membership of 4,668, now the second largest division
- Brumbaugh Award to Dr. Ron Snee
- Shewhart Medal to Dr. Ed Schilling
- Outstanding statistical presentations by Division members at the AQC (Mike Flynn's talk was of particular note)
- Sponsorship of a conference on the Statistical Education of Engineers jointly with the American Statistical Association and the Ellis Ott Foundation
- Education programs with the Minnesota and the Akron-Canton Sections
- Cooperation with the Chemical and Process Industries Division on the 1983 and 1984 Annual Fall Technical Conference program
- An outstanding newsletter.

"our Division could best serve... through participation in the statistical education aspect of meetings, conferences, and short courses..."

This year we extensively explored the division's role in statistical quality control education in relation to the role of private consultants, Universities, and other divisions. We concluded that our Division could best serve our membership and, more widely, the quality profession through participation in the statistical education aspect of meetings, conferences, and short courses in cooperation with sections and other divisions rather than establish a separate short course program of our own. Programs developed in this manner during 1983-84 were quite successful and we plan to expand this activity through our regional Councilors and through the development of a speakers' list Contact your Councilor if you would like to participate.

I wish to thank our current officers for their outstanding work. Each will be continuing in a leadership position in 84-85. Treasurer and newsletter editor Ed Mykytka has done an exceptional job. He will continue next year in the same role.

Secretary Pete Jacobs has served as Division liaison with the Chemical Process Industries Division and the American Statistical Association on the Annual Fall Technical Conference, He also arranged the Division's educational program at the Minnesota Section's Annual Conference and prepared the Division's brochure and the AQC display booth. Pete becomes chairman-elect.

Chairman-elect Bill Mead has handled our education program and becomes chairman for 84-85. Ron Askin chaired the Division's AQC program committee and becomes secretary. John Cornell and Sam

Shapiro will continue their excellent work as editors of the "How-to Series."

Many other members have participated in the Division activities. Marilyn Hwan, Region 6 Councillor, has been very active in the Bay Area promoting statistical quality control education. Mike Mazu, Region 8 Councillor, organized the statistical education portion of the Akron-Canton conference.

Planning has already begun for the AQC-Baltimore/85. Lynn Hare is our program chairman and former Division chairman Frank Alt is on the national program committee.

INCOMING CHAIRMAN'S MESSAGE

How Can We Serve You?

by **Bill Mead**

In reading over the initial messages of our five previous division chairmen, I find one recurring theme--Service--mostly in the context of the membership of the Statistics Division serving the Quality Community. Service is the theme of this message also, but with a slight twist.

Each of you had reasons for joining the Statistics Division; each of you had expectations of the Statistics Division. I'd like to know something about those reasons and expectations.

The officers and councilors of the Statistics Division want to be of service to the members, but we need your help. How can we serve you? What do you want the Division to do? What role should the Division fill within and without the ASQC?

It takes a little effort to take pen in hand and answer these questions. Don't forget, though, when you became a member of the Division, you assumed a responsibility. After all, you elected the current officers. Now that you've done it, tell us what you want us to do. Tell us why you joined; tell us what you expected; tell us what the Division can and should do for you and for the greater Quality Community. Take a few minutes--write me a letter. You'll be doing yourself and the Division a service, and, in return, give us a chance to serve. Tell us--we'll pay attention

'HOW-TO' SERIES NOW CONTAINS SEVEN VOLUMES

The ASQC Basic References in Quality Control Statistical Techniques booklet series (often referred to as the "How-to" series currently contains seven volumes in print. The latest three volumes that appeared in 1983 are:

Vol. 5: *How to Run Mixture Experiments for Product Quality*, by John A. Cornell,

Vol. 6: *How to Analyze Reliability Data*, by Wayne Nelson,

Vol. 7: *How and When to Perform Bayesian Acceptance Sampling*, by Tom W. Calvin.

