Chairperson’s Message
by Lynne Hare

In this issue you will find a paper by Ron Snee discussing the role of statisticians in quality and productivity, a paper by Stu Hunter summarizing his Fall Technical Conference Luncheon comments, and the second and final installment of Blan Godfrey’s Youden Address, also present at the Fall Technical Conference. Blan’s paper was published in two sections to keep you on the edge of your seat waiting for this issue.

In all of our newsletters, we attempt to keep our membership informed concerning events and issues, and we try to present the thinking of some statisticians who are quality leaders. (Note the double entendre.) The Newsletter can be more than that too, and we intend to use it to do more. It can be a two-way channel of communications. Our editor, Beth Propst, made a good start by soliciting comments in an earlier issue and then publishing some of them in the next. We’ll continue that, and we’ll announce jobs needing membership attention. If the voices of statisticians are to be heard, we need a more active Division membership. Who wants to write questions for CQE and CRE exams? Who wants to sit on committee that review standards? Who wants to speak on behalf of the Division in primary or secondary schools about practical applications of statistics? In future issues, we will announce job openings and provide position descriptions.

All of this is consistent with the Division Mission which appears in Conrad Fung’s summary of our long range planning meeting [Elsewhere in this issue]. Nine Division Council members met for 2½ days of hard work to study our visions, examine strategies consistent with those visions, and then re-examine our mission statement. We decided, that to follow this mission, we need to build the Division’s infrastructure. This means more involvement and more communication.

So the ball is in your court. Do you want to get involved? Start by recommending ideas and volunteering for jobs. Come talk to the Statistics Division Council at our Council meeting in Toronto (Sunday, May 7, 8:30-10:30 P.M.) or come to the hospitality suite.

Who knows; if nothing else, maybe you can get one of us to tell you the gorilla joke!

STATISTICS DIVISION PARTICIPATES IN 13TH ANNUAL QUALITY ASSURANCE DAY AT ARGONNE NATIONAL LABORATORY

On Thursday, April 13, 1989, the Statistics Division will sponsor a technical session at the 13th Annual Quality Assurance Day at Argonne National Laboratory. The conference begins with lunch at 11:30 a.m. and concludes with dinner and an evening speaker. This year Jed Heyes (Rank Video Services America) is coordinating the Statistical Division’s program as follows:

1. “Uses and Abuses of Correlation and Regression” by Gerald B. Heyes-Rank Video Service America

2. “The Lynx in the Office Proved to be a Puss on the Course” (A parable on Promoting Statistical Application) by Peter J. Tiemstra - WM Wrigley Jr. Company

3. “Cp, Cpk, and Non-Normal Distributions” by Bob Dovich of Ingersoll Cutting Tool Company

This is the third year that the Division has sponsored a technical session at this conference. Galen Britz and Beth Propst coordinated the sessions in 1987 and 1988 respectively.

REGION 7 CONFERENCE

The American Society for Quality Control (ASQC) Region 7 Statistics Division is presenting a “Statistical Applications in Quality Assurance and Reliability” conference on June 2, and 3, 1989 at the University of California, Riverside (UCR). This conference will be co-sponsored by the Southern California American Statistical Association (ASA) and the UCR Statistics Department. Douglas C. Montgomery from Arizona State University, author of several books and publications in statistical quality control and design of experiments will be the keynote speaker.

CONTACT: Cliff Yarbrough (714) 737-5934
Statistics in Quality and Productivity - An Experience Opportunity

Dick Freund, Chairman of ASTM Committee E-11 on Quality and Statistics has sent an update on the activities of E-11 as well as an invitation to those interested in becoming members.

ASTM is recognized nationally and internationally for the excellence of the standards it issues in a variety of fields. ASTM Committee E-11 on Quality and Statistics serves to provide statistical guidance and assistance to other ASTM standards-writing committees. These committees (over 150 in number) deal with areas such as environmental monitoring, textiles, electronics, solar energy conversion, sound absorption, ship building, erosion and wear, metals, to name only a few.

Committee E-11 plays two major roles. In one it prepares standards and guides to assist other ASTM Committees in the use of appropriate statistical methodology in their work. In the second it endeavors to help other committees in the preparation of statements about quality.

The ASTM Manual on Presentation of Data and Control Chart Analysis (ASTM STP 15D, the earliest version of which was prepared by a committee headed by Harold Dodge and is dated 1933) is probably its best-known work and for years served as the definitive standard on Shewhart Control Charts. In the area of interlaboratory studies, standard E691 "Standard Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method" is its current "best seller".

Today the work load confronting E-11 is continuing to increase. Not only is the current industrial recognition of the importance of sound statistical design and analysis a factor, but so is the government move to use the voluntary standards community efforts whenever possible rather than have an agency write its own standards. The success of this move, of course, is dependent on the completeness of the voluntary standards.

The committee would like to provide more service to the other ASTM committees without overburdening any single member. (By service, we are talking about guidance in appropriate, simple techniques and not data handling which the other committees must provide for themselves.) E-11 also needs to develop new tools based on the many advances in statistics over the past decade. Some of the topics include the sampling of bulk materials, reliability and degradation effects. To undertake the large amount of fascinating work ahead, E-11 will need more active members.

Membership Report

The membership of Statistics Division has grown rapidly over the last ten years. In the last year alone, Division membership has increased by almost 3,000. Current paid membership is nearing the 12,000 mark making Statistics Division the largest division in ASQC. Twenty percent of ASQC members belong to Statistics Division.

ABET Holds Conference On Statistics

The Accreditation Board for Engineering and Technology (ABET) announced that it has organized a Conference on Statistics and Probability in Engineering Education to be held May 31-June 2, 1989 at the Xerox Training Center in Leesburg, VA. The conference will provide a forum for the discussion of the need to incorporate into engineering curricula the topics of statistical experimental design, data analysis, stochastic processes, probability, quality management technology and other related areas.

Additional sponsors of the conference include the American Statistical Association (ASA), the American Society for Quality Control (ASQC) and the American Society for Engineering Education (ASEE), with the participation of the Committee for Undergraduate Programs in Mathematics (CUPM). The Allied Signal Foundation, the Ott Foundation, the Statistics Division of ASQC and the Quality and Productivity Section of ASA have provided financial support.