Currently being written are two more volumes, titled *How to Apply Response Surface Methodology*, by John A. Cornell, and *How to Use Regression in Quality Control*, by Douglas Crocker. Each is expected to be in print by the end of this year. (Booklets may be purchased by contacting Sandra Shed at ASQC Headquarters (414) 272-8575. Ordering information and coupons also appear monthly in the Bookmart section of Quality Progress).

Several topics have received considerable attention from the industrial community as being very desirable. They are:

- How to Control Two or More Related Variables
- How to Use Prediction/Tolerance/Confidence Intervals
- How to Design and Analyze Repeated Measurement Experiments
- How to Use Control Charts for Variables
- How to Use Evolutionary Operation (EVOP) Procedures
- How to Use Sequential QC Methods.

The co-editors, John A. Cornell and Samuel S. Shapiro, invite prospective authors to submit their names for undertaking the responsibility of writing booklets on the above topics. Interested individuals will be given prompt consideration. The co-editors may be contacted at the following addresses:

Professor John A. Cornell
Department of Statistics (IFAS)
411 Rolfs Hall
University of Florida
Gainesville, FL 32611
(904) 392-1946

Professor Samuel S. Shapiro Department of Mathematical Sciences
Florida International University
Tamiami Trail
Miami, FL 33199
(305)554-2030

Volume 5: How to Run Mixture Experiments For Product Quality

John A. Cornell

A mixture experiment is performed by mixing together several ingredients. This booklet explains how to choose the proportions of the ingredients to be used in an experiment, how to analyze the data collected from the experimental trials, and how to interpret the results of the analysis. The methods are carefully explained using industrial and biological examples. Basic knowledge of hypothesis testing is needed for some parts of this booklet. A comprehensive set of references is given to allow for further study of the techniques and principles.

T3505 \$5.50

Volume 6: How To Analyze Reliability Data

Wayne Nelson

Almost every major company yearly spends millions of dollars on product reliability. Much management and engineering effort goes into evaluating risks and liabilities, predicting warranty costs, evaluating replacement policies, assessing design changes, identifying causes of failure, and comparing alternate designs, vendors, materials, manufacturing methods, and the like. This volume presents modern methods for extracting from life tests and field data the information needed to make sound decisions. Included in this up-to-date manual are discussion of the basic concepts and theory for product life distributions, graphical analyses of life data, numerical analyses of life data, and a survey of related topics.

T3506 \$5.95

Volume 7: How and When To Perform Bayesian Acceptance Sampling

Thomas V. Calvin

Many discussions of Bayesian acceptance sampling are rather mathematical and discourage study by the average quality control practitioner. Often it is difficult to relate the vaguely understood concepts to a real-world situation. This book is restricted to Bayesian acceptance sampling by attributes and its effect on sampling risks.

T3507 \$5.00

Volume 8: How To Apply Response Surface Methodology

John A. Cornell

Response surface methodology consists of a set of techniques used in the empirical study of relationships between one or more responses and a group of input variables. This booklet explains how to exploit simple empirical models such as first- and second-degree polynomials to approximate a relationship between a response variable and the input variables over a selected region of interest. A comprehensive set of references is given to allow for further study of the techniques and principles.

T3508 \$9.00

Volume 10: How To Plan An Accelerated Life Test-Some Practical Guide-lines

William Q. Meeker and Gerald J. Hahn

This book will be available in November. For further information contact Publications Department.

Wescott Laboratory Dedicated at RIT

Mason F. Wescott, well-known for his dedication to the advancement of applied statistics, recently was honored with the dedication of the Mason F. Wescott Statistics Laboratory at the Rochester Institute of Technology.

Housed within the newly created Center for Quality and Applied Statistics, the laboratory will provide students with an environment in which to practice statistical consulting and to explore the changing role of the computer in statistical analyses.

Professor Wescott is a Fellow and Honorary Member of ASQC. He was the editor of Industrial Quality Control from 1947 to 1961, was awarded the Shewhart Medal in 1964, and was a Grand Awardee of ASQC in 1981. He was the founding chairman and is now professor emeritus in the Graduate Statistics Program at RIT, entering his 60th year of teaching.

SQC QUESTIONS, QUERIES, AND QUANDARIES

Two-Stage Nested Designs

by Joe Pignatiello

The following question was sent to me from an engineer working for a military contractor:

"Five parts were randomly sampled from a lot. The quality characteristic for each part was measured twice since individual readings vary due to errors in making measurements. A random sample of five parts was taken from a second lot and once again the quality characteristic was measured twice,

"The question is: how does one test the hypothesis that the variance of the quality characteristic is the same for both lots?"

The engineer added that if there was no significant difference in the variances, he would then take the average measurements on each part and perform an equality of means test since that was his ultimate goal. Aha! The engineer was actually interested in an equality of means test!

Well, unbeknownst to the engineer, the data collection plan that he has described is known as a two-stage nested design. The particular lots are to be compared by examining five randomly chosen parts from each lot. The first part chosen from lot 1 has no relationship to the first part chosen from lot 2 and, similarly, for the other four parts sampled from each lot. The differences between the parts selected from a lot are nested within that lot.

Since the parts are chosen randomly from two particular lots, the model is "mixed", with lots being a fixed factor and parts a random factor. The model statement for this situation may be given as

$$Y_{ijk} = \mu + t_i + \beta_{j(i)} + e_{(ij)k}$$

$$i = 1, 2, \dots, a ;$$

$$j = 1, 2, \dots, b ;$$

$$k = 1, 2, \dots, n,$$

where Y_{ijk} = value of measurement k on part j from lot i ,

μ = overall mean,

t_i = the effect of lot i ,

$\beta_{j(i)}$ = the effect of part j within lot i

$e_{(ij)k}$ = the (measurement) error of measurement k of part j from lot i , and

a = number of lots,

b = number of parts from each lot,

n = number of measurements taken on each part.

The expected mean squares are given in [Table 1](#) and the analysis of variance formulas are displayed in [Table 2](#). By examining the expected mean squares, one sees that to test the equality of the means of these two lots, the appropriate test statistic is $F1 = MS_{LOTS}/MSPARTS_{(LOTS)}$.

This test statistic has an F-distribution with $a - 1$ and $a(b - 1)$ degrees of freedom. To test the hypothesis that there is no part-to-part variation within lots, the test statistic $F_2 = MS_{PARTS (LOTS)} / MS_{ERROR}$ is used. This statistic has an F-distribution with $a(b - 1)$ and $ab(n - 1)$ degrees of freedom.

As an example, consider the data shown in [Table 3](#), showing the measurements on each of five parts taken from two lots. For these, one can compute $y_{1..} = 98.7$, $y_{2..} = 108.9$, $y_{3..} = 207.6$.

Then, using the formulas from [Table 2](#), one can obtain the analysis of variance table shown as [Table 4](#).

Based upon the significance probability of the F-statistics (shown as a * in [Table 4](#)), it may be concluded that the means for the two lots are the same but that there appears that there may be significant part to part variation within lots.

TABLE 1: Expected Mean Squares

FACTOR	TYPE	E (MEAN SQUARE)
LOTS	Fixed	$\sigma^2 + n\sigma_{\beta}^2 + \frac{bn}{a-1} \sum_i \tau_i^2$
PARTS(LOTS)	Random	$\sigma^2 + n\sigma_{\beta}^2$
ERROR	---	σ^2