The conference will follow up on a resolution presented at the National Congress of Engineering Education (NC2E) in November 1986 that made recommendations for specific language on statistical education to be included in ABET's accreditation criteria. The language itself suggests that statistical practices be "...an integral part of all laboratory experiences," that they be "...infused throughout the engineering curricula...with some...coursework in applied statistics..." and that statistical concepts be incorporated into the engineering design requirements. The conference will follow up on a resolution presented at the National Congress of Engineering Education (NC2E) in November 1986 that made recommendations for specific language on statistical education to be included in ABET's accreditation criteria. The language itself suggests that statistical practices be "...an integral part of all laboratory experiences," that they be "...infused throughout the engineering curricula...with some...coursework in applied statistics..." and that statistical concepts be incorporated into the engineering design requirements. The education of engineers in the basics of quality management and statistics has been one of the major aspects of the industrial effort to improve quality and productivity and, hence, the competitiveness of American industry. The goal of this conference is to permit representatives of the engineering societies, engineering faculties, and industry to consider appropriate responses to this pressing concern for ABET and for the engineering curricula. The conference results will be developed in a proceedings document that will be prepared for general distribution.

ABET President Francis J. Cashin and ABET Past President Russell C. Jones, who chairs the committee in charge of this conference, will open the meeting. Among the confirmed keynote speakers are Craig Barrett, Senior Vice President and General Manager of Components Technology and Manufacturing at Intel, Gordon H. Geiger, Senior Vice President at Cargill, Inc., and Myron Tribus, former Vice President at Xerox Corporation and Professor at M.I.T. These and other speakers will underscore the serious concern of industry regarding the need for developing statistical literacy in all engineering graduates.

Other topics will include necessary knowledge for engineers based on industrial practices, the role of probability, the way probability and statistics might be integrated into the mathematics sequence, and pre-college statistical education in other countries.

Additional information may be obtained from ABET, Attn: Statistics Conference, 345 East 47th Street, New York, NY 10017. For technical information contact the Conference Coordinator, Neil R. Ullman, County College of Morris, Randolph, NJ, (201) 361-5000 or (201) 989-8365.

Registration is limited to 200 participants. The registration cost is $375.00 and includes housing, meals and conference materials.
ABET is a federation of 26 professional and technical societies that represent over 1.2 million individual engineers. ABET's main objective and responsibility is the maintenance and improvement of the quality of education in engineering, engineering technology, and engineering-related areas. Through its accreditation commissions and Board of Directors, ABET addresses current and future issues, performs studies, and develops policies that, by a consensus of the profession, become criteria which are then implemented by ABET's accreditation commissions in carrying out comprehensive evaluations of engineering, engineering technology, and engineering-related curricula in postsecondary educational institutions.

I would also like to comment on your Letter from the Editor in the Winter, 1988 issue. I have a further suggestion to all quality professionals that would be helpful in spreading the message to the American community at large. In every school district across the United States there is an adult and/or continuing education function that offers short courses to the community. Everyone should be urged to offer to teach a short course (especially one to two weeks with nominal pay) on Quality (give it a sexy name like Japanese Management Approaches). This may be the fastest way of spreading the word about the importance of quality to the populace at large. I myself will be teaching such a two hour per week two week course for my local community in late March of 1989.

The Awareness Committee is developing a bibliography of published articles on the use of statistics to improve quality and productivity. In addition, they will be exploring the possibility of reprinting some of these articles for distribution by ASA's Office of Scientific and Public Affairs. If you have know of an article which should be included, please send a copy to the committee chair, David Sylwester, Dept. of Statistics, College of Business Administration, University of Tennessee, Knoxville, TN 37996-0532.

The chair of the Latin American Applications Committee, Dr. Victor Aguirre-Torres, has a new address. It is IIMAS-UNAM, Apdo. Postal 20-726, Admon. No. 20 Mexico, D.F. 01000, Mexico.

Officers for 1990 will be elected by the Section membership this summer. As a new section, the ASA Board of Directors appointed officers for 1989. They are: David Fruharty, Chair; Jack Wood, Secretary; Gale Rex Bryce, Treasurer; Robert L. Perry, Program Chair; Samuel S. Shapiro, Program Chair Elect; Frederick Faltin, Publication; and Thomas J. Boardman, Representative to the ASA Board of Directors.

The ASA Q&P officers and committee chairs will have a long range planning meeting in May. Suggested topics for this meeting are welcome. They should be sent to the section Secretary, Jack Wood, Ford Motor Company, EEE Building, Drop 57, PO Box 2053, Dearborn, MI 48121. As always, the Section needs volunteers to work on its various committees (Awareness, Education, Publications, Research, Reliability, Applications, Latin American, and Health Care Delivery). Volunteers should also write committee chairs or to Jack.

Grandma's Pearls
Of Wisdom

A diet is what you keep putting off while you are putting on.

Human rights rest on human dignity.

About the only part of the body that is over exercised is the lower jaw.

When someone gives you a piece of his mind, it's always a long and narrow one.

One good way to have a clean mind is to change it occasionally.
Editor's Corner

Dear Beth:

I would like to add my congratulations, along with others. I think that you are doing a super job as editor. You have a nice informal style that has gone over well. Keep it up!

I enclose an Appendix to my survey of Q & P academic programs. I really do NOT want to stay in this survey business; so I hope this is the last update. You would be interested to know that ALL of these new ones were due to your reprinting this survey in your Newsletter. None came in response to the original publication in AMSTAT NEWS.

With my very best, I am

Sincerely yours,

Robert V. Hogg
Past President
American Statistical Association

Appendix to the Partial Survey of Academic Programs in Quality and Productivity

Robert V. Hogg
University of Iowa

About two years ago, the results of the original survey were published. In summary: (1) BYU, Iowa, RIT, Tennessee, and Wisconsin have some degree program with Quality in the title; (2) Delaware, Georgia Tech, Iowa State, and Oakland have strong subtracks in the Quality area; (3) those having programs that could be adapted to Q & P are Denver, Georgia, Kansas State, Michigan, Purdue, South Carolina, and SMU; (4) ones with no program but, with imagination, could create individualized ones are Arizona, Ball State, California at Riverside, Michigan State, Minnesota, and North Carolina State.