TABLE 2: Analysis of Variance Formulas

SOURCE	SUM OF SQUARES (SS)	DEGREES OF FREEDOM (df)
LOTS	$\frac{1}{bn} \sum_i y_{i..}^2 - \frac{1}{abn} y_{...}^2$	$a - 1$
PARTS(LOTS)	$\frac{1}{n} \sum_i \sum_j y_{ij.}^2 - \frac{1}{bn} \sum_i y_{i..}^2$	$a(b - 1)$
ERROR	$\sum_i \sum_j \sum_k y_{ijk}^2 - \frac{1}{n} \sum_i \sum_j y_{ij.}^2$	$ab(n - 1)$
TOTAL	$\sum_i \sum_j \sum_k y_{ijk}^2 - \frac{1}{abn} y_{...}^2$	$abn - 1$

Note: A dot (.) in place of a subscript is used to denote summation over that subscript. For example

$$y_{i..}^2 = \sum_j \sum_k y_{ijk}^2$$

TABLE 3: Example Data

	Lot 1 (i = 1)					Lot 2 (i = 2)				
	Parts (j)					Parts (j)				
	1	2	3	4	5	1	2	3	4	5
y_{ij1}	10.2	8.4	9.2	10.5	11.3	10.9	14.1	11.8	12.8	13.3
y_{ij2}	9.1	10.4	9.1	10.1	10.4	12.6	11.5	11.4	10.7	12.5
$y_{i.}$	19.3	18.8	18.3	20.6	21.7	23.2	27.3	15.8	23.8	18.8

TABLE 4: ANOVA Table—Example Data

SOURCE	SS	df	MS	F	α^*
LOTS	5.202	1	5.202	0.9358	0.362
PARTS(LOTS)	44.470	8	5.559	2.1315	0.130
ERROR	26.080	10	2.608		
TOTAL	75.752	19			

For more information, see any of the texts listed below.

References

Anderson, V. L. and McLean, R. A. (1974) *Design of Experiments: A Realistic Approach*. New York: Marcel Dekker, Inc.

Hicks, C. R. (1982) *Fundamental Concepts in the Design of Experiments*, New York: Holt, Rinehart & Winston.

Montgomery, D. C. (1984) *Design and Analysis of Experiments*. New York: John Wiley & Sons.

Readers are invited to submit questions, queries, or quandaries to be answered in this column to:

Dr. Joseph J. Pignatiello, Jr.

Systems & Industrial Eng. Dept.

University of Arizona

Tucson, AZ 85721.

Questions should be submitted in written form. A name, address, and telephone number should accompany each request. Anonymity will be preserved upon request.

COUNCILLOR SPOTLIGHT

James R. King- Region 1

James R. King, PE, is president of TEAM-Technical Engineering Aids for Management, a firm which provides special purpose graph and probability papers, aids for continuing education, and consulting and training services.

Having had vast industrial and teaching experience, Jim is now a self-employed consultant in quality and reliability engineering. His field of expertise includes training industrial personnel in conventional and advanced adaptive methods of statistical quality control and developing improved methods of contemporary statistical analysis and associated software to facilitate optimum solutions quality and reliability problems.

He is the author of two textbooks and has published more than 50 papers about effective problem solving in quality and reliability using advanced and practical statistical methods.

Jim is a Fellow of ASQC and is a past chairman of the Merrimack Valley and Northern New England Sections. He is also a Fellow of both the American Association for the Advancement of Science and the Academy Marketing Sciences.

Fall Technical Conference: October 25-26

Statistics and Practical Problem Solving: The New Wave in Quality Control" will be the theme of the 28th Annual Fall Technical Conference to be held on October 25 and 26 in London, Ontario.

Co-sponsored by the Chemical and Process Industries Division of ASQC and the Section on Physical and Engineering Sciences (SPES) of the American Statistical Association, this conference features three concurrent series of sessions in the areas of Statistics, Quality Control, and Tutorials.

A highlight of the conference will be the delivery of the Youden Memorial Address by Professor Brian B. Joiner who will speak on "Statistics, Quality, and Productivity." In addition, Mr. N. Thomas, director of research at DOFASCO, and Dr. R.I. Savage, president of the American Statistical Association, will serve as luncheon speakers. Registration fees are \$75 (U.S. dollars) for the complete two-day conference, including luncheons (\$80 after October 1). Checks should be made payable to "FTC-London" and sent to

Allan Hood
221 Manitoulin Drive
London, Ontario
CANADA N5W 1M8

along with name, address, telephone and company affiliation. Further information can be obtained from Christine Bell at (519) 451-2500.

Lodging arrangements and information can be obtained by mentioning the conference by name when contacting the Holiday Inn--City Center Complex in London at (519) 439-1661.

1984 W. J. Youden Memorial Address: The Key Role of Statisticians in the Transformation of North American Industry

By Brian L. Joiner

There is much to be done if North American industry is to survive in the new economic age. We statisticians have a vital role to play in the transformation that is needed to make our industry competitive in the world economy. As statisticians, we are faced with a major challenge—and a major opportunity—unlike anything we have ever experienced before. This note describes this opportunity and seeks to interest others in joining forces to help our industry meet its challenges. The discussion will move from the goal—improvements in quality and productivity—to the nuts and bolts of how statisticians can prepare for a new role in industry.



We begin with a reminder that major improvements in quality and productivity are indeed necessary if our industry is to regain a competitive position in world markets. The second point is also a reminder: statistics and statisticians are important in generating these improvements. The third point is not yet so widely accepted: a new managerial climate is necessary before these gains can be sustained. Fourth, and even less well known, is that statisticians have a major role to play in creating this new climate. Finally, specific steps are recommended for those who wish to prepare for a new role in helping to create the right managerial climate for achieving major continuous improvements in quality and productivity.

THE NEED FOR IMPROVEMENTS IN QUALITY AND PRODUCTIVITY

Automobiles, cameras, stereos, color TVs, food processors, microwave ovens, athletic equipment, computer chips, medical equipment, industrial robots, optical equipment, hand tools, electric motors.... This is a portion of a list developed by Stanford Professor Steven Wheelwright; it was communicated to me by Blan Godfrey of AT&T Bell Laboratories. What do these products have in common? They are attractive, complex products of high technology, demanded in high volume—just the types of products for which a country would like to be a leader in design and manufacture. But these are products in which the U.S. worldwide market dropped by 50% during the 1970s. And this list is just the tip of the iceberg. Japan and, increasingly, other countries are beating our socks off and they show no signs of letting up.

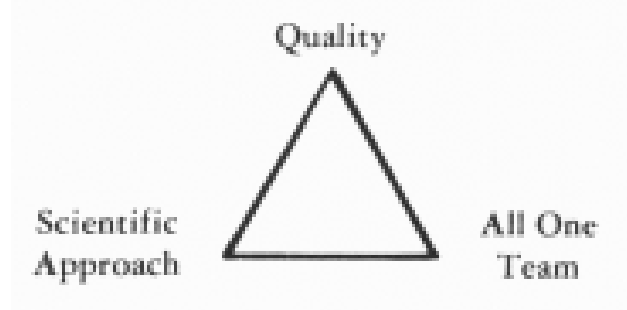
STATISTICS AND STATISTICIANS

Statistics and statisticians are already helping our industries to make gains in quality and productivity. There are many excellent, dedicated statisticians in industry today. Nevertheless, those of us who work in

and with industry know that our effectiveness is related to the managerial climate in which we work; we know we could accomplish much, much more in a more favorable climate. This brings me to my major point: the need for a managerial climate in which major gains in quality and productivity become the norm.