Clearly not all colleges and universities responded to the original request. During the last two years some of these have been heard from. With no particular order or classification, consider the following:

(a) Rutgers University now has the M.S. Quality Program
(b) Lima Technical College gives an Associate Degree in Quality Engineering Technology
(c) Drexel University has a Center of Quality and Productivity within the College of Business
(d) University of Massachusetts at Amherst offers an option of Q & P in its M.S. in Engineering Management, Dept of IE and OR
(e) Southern College of Technology has a Quality Assurance Option to its BSIE degree
(f) Technion (Israel Institute of Technology) gives the M.S. degree in Quality Assurance and Reliability
(g) University of Minnesota provides through the IE division, in cooperation with the Productivity Center and the State Council on Quality and Productivity, work in quality-related areas
(h) Michigan State University now offers a senior level course in "Statistics for Quality and Productivity Improvement" as well as a flexible M.S. in Applied Statistics
(i) Linkoping Institute of Technology (Sweden) allows IE students to choose a branch in Quality and Maintenance Engineering
(j) Centro de Investigacion en Matematicas, A.C. Guanajuato, Mexico) has Masters program oriented towards Quality and Productivity
(k) California State University (Long Beach), through its Engineering and Industrial Technology Dept., offers a B.S. in Quality Engineering Technology
(l) San Jose State University gives the M.S. in Quality Assurance
(m) STAT-A-MATRIX Institute provides a M.S. degree in Quality Management

It is of great value to have so many schools interested in this important area.

Dear Beth:

Please notice that my new mailing address is:

Dr. Victor Aguirre-Torres
IMAS-UNAM
Apdo: Postal 20-726, Admon. No. 20
Mexico, D.F. 01000
Mexico
Telex: 1764062 - IMASME
FAX: 550-0047

Editors Note: Dr. Torres is the Chairman of the ASA Q & P Committee on Latin American Applications.

Dear Beth,

I read your "Letter From The Editor" in the statistics Division Newsletter, (Winter, 1988) and except for our ference in gender you and I have a lot of parallel thoughts and observations as far as history, time, and playing an important role in the present and the future. It's clear you're an American to the hilt. I thought it was a good article.

I hired in at my present job for the purpose of starting a quality department. This company sent me to a junior college to learn "SPC." I had been in supervision for other companies before I started working here, so I had some background for quality requirements. I had my own ideas as to how management and employee working relations should be. This always got me into trouble with management, however my present job allows me to use some of my ideas. The "SPC" training I received fell right into line with the way I thought Emloyee/Management Teams should work together. In the first year of "SPC" implementation at this company we had 87% fewer customer rejections. We now have more customers and make more money. I feel I've found at least a part of my purpose in life. I just thought you might like to hear some good news about how "SPC" is working.

I am a member of "ASQC" and I would like to make a couple of statements about the only flaw I've observed in this organization. All of us members receive publications of some sort almost daily, if not, at least weekly. In these publications it is easy to find a lot of misspelled words and bad sentence structure. If you can remember, back in the "Fifties," the teachers used news articles to emphasize correct spelling and sentence structure. It would seem to me that a quality organization would want its publications to be a quality piece of work. Even your "Letter From The Editor" had a misspelled word in it. I wonder, as "Quality Warriors," should we overlook this problem and go on to other things or practice what we preach?

Len Johnson, Jr.
Quality Director
Middleville Tool & Die Co.

Editor's Note: I, too, would like to see perfection in our newsletter. Typeset errors are hard to catch when you are not a professional proofreader. I do my best, but — as we all know — 100% inspection does not guarantee no defects.
Dear Readers:

I hesitated a long time before deciding to print this letter. Then I decided if the writer had the courage to send it, I could have the courage to print it. I suspect some of you work under conditions as adverse as these, but haven't taken such drastic action. Judge for yourselves. I have printed this exactly as I received it:

I am writing with some reserve. I am not a college graduate, nor am I well educated. After High School, my primary education has been experience.

A few years ago I was given the opportunity to work in the Quality Control field. With it came the necessity of taking some further education, including Statistical Process Control.

Corporate changes, and the development of Operator Process Control, caused the restructuring of the Quality Control Department. Co-incidentally, I was offered the chance to become "Quality Control Manager" for a small manufacturing company.

Being invited to accept the position was exciting!!! The General Manager spoke of wanting to "keep up with customer expectations," "implement S.P.C. for the entire shop," "to gain 'Certified Vendor Status' with the industry leaders" to which they were a supplier. I heard about all the big plans to expand and develop the company. And, I was told, there were other people that were responsible for some of the inspection, so I would have time to "develop all these necessary things."

I took the job, expecting to put to use all the ideas I had gained by studying and reading all the inspired wisdom of the great American Society for Quality Control.

As-soon-as I started working, I found that the company, including the General Manager, really wanted no changes at all. I found that, contrary to what I was led to believe, if anything at all was to be done by way of Quality Control or Process Control, it was to be done by me. They had wanted nothing more than after-production-inspection, a "parts-checker" that could also fill the customer's specific demands for X & R charts. Did I mention making charts from random samples of parts that were "farmed-out" to other sources? I often ended-up doing charts at home, as the inspection of parts took so much time. (up-to-six dimensions per part.)

The Production Manager was typical, "no added work for 'my' people," was his reaction to any form of process or operator control. I couldn't even get the Receiving Department to pause for me to do an incoming Material Inspection. What's more, the only time anyone else checked a part was to confirm or deny the results of any negative result of my inspection.

I fought, sometimes very subtly, sometimes very obviously, to get simple process controls considered, but none were ever instituted.

Finally, I was amazed at what I had considered an extinct dinosaur of American business... ...my employer was keeping and obtaining new contracts on the basis of cost and 'long lunches' and 'gifts' to the 'right people' at the 'right time.'

There we were, a small supplier (of critical parts) to major suppliers (of critical assemblies) to the automotive industry leaders. My conscience and integrity could-not take it. After much consideration I realized that no title or future compensation was worth the risks involved to the consumer, which included myself. I then sighted "severe ethical differences" as my reason for terminating my employment.

It is still costing me today, a year later, as I continue to get bad reviews, to all prospective employers, from that company. (Off the record, so I've been told by several well-meaning Personal Departments.)

What I'm trying to say, is that Quality doesn't start anywhere but at the top. No other position can effect it. And, don't assume that the customer will demand it, they just may never get around to it.

I am still often inspired by articles, written by wise authors, but I have learned a very hard lesson in the reality of business in America.

Sincerely,

Author's name withheld

Dear Beth,

Thank you so much for the incisive article by Bill Goodenow in the Winter issue regarding the Taguchi/Classical wars. Lights went on as he described the importance of Brainstorming, a routine practice in the Japanese environment, and how a thorough exercise of this tool demands less statistical rigor in a DOE that would be needed starting from scratch.

We are currently engaged in such an exercise at our company which you may find interesting. Wafer Fab engineers are charged with the task of designing continually improving processes with the demands of smaller and smaller integrated circuit geometries. The physics of smaller geometries puts tremendous pressure on existing fab techniques, and the elusive "best recipe" always seems just out of reach.

I had just finished teaching a five week class on DOE to a group of engineers when one wanted to try a Taguchi array on a Fab design problem. That was the first breakthrough. His supervisor and peers were tolerant but extremely sceptical. Our first exercise was as thorough brainstorm, where the knowledge and insights from several knowledgeable engineers was gathered. This exercise whittled a list of 15 variables and five possible interactions down to 11 variables and no interactions. We then modified an L16 to handle two 3-level and nine 2-level variables.

The design was a smashing success, but what rang so true in Bill's article was demonstrated by this recent experience. First; to use Taguchi in a cavalier manner without considering appropriate caveats is insane. If interactions are totally disregarded, as some suggest the Taguchi methods do, the effectiveness of the technique is fraught with danger. Second; Brainstorming is not a natural exercise in traditional Western engineering societies. In our experience, while the initial brainstorm was essential to the success of the design, it was neither natural nor easy. It was very difficult to get those engineers to sit still for three hours and share personal insights into the process. Rather, in the western tradition, we are very individualistic. We play our cards close to the chest, doing too much by ourselves and for ourselves. The overall good of the team is not a natural attitude in our industry. No wonder we have to resort to traditional classical design techniques, leaving nothing to chance by way of interactions.
Goodenow’s article went a long way to explain some of the background that has created this Taguchi/Classical war. My fervent position is summarized by J. Stuart Hunter who said, “...as students and practitioners our objective must be to apply the best of both.” I heartily recommend Taguchi DOE as an adjunct to the classical methods. There is so much to offer practicing engineers.

I’ve developed a series of modules using Taguchi/Classical techniques on Lotus worksheets which allow engineers to try their new skills on simulations, including differing levels of variability and unknown biases. These units provide hands-on experience with the skills both before and during on-line applications, everything from Box-plots to ANOVA, from Sampling plans to Control Charts. I look forward to further comments and insights into the “wars.”

I learned later that the real engineers in the design mentioned above decided they do their own design in the traditional way in parallel to ours. They set all variables at a constant level and varied only the two they know to be important. They missed the “sweet spot” dramatically, having set one variable at a wrong level. “Another missed opportunity!” How long can we survive with that phrase running around?

Sincerely,

Bob E. Robertson, P.E.
3 Sandra Court
Huntington Station, NY 11746

Dear Beth:

Bill Goodenow’s article in the Winter ‘88 edition, “The Taguchi — Classical Wars Go On” stimulated me to offer some thoughts which may add fuel to the fire and hopefully produce as much light as heat.

Taguchi’s Signal-To-Noise invention owes more than its name to the field of communications. It embodies the notion that our knowledge of any process is ultimately statistical, and that the laws of probability determine how much information is contained in a collection of data.

One of the most productive intellectual achievements of the twentieth century was the creation of the entirely new scientific concept of Information Theory. It merged from the incredible fecundity of the Bell Telephone Laboratories via the publication in 1948 of the work of the most famous of Norbert Weiner’s MIT students, Claude Shannon.

Weiner, himself, had become interested in random behavior during his days at Cambridge, where Bertrand Russell had called his attention to a paper by Einstein on Brownian Motion. Shannon had set out to solve a specific problem in radio and telephone communication, and the solution he arrived at was essentially identical to the formula for entropy that had been established in Victorian times, suggesting a powerful analogy between energy and information.

The intuitively obvious connection between Information and Signal-To-Noise can be followed in a one-hundred year path from the brilliant insights of Genichi Taguchi to the formula inscribed on the tombstone of its inventor, Stephan Boltzmann:

Taguchi:

Signal-To-Noise = –10 log (mean square deviation)

Boltzmann:

Entropy = k log (degrees of freedom)

The relationship is a sophisticated combination of the abstract and physical, dealing with the connection between order and the state of one’s knowledge of the behavior of a system, and is bound up in the ambiguous nature of probability. Statistics attempts to extract stability out of randomness by seeking regularity in the frequency of events, calling on the theory of limits to create the mathematics of probability and the analysis of variance.

There is today an ongoing argument among formal statisticians as to whether Taguchi’s methods are inductive or deductive. But as Myron Tribus of MIT put it:

“Any theory of probability is concerned with taking information and encoding it in such a way that it enables us to act on the information without presuming more that we know. . . . The fruitless debate over subjective versus objective interpretations of probability is. . . a snare and a delusion. . . . made obsolete by an understanding of the deep relationship which exists between probability and information.”

Real-world experiments too often do not yield results which lend themselves to textbook treatment; it is sometimes impossible to locate a control factor which influences variability without shifting mean, or vice-versa. It becomes obvious that compromises are necessary, and the literature of the Design of Experiments is regrettably silent on this subject. With a little stretching, the techniques of linear programming may be applied to the simple problems. The compromises become even more complicated if one has difficulty in deciding between multiple performance requirements (e.g., it does no good to reduce the shrinkage in a plastic part to an acceptable level, if the required process change simultaneously deteriorates another property, like strength).

In my studies in this area, I begin to see a pattern emerging where problems can be categorized (in a way that is related to degrees of freedom) into classes which lend themselves to discrete solution algorithms.

It seems not too far-fetched to me to suggest that families of solutions can be fitted to these classes (not unlike the equations servicing the thermodynamic cycles of ideal gases), and that these will emerge someday from the mathematical aquarium of chemical engineering.

Very truly yours,

Mel Spat, P.E.
Senior Consultant
ARGYLE ASSOCIATES, INC

SHORT COURSES FOR 1989

University of Wisconsin-Madison
Center for Quality and Productivity Improvement

“An Explanation and Critique of Taguchi’s Contributions to Quality Improvement
May 22-25, 1989
September 11-14, 1989

Instructors: George Box, Soren Bisgaard and Conrad Fung of the Center for Quality and Productivity Improvement.

Recently there has been much interest and some controversy concerning methods of Professor Genichi Taguchi for improv—
Designing Industrial Experiments: The Engineer's Key to Quality
April 24-28, 1989
November 13-17, 1989

Instructors: George Box, Soren Bisgaard, and Conrad Fung of the Center of Quality and Productivity Improvement.