NEW MANAGERIAL CLIMATE

Managerial climate is the secret to Japan's success. Not robots, not tax policies, not cultural differences. But what managerial climate is best, and why? An article in the Wall Street Journal for April 29, 1983, illustrates what the "new climate" is all about. RCA built a TV plant in Memphis in 1966, but shut it down five years later after a series of wildcat strikes, union-authorized strikes, apparent product sabotage, and layoffs that reduced the payroll from 4200 workers to 1600. Then Sharp of Japan moved in, to salvage the plant and the reputation of the Memphis workforce. During the past four years, this Japanese-managed plant has rolled out a million color TVs and a million microwave ovens. Productivity is high; defect levels are very low. Sharp accomplished this with American workers, American components, and a serious recession—and without layoffs or loss of profitability. What is their secret? It has three parts: (i) obsession with quality, (ii) achieving a feeling among employees that they are one big family, and (iii) identifying and correcting problems by means of data, not opinion or emotion. These principles are best illustrated by a triangle, which connotes integrity—wholeness—and a synergy among the parts.



An Obsession with Quality

Let me tell a story to illustrate what I mean by an obsession with quality. One company I work with had acquired a very large number of parts (434,000, to be exact) from a supplier before they experienced their first failure with that part. It was a "minor" part, costing only 11 cents. They notified the supplier, and the supplier came to inspect the failed part and the circumstances of the failure. The part proved to be defective, so the supplier changed their process. The company subsequently purchased over three million of these parts with only one more failure. Now I ask you, do you think this supplier was under American or Japanese management? Another part used by another company experienced an 8.5% failure rate. The supplier of that part wanted to know why the company was complaining; the 8.5% failure rate was better than the industry average. You guessed. That supplier was American-managed!

Scientific Approach: Focus on Processes

The key to improved quality is improved processes. Quality is improved through improvement in process, not by inspection. This recalls the 85/15 rule of Juran and Deming, which says that at least 85% of problems are system problems, and less than 15% are due to workers. (Deming now says that over

94% of problems appear to be system-related.)

Processes make things work. Thousands of processes need improvement, including things not ordinarily thought of as processes, such as the hiring and training of workers. We must study these processes and find out how to improve them. The scientific approach, data-based decisions, and teamwork are key to improving all these processes. This kind of emphasis on processes is one of the principal things Japanese managers have achieved, but American managers typically have not.

All One Team

This is absolutely necessary. Lacking team spirit, employees can, through passive resistance, impede the best efforts at quality improvement. With it, everyone seeks improvement, everyone gains from improvement, and teamwork becomes pervasive.

Here is an example of how one American-managed company improved its productivity and at the same time fostered the team spirit among its workers. This company employed 20 workers in a metal finishing area. These workers, their managers, and technical support people set to work to improve productivity. As a result the number of workers required dropped first to 11 and then to 7. Now the usual response of American management would be to lay off the "surplus" workers. This company, however, taught them new skills, moved them into new jobs, and recognized their contributions to the company. What would have happened if they had been laid off, instead?

Another success story (William Serrin, New York Times) is about a Warwick TV plant that moved from the Midwest to the Sun Belt in order to be competitive. But that didn't work either, and after a few years the plant was sold to Sanyo, a Japanese company. Sanyo kept the same work force and now turns out excellent TV sets at a high level of productivity. The secret? A new managerial climate, with authoritarianism de-emphasized. A 12-year worker says, "We are a family."

The triumph of Japanese management is being repeated all over North America. The companies are not perfect, but they are highly successful. The February 2, 1984, issue of USA Today reports that 476 Japanese-owned companies now employ 82,900 American workers in the manufacture of everything from balloons to automobiles. It can be done in North America. It is being done.

The triangle, which has quality, teamwork, and the scientific approach at its apices, summarizes the major requirements of the new managerial climate needed for our industry to regain its competitive position in world markets. You may recognize that this triangle is also a condensed form of Dr. W. Edwards Deming's 14 Points for Management. Now I acknowledge that not everyone agrees with Deming. But I must tell you that after several years of focused study and hard work in this area, I have become increasingly convinced that while Crosby, Juran, and others have many good ideas, Deming goes much further in understanding the deep underlying problems facing North American industry.