This 4½ day course is especially tailored to the needs of engineers involved in design, research and development, manufacturing, and quality engineering. Statistical design of experiments is an enormously powerful tool for the efficient study of the many factors affecting optimal performance of products and processes and for building in quality upstream so that products are robust and rarely go wrong. Participants will learn by doing, each step being illustrated with examples. Some prior acquaintance with elementary statistical concepts would be helpful.

Case Studies in Quality Improvement
A Symposium
September 14-16, 1989

A focus on quality continues to be one of the United States' best strategies for regaining a competitive advantage. This case studies symposium, a dynamic forum for the exchange of ideas and experiences among quality professionals, will help sustain the growing quality movement in the U.S. by accelerating understanding and awareness of the potential of modern quality improvement ideas.

You will see case studies presented by workers from a diverse cross section of manufacturing and service organizations. A guiding principle will be that the methods used are appropriate for the problem — these studies will be problem-driven, not method-driven. Ample time will be scheduled for discussion of each case study.

1989 William G. Hunter Conference on Quality
April 19-21, 1989

Plans are underway for the 1989 William G. Hunter Conference on Quality, which will take place April 19-21, 1989 in Madison, Wisconsin. The conference is being organized by the Madison Area Quality Improvement Network (MAQIN). For information, or to volunteer your help, contact Barb Hummel, MAQIN, 1010 Mound Street, Madison, WI 53715, (608) 267-6581.

For registration information, write or call:
Thomas J. Snodgrass
Engineering Professional Development
432 North Lake Street
Madison, WI 53706
(608) 263-3371 or (800) 262-6243
(800) 362-3020 in Wisconsin

Nominations Sought for Hunter Award

The Awards Committee of the Statistics Division is seeking nominations for the William G. Hunter Award which is presented annually in order to encourage the creative development and application of statistical techniques to problem solving in the quality field. Named in honor of the Division's founding chairman, the award recognizes that person (or persons) whose actions most closely mirror Bill Hunter's strengths, which were as

- a communicator,
- a consultant,
- an educator (especially for practitioners),
- an innovator,
- an integrator (of statistics with other disciplines), and
- an implementor (who obtained results).

The award is intended to honor that person (or persons) who, in the opinion of the Awards Committee, demonstrates the most imaginative development and/or application of statistics during the year for which it is given. In addition, since it is to be given to a person who embodies Bill Hunter's qualities, it is also to be based on a solid record of accomplishment and not solely on one specific event.

The first of these awards was presented at the 1988 Fall Technical Conference to Dr. William J. Hill, director of the Center for Applied Mathematics at Allied-Signal, Inc. The next award will be presented at the 1989 Fall Technical Conference in Houston.

Nominations for this year's award should be sent to
Edward F. Mykytka
Industrial Engineering Department
207 Dunstan Hall
Auburn University, AL 36849-5346

to be received no later than June 30, 1989. Your letters of nomination should include a thorough discussion of the nominee's qualifications and the names, addresses, and phone numbers of both the nominee and the person making the nomination.

How To Order "HOW-TO" Books

The "HOW-TO" books may be purchased directly from ASQC in one of THREE ways.

1. You may call ASQC (414) 272-8575. In order to exercise this option you must be prepared to give a purchase order number or a valid credit card number as well as your ASQC member number.

2. You may use the order form which appears in the book section of Quality Progress.

3. You may use the order form which appears in the ASQC Publications Catalogue which is mailed to all members several times a year.
The Statistics Division was chartered by ASQC on July 6, 1979. In our first decade we’ve grown rapidly to a membership of over 13,000, about 20 percent of ASQC overall! To ensure the readiness of the Division’s infrastructure to meet the continuing challenges of serving our members and leading the profession, nine Division Council members met in February to re-examine our mission and plan the long range future of the Division.

We modernized the Division Mission to recognize that fostering statistical thinking in all activities is much more at the heart of quality and productivity improvement than is the isolated application of particular statistical methodologies — although the development and application of powerful methods remains vitally important. With this perspective, the full mission of the Statistics Division is:

- To promote statistical thinking for quality and productivity improvement;
- To be an authoritative resource organization specializing in statistical methods for quality and productivity improvement serving the Society, industry, academia, and government;
- To provide a focal point within ASQC for research, development, and application of these methods; and
- To aid in the professional growth and development of division members.

We are proud of the many things the Division does already — including publication of this newsletter and the How-To Booklet series, cosponsorship of the Annual Fall Technical Conference and the Applied Statistics Conference, organization of several sessions at the Annual Quality Congress, organization of preconference seminars, support of local conferences, the review and development of standards, and active participation with the new Section on Quality and Productivity of the American Statistical Association. We’ll continue with these activities, but we want to be even more effective, and we want your help.

Our top two priorities are to understand members’ needs and to build the Division’s infrastructure to serve those needs. To start on the first objective we will conduct a membership survey during the next month via telephone interviews with a stratified random sample of Division members. The results will be summarized at the Division Council meeting in Toronto in May and in a future newsletter. We will also use this newsletter to foster two-way communication with our members, as Lynne Hare mentioned in his Chairman’s message.

To build the Division’s infrastructure, incoming Chairman Steve Bailey is forming a committee of Council members to evaluate current jobs in the Division and to define additional positions that might be required. The results of that committee’s work will be summarized in a future newsletter. In particular, vacant positions will be well publicized.

Many other strategies for improvement of the Division were also discussed, including improving our role as a value-adding force in the National organization of ASQC, and more effective interaction with local sections and regional councilors.

We invite you to get involved. Volunteer for jobs and recommend ideas. We hope to see you at the Division Council meeting at the Annual Quality Congress in Toronto (May 7, 8:30-10:30 pm), at our booth at the Congress, or at our hospitality each evening.
Chairman Lynne Hare makes a point while Membership Chairperson, Nancy Baxter, listens attentively.

Division Treasurer Conrad Fung
Sponsors: The Chemical Process Industries Division of the ASQC, the Section on Physical, Chemical and Engineering Science of the ASA, and the Statistics Division of the ASQC. Host: North Jersey Section of the ASQC

At the end of WWII our nation found the entire world eager for its industrial products. In the early post-war days the voice of the customer was suppressed by his desperate need for goods. His perpetual dependence upon our industry was, we thought, guaranteed by offering him easy credit, and by providing him with products with built-in obsolescence fancied up by frequent style changes. Do you recall the play "Death of a Salesman" wherein Willy Loman complains how, by the time one out and needed replacement? Only within the past dozen years or so has American industry awakened to the fact that others can produce superior refrigerators, watches and cameras, TV sets and automobiles, and more to the point, better, faster and cheaper than we. We have found in recent years our markets eroding, and many completely vanished. The search is now to find our way back.

To discover what went wrong our industrial leaders traveled abroad to see for themselves how these miracles of productivity could have arisen. Frankly, they rediscovered the wheel, and were taught lessons they might have learned earlier from Deming or Juran, or if awakening today, by listening carefully to Godfrey, Joiner, or Snee.

They discovered that improved productivity went hand-in-hand with product quality: that quality and productivity were but two sides of the identical coin. Further they learned that increasing quality and productivity requires the active commitment and collaboration of both management and worker, that team efforts at problem solutions are of great importance, and that vast reservoirs of talent exist on the production floor. They also discovered that education in the simple quantitative methods of the statistician was of great value. But the single major lesson learned was that quality is the key to enhancement of productivity, competitive advantage, and profits.

The formal definition of "quality" as noted in the ANSI/ASQC consensus standard A3 (1978) is:

"Quality is the totality of features and characteristics of a product or service that bear on its ability to satisfy given needs."

I suspect today one could go on further and state that quality should go beyond "given needs" and provide the customer with more benefits than he expected.

The definition provides a broad umbrella for a host of activities: the awakening and involvement of upper management, the improvement of interpersonal relations, methods for determining the voice of the customer, techniques for problem solving, Dr. Deming's fourteen points, . . . , one could go on. Further, the definition holds whether we are discussing goods or services. Some of us might argue that many of these activities are not statistical in any technical sense of that word. Others would maintain that statistical methods are ubiquitous in all of the described areas. I do not wish to argue these matters. My concern in today's conversation is much more narrow. I would like to discuss the present and future role of statisticians in the design, manufacture and use of industrial products.

The applications of statistics on behalf of the quality of manufactured products has grown tremendously over the past few years. Everyone in industry it seems is now in the midst of learning how to apply Ishikawa's seven graphical problem solving tools, and even how to plan and analyze simple statistically designed experimental programs. One's daily mail comes laden with announcements of short courses and software programs designed to make our transition to these higher levels of quantitative and statistical literacy easy and painless. As you all know, I along with many others make a living by providing these services. And it is important work. The problem is that what we are providing is far from enough. Education in charting, control charts and the design of simple comparative experiments is necessary but hardly sufficient. These tools are simple and useful, but they form only part of the cutting edge of modern productivity.

The successful enhancement of the quality of manufactured products directly involves technology. This statement is not meant to disparage the necessary contributions of managers or workers, or the labors of those teaching the elementary tools of statistics. But I believe the cutting edge of industrial quality rests upon the contribution of professionals in the chemical, physical and engineering sciences. They are the crucial ones. Japanese and European products excel when compared to many American products because their engineers, with quality on their minds, have designed and produced a better product.

Accomplishing the engineering of a better product is a technical and cross-disciplinary art. It draws down directly upon the material and physical sciences, and it is not fearful of mathematics beyond the arithmetic. It is of course respectful of management and good organization. But as Bill Kruskal would note, it is an "n-culture" activity. This n-culture was recently described as "Simultaneous Engineering" in the September 1988 issue of Manufacturing Engineering. The major article is written by its executive editor Robert E. Stauffer who quotes W. David Lee, Director of the Arthur D. Little Center for Product Development. Dr. Lee defines simultaneous engineering as "the process in which key design, engineering and manufacturing professionals provide input during the early design phase to reduce downstream difficulties and build in quality, cost reduction, and reliability from the outset." Editor Stauffer further notes that successful simultaneous engineering requires a "marriage" among team members and the creation of a multi-disciplinary culture.

The concept of simultaneous engineering seems to have many parallels. The Mechanical Engineering Handbook, (John Wiley, 1986), identifies "Productivity Engineering" as the intersection between product design and manufacturing and notes that "designing for economic producibility not only during the concept and development of the design, but also during the production phases and throughout the entire life cycle of the product."
Simultaneous engineering could also be considered an adaptation of "Systems Engineering". Professor Andrew P. Sage of George Mason University notes that system engineering involves requirements specifications, preliminary design, detailed design and testing, evaluation and operational deployment. Systems engineering is further identified as a management technology to support policy making and planning for decisions.

The concept of simultaneous engineering seems to find a harmonic resonance in many professional societies. The SME (Society of Manufacturing Engineers) is entirely devoted to research, development, application and exposition of all aspects of manufacturing, product quality and productivity. The ASQC has similar objectives. But more important is the fact that all the major engineering professional societies have divisions and publications devoted to discussion of the problems and philosophy here identified as simultaneous engineering. A good example is the ASME (American Society of Mechanical Engineers) *Journal of Engineering for Industry*. Other examples with more managerial flavor are the IEEE (Institute of Electrical and Electronics Engineers) publication *Engineering Management Review*, the ASCE (American Society of Civil Engineers) *Journal of Management in Engineering*, and the IIE (Institute of Industrial Engineers) *Industrial Management*. Other journals and magazines offer technical papers and popular articles concerned with the objectives we have identified here as 'simultaneous engineering'. Examples are the *Naval Research Logistics Quarterly*, the *International Journal of Production Research*, the *Journal of Manufacturing Systems*, the new journal *Quality Engineering* and at a less technical level the magazines *Quality, Quality Progress* and *Manufacturing Engineering*.

Clearly what is evident here is the emergence of a new engineering philosophy traveling under the varied names of simultaneous engineering, producibility engineering, systems engineering, manufacturing engineering, and one might even propose Quality engineering. Whatever its name, it is engineering its substance and orientation. Further, it is obvious to this observer that it is a branch of engineering that offers unusual opportunities for the present application and future development of statistical methods.

This developing concept of simultaneous engineering received an important boost in March 1987 when Frank Carlucci, the Secretary of Defense, sent a memorandum to everybody who was anybody in the Department of Defense on the subject of "Total Quality Management." The American Statistical Association was among the many external organizations that also received a copy. Let me read you the essential paragraph.

"Quality in weapons systems is central to the DoD mission. Therefore, I have asked the Undersecretary of Defense Acquisition to lead the TQM thrust by implementing it as an integral element of the entire acquisition process. In doing so he will be seeking a fundamental change in how the acquisition community views product quality. He will develop the policies and seek appropriate federal acquisition regulations and other regulatory changes to ensure that TQM is enforced in regulations formulation, design, development, production planning, solicitation, source selection, manufacturing, fielding and support."