Some statisticians think Deming has gone too far and is too confrontive with top management. I will not argue about the packaging of his message; it might be improved. But I believe the message itself is right on target, and I ask you to suspend judgment on Deming and open your mind to the possibility that he may be right. Let us review his 14 Points for Management, which apply to organizations of all types and all sizes-not only to entire companies, but to their parts.

1. Create constancy of purpose toward improvement of product and service.
2. Adopt the new philosophy; we are in a new economic age.

3. Cease dependence on inspection to achieve quality.
4. End the practice of awarding business on the basis of initial cost.
5. Improve constantly and forever every activity.
6. Institute training and education on the job, including management.
7. Institute supervision.
8. Drive out fear.
9. Break down barriers between departments.
10. Eliminate slogans and exhortations.
11. Eliminate work standards that prescribe numerical quotas.
12. Remove barriers that rob workers of their right to pride of workmanship.
13. Institute a vigorous program of education and retraining.
14. Put everybody in the company to work in teams to accomplish the transformation.

Trust of Management-Absence of Fear

Statisticians can help bring this about by demonstrating to managers that at least 85% of problems are system-related, not worker-related. When we urge and help managers to improve processes throughout the company, they come to understand the 85/15 rule. These process improvements in turn help convince workers that management really cares about the organization and thus cares about their collective survival.

We can also eliminate the making of demands inconsistent with process capabilities. We can help identify and eliminate inadequate materials or training. Workers will no longer take the brunt of the blame when processes fail. Thus we may ultimately be able to convince management not to terminate workers when productivity gains are made, or lay them off when the economy dips downward. We may also be able to help to convince management and labor that gains in productivity lead to more jobs and greater job security, not to fewer jobs and less security.

Some statisticians may say we can do well enough without the change in managerial climate. But I do not believe it. Let me cite an example. One manager I know got really turned on when he learned about statistics. He studied processes and improved them. He used Pareto charts, control charts, and design of experiments. He isolated the causes of problems and eliminated them. His workers thought he was super, because he worked with them and helped them get rid of many of the hassles that had plagued them in their jobs.

Then, he was relieved of his responsibility because his manager and other managers did not understand the 85/15 rule. When he pointed to problems outside his own area, the other managers felt he was pointing to them-where in reality, he was pointing out the problems in the system.

You may encounter similar problems. Your work may often be stopped at departmental barriers. You may be asked to work on problems that you know are not the most important and urgent problems of the company. Do you work in a place where other employees, from top to bottom of your organization, actively seek your advice to help them improve quality and productivity? You are useful to your organization now, but you could be much, much more useful.

ROLE OF STATISTICIANS IN CREATING THE NEW MANAGERIAL CLIMATE

I have briefly described the new managerial climate and why it is important. I hope you agree with me that it is needed. The next question is, is there anything we statisticians can do to help create the new climate? The surprising answer is yes. There are things that we statisticians are among the best prepared to do. Dr. Deming told me that for three years before I believed him. He said, "Nothing less is required than the transformation of the American style of management—and you (statisticians) must show management how to create that climate."

I could not see it. I could not see why I or other statisticians should be involved in the creation of a new climate. I could see why statisticians would benefit from the change—that part was relatively easy. But what did I know that would help with the transformation of the American style of management? Only in the past year have I come to understand what Deming means and I would like to share with you my new understanding of his message. I do not expect to convince everyone to become involved in the transformation of management. That is not necessary. But some of us do need to be involved.

It will not be easy. The transformation of management is not a role that we have been well prepared for. It is a much broader and more ambitious role, which requires new skills that most of us have not tended to develop. But let us look at a few aspects of the new management philosophy and note what contribution statisticians can make toward their implementation.

Everyone Seeking Improvements in Quality and Productivity

Statisticians can help implement this by teaching managers how to focus on processes rather than on blaming individuals. American managers do not normally think in terms of processes, especially not processes like: the process of recruiting well qualified employees, the process of training first-line supervisors, the process of introducing new products. Teaching managers how to study and improve such processes helps them understand why everyone else should also be studying processes and seeking improvements. Many statisticians find it natural to think in terms of processes; we know how to gather and interpret data from processes to help improve them.