Shortly thereafter IDA (the Institute of Defense Analysis) was asked to prepare a report for the DoD on the "Role of Concurrent Engineering in Weapons System Acquisition." Concurrent engineering has been defined by Leo Hanifin at RPI as "a systematic approach to creating a product design that considers all elements of product lifecycle from conception through disposal and in so doing simultaneously defines the product, its manufacturing process, and any other required life-cycle processes, such as maintenance." Obviously, we have still another name for simultaneous, producibility, systems, manufacturing and quality engineering!

IDA then began its investigation into concurrent engineering and in December 1987 held a Concurrent Engineering workshop, followed by two more workshops in early 1988. A preliminary report was prepared. This report first came to the attention of the statistical fraternity in late August '88 at the conclusion of the ASA annual meeting in New Orleans, thanks to the efforts of Bob Lundegard and Raghu Kackar of NIST (the National Institute of Science and Technology, the old National Bureau of Standards). The IDA report said almost nothing about the possible important and broad contributions of statistics to Concurrent Engineering except for the frequent mention of Taguchi Methods and the offer of the American Supplier Institute: Center for Taguchi Methods to teach courses.

It was simply incredible to me that so important a document could have come so close to completion without at least some of the nation's leading industrial statisticians being involved. I am happy to report now that many recognized statisticians have had an opportunity to comment upon the IDA report and to submit materials to IDA for their consideration. We trust that future discussions about Concurrent Engineering, and the use of the DoD's vast resources on its behalf, will continue to consider the professional contributions of the nation's industrial statisticians.

And now let me change the subject slightly. The issue of the melding of statistics and engineering becomes particularly important when we begin to consider the education of the engineer, the second major concern of today's discussion. It still takes four and possible five years of work on the part of a motivated intelligent student to acquire a degree in engineering or the sciences. It may take several more years before the graduate becomes a productive worker. Given the pressure of current events we can forecast that the education of students in engineering, and particularly in Concurrent Engineering, is likely to increase dramatically and we here all recognize this as an important opportunity for the statistical profession. I bring this conversation around to education to provide an opportunity to discuss present efforts to make statistics an integral part of the undergraduate education of every engineer.

Serious efforts by statisticians began four years ago with the three day conference organized by Bob Hogg at Iowa City in 1984. The meeting represented a tremendous investment of time and energy on the part of many individuals, and was organized outside of regular ASA or ASQC activities. The conference was attended by over forty statisticians, half from industry and half from academia. Their recommendations appear in the August 1985 issue of the American Statistician. In November 1986 Neil Ultman and Don Marquardt attended a National Conference on Engineering Education. Don spoke and made a
special plea that the Conference urge ABET (the Accreditation Board for Engineering and Technology) to support a recommendation to include statistics as an integral part of all engineering studies. The Conference passed the resolution. It reads, in part, "that appropriate knowledge and practical experience of statistical experimental design, data analysis, and quality management techniques must be an integral part of every engineering program."

As many of you know, ABET accredits almost all engineering colleges and universities in the United States and its recommendations are closely watched. If ABET would make the resolution on statistics part of its general requirements that would indeed be a great boon to statistics and, I'd like to believe, to industrial quality.

Neil Ullman then began what can only be called a personal campaign to get ABET to accept the resolution. He persuaded David Reyes-Guerra, executive director of ABET to write a letter to all the deans of engineering in America inviting them to attend a conference to consider the recommendation and to discuss the teaching of statistics in engineering. The conference was scheduled for January 1989 and considerable work went into planning the meetings. They were postponed in September.

It is not hard to imagine what the Deans of Engineering must have thought upon first being invited (almost an ABET command) and then being told that a meeting on education in statistics for engineers was being postponed. Postponement was due to several causes, but from where I sit the major cause was money. The hotel at which the meeting was scheduled required a refundable deposit of $25,000. Other expenses equalled approximately the same amount. Some financial support for Ullman's efforts were obtained from the Ott Foundation, the Statistics Division of the ASQC and, thanks to the efforts of Bill Hill, from Allied-Signal. But these resources were far from enough, and so, for the lack of dollars, the game was postponed. The only good news I have is that ABET has plans to submit a proposal to the NSF. ABET, it seems, is doing the statistician's work. (Since giving this talk, the ABET meeting has been rescheduled for 31 May, 1 and 2 June 1989.)

I would like now to make a final point. Isn't it amazing how ineffectual we are? Somehow or other the DoD and IDA managed to go almost six months investigating what might be done to advance Concurrent Engineering amongst its vendors before any real statisticians even became aware of their efforts. And on an issue as important to our profession as engineering undergraduate education in statistics we find ourselves thwarted because of lack of money. My heavens, money abounds, languishes for years in the treasuries of our sponsoring organizations, the SPES, the Statistics Division and Chemical Process Industries Divisions of the ASQC, in the Reliability Division of the ASQC, not to mention other interesting groups and organizations throughout the nation. I feel a bit like a member of a team who has been up to bat twice and cannot get anyone on base... the Rodney Dangerfield team of industrial statisticians.

Why was the ABET opportunity missed, and why were we not asked sooner (almost not at all) to comment on the DoD initiative? I believe the answer is a simple one.

WE ARE FRACTURED INTO TOO MANY GROUPS
WE ARE BALKANIZED!

We are served by several leaderships. We are all submerged into larger organizations that, though sympathetic to our needs, lack the zeal, lack the orientation and concern, that would be required to successfully serve a profession of industrial and applied statisticians. The consequence is clear, as the evidence suggests, we are not recognized as professionals.

And yet there is much to counter this impression. We certainly take on the coloration of a professional group. We obviously have the manpower and the talent to support excellent technical meetings each year, this among the best. We publish fine technical journals, Technometrics, JQT, the IEEE Transactions on Reliability. Many of us are authors of excellent texts. We are a reasonably homogeneous group, most of us with college degrees in engineering or the sciences, and many with degrees in statistics. And yet, we hide our light under a bushel... or should I say, several bushels?