Statisticians can also help speed up improvements, and the success of these efforts tends to build confidence and esprit de corps. We tend to seek out causes, not jump to solutions. More often than others we ask why? How do you know? As a result, projects to improve processes are usually completed much faster and with much better results when statisticians are involved.

For example, in one company a production line often went down. Why? Study found that the ink jet-labeling machine failed frequently. Why? The major cause turned out to be fluctuating pressure in the airlines. The machine failed whenever the pressure dropped below 66 psi. The study team recommended purchase of local compressors to supply uniform pressure. But they should have asked why one more time: they should have asked why the pressure fluctuated, because it turned out that other machines also had problems when the pressure dropped. Statisticians tend to persist longer in asking why and thus tend to help teams achieve better results.

Eliminating Barriers Between Departments

Statisticians can help to quantify current process capabilities. Only when these capabilities are truly known will others be able to place realistic expectations on them. Unfortunately, management knows

today that if they put enough pressure on one point that group will generally come through. They often interpret this to mean that increased pressure is the best way to get results. But they need to learn how this pressure distorts the system and interferes with overall quality and productivity.

We can show how understanding processes helps provide ways for data-based communication of departmental needs. We can help to eliminate finger-pointing and get down to the facts. "In God we trust. All others must bring data." Or, "Facts often kill a good argument."

HOW STATISTICIANS CAN PREPARE FOR THIS CHALLENGE

Statisticians have three types of special knowledge. We are uniquely well qualified (i) to figure out what data to collect and how, (ii) to interpret data in the face of variation, and (iii) to coach others in the proper use of the scientific approach.

The first and second types of knowledge, figuring out what data to collect and interpreting the data in the face of variation, are obvious. But the third point may be surprising. We often think that other people approach problem solving and process improvement in the same way we do, even though most statistical consultants would admit that one of the most valuable contributions they make to an investigation is the use of a logical, data-oriented approach. As Cochran and Cox (1957) remind us, perhaps the major contribution a statistician can make in the planning stages of an investigation does not involve statistical theory at all, but simply forcing the investigator to explain clearly why he is doing the study, why he chose the proposed method and why he thinks the completed study will answer the questions it was intended to answer. Although we statisticians do not usually think of our role in this way, the role is a natural one, because we as a group are most likely to ask why? How do you know? And, how will you know?

But to be maximally useful in the transformation, we must further educate ourselves. We must learn the new philosophy in depth. We must thoroughly understand the Quality-Teamwork-Scientific triangle and the teachings of W. Edwards Deming, Juran, and others. We must understand current American management style, its strengths and weaknesses. Finally, we must prepare to venture far beyond our familiar statistical territory to learn new skills—interpersonal skills, team-building skills, how to plan for change, and how organizations work.

In conclusion, here are a few specific recommendations for action:

- Locate one or more partners who specialize in the new skills and who complement your strengths.
- Educate yourself and others as to what must be done and why. Listen to and study Deming, Juran, and others.
- Seek to change roles. Think bigger, more strategically—more like the president of the company or the chairman of the board. Help get a team organized to work on a key project. Help to obtain major, highly visible gains in quality and productivity. Get higher and higher level managers on board with respect to understanding the new philosophy.

Then when enough of us have done these things, we will be in a position to make major contributions toward the survival of North American industry.

SUMMARY

1. Major changes in management are needed if we are to become and remain competitive with the Japanese.
2. Statisticians have a vital role to play in the creation of the new managerial climate.
3. Some of us need to expand our view of what we can contribute to our organizations.
4. We need to develop new skills and new ways of thinking about our roles.
5. Then we will be ready to achieve and sustain major gains in quality and productivity.

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