The point I am trying to make now (and let me make clear that none of those here at the head table have been forewarned and therefore may be excused from any responsibility for what follows) is that the time is ripe, nay overdue, for the nation's industrial and applied statisticians to form their own professional society. I do not contemplate a marriage of our separate Divisions and Sections here assembled. They can keep their separate bank accounts and when required attend to the needs and requirements of their parent societies. I am suggesting an offspring, a child, something that we could create together, something in addition to our separate selves. We have lived together a long time, perhaps a child is due! The child would undoubtedly have to call upon its parents for steady sustenance in its early years, and good parents would provide sustenance. I suspect however that it would be a babe for very long and would one day take its earned position alongside the major professional technical societies.

A separate professional society! Now there's a challenge for all industrial and applied statisticians.

In closing I would like to thank the conference organizers, in particular Dick Trout, Lynne Hare and Dick Gunst of the sponsoring societies, and our local hosts Gus Donnell and Bob Spinosa for the opportunity to address this very special audience, and to remind everyone of the title for this conference and talk: "Statistics at Quality, It's Only A beginning." Thank you.

Editor's Note: The opinions expressed here are the author's and do not necessarily reflect those of myself or other officers.

STATISTICIANS: WHERE ARE WE HEADED?
by: Ronald D. Snee

More than ever before, the world of commerce and industry is going through the ordeal of rapid change, trying to become more competitive. It seems that everyone, from individuals to whole industries, is in on the search. So is the statistics profession. Statisticians are examining their role in the Quality Revolution as well as in other activities.

Over the years, statisticians have had a fairly limited number of roles. Mostly, we've been technical specialists, sometimes as a member of problem-solving team, and
often enough, teachers to other professionals. In the jobs we did — the problem formulation, data collection, analysis and interpretation of results — we usually worked one-on-one with a client, or better yet, we were part of a team. When we were teachers, we often faced large numbers of scientists and engineers. But we spent very little time working with corporate management and determining what they needed, or working with the corporation as a whole.

Our focus was on the individual client. As Bill Hunter pointed out, the role of the statistician in the relationship with the client came to depend on whether one or the other was active or passive. This gave us the old view of the statistician:

**THE OLD VIEW**

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That old view is passing. Today, many American companies have found the route to becoming more competitive is a new emphasis on quality. The very concept of quality is loaded with implications for the statistician. Consequently, a new variable — the ORGANIZATION — enters the scene. We find that the resulting number of roles for the statistician has greatly expanded, and the OPPORTUNITY TO CONTRIBUTE HAS EXPANDED accordingly. Bill Hill has emphasized that this gives us what I call "The New View" of the statistician:

This matrix may seem strained to make a point, but who can deny that the roles are fairly portrayed? Whereas in a passive organization, the statistician can aim to become a colleague of the client, in an active organization the statistician can aim to be a colleague of the entire organization. Doing so leads to new roles as teacher, leader, data blesser, and collaborator, but in all cases, being involved in how the organization works.

These roles and others were discussed in the January 1988 issue of Quality Pro-

**THE NEW VIEW**

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A statistician who has a grasp on organizational development (OD) techniques is already a better teacher and leader. OD is the best way to introduce new technology, to communicate values, and to create better project teams. These are things that have to be done to make statistics a constituent part of all business functions. By the time that is accomplished, the statistician will already have achieved the role of collaborator. Along the way, learning OD techniques is best done by teaming up with an organizational development specialist. This is no different from our traditional view that scientific problems can best be solved when scientists and engineers work hand in hand with a statistician.

There is another way to look at these roles which may be more meaningful to the career statistician: they form a career path similar to that of other professionals. The Dalton model for professional career progression identifies four typical stages: the apprentice, the colleague, the mentor, and the sponsor. The seven roles of the "New View" are not perfectly aligned with these four, but crusader, helper, and colleague are similar to apprentice and colleague. A mentor aligns with teacher and leader, and a collaborator is consistent with being a sponsor and helping shape the organization's direction. (I have intentionally skipped over data blesser.)
I think that in the past, too many statisticians have spent their energies within the first two stages, and too few have moved on to mentor or sponsor. It doesn't have to be that way any longer. Industry's emphasis on total quality has already forced many statisticians into leadership roles, and some are now shaping the new culture of their organizations.

Many people question whether statisticians can meet the challenge of total quality. I believe that we can if we understand total quality and the management issues involved. In order to do this, we must change the way we do things and focus on the needs of the organization, as well as on the statistical tools we use. We will also have to become part of the effort to change the culture of the organizations we work for, and make total quality and statistical thinking part of the new culture. This is where I believe that statisticians are headed.

References
Snee, R.D., "Comment on Training of Statisticians," American Statistician, 36, 82-87.
There are many ways companies try to increase the probability that a problem tackled is actually solved. These are similar to the ones we have discussed before.

The Number of Applications

But these are still considerations about how to maximize the average return on what is done. The more important question is how do we increase the number of applications.

The Number of People Trying

The answer should again be obvious. Get more people in the game! What we need to have for a revolutionary rate of quality improvement is an incredible number of people engaged in quality improvement projects. We need to have everybody in the company working together, working individually, working on quality as part of each day's job. There are several keys to this.

Training

If we are going to have large numbers of people in a company engaged in significant, meaningful quality improvements, we must provide them the knowledge, skills and tools they need. They must know how to identify important projects, they must know how to analyze existing data, they must know how to formulate theories based on these results, they must know how to collect the relevant data to test these theories, they must know how to test these theories, and they must know how to determine the true cause of the problem.

Designers must know how to predict reliability, estimate reliability and improve the reliability of new products. Designers must know how to design for simple assembly and testability. Market researchers must know how to gather relevant information on customer needs, wants and expectations and how to translate this information into design requirements. The training we provide these people must be focused on the jobs they are actually doing.

We sometimes get so hung up on our own statistical analyses of the number of worms in the tree that we fail completely to see the forest. A current example is all of the furor over robust design or Taguchi methods versus classical experimental design. What we are failing to stop and consider is that planned experiments are being run in American companies today at a rate unthought of ten years ago. Why?

The best answer I've seen was Anne Shoemaker's presentation at the EQQC Seminar on Improvement and Optimization of Products and Processes in Salzburg two weeks ago (Shoemaker and Kackar, 1988). The way Anne explained robust design methodology was by describing the following four steps:

- Formulate the Problem
- Plan the Experiment
- Analyze the Results
- Confirm the Improvement

In the Robust Design Workshops at Bell Laboratories they spend considerable time on each of these steps. They show the engineers how to work together to state the objectives of the experiment and specify product/process response characteristics that reflect these objectives. They help the engineers develop the lists of control parameters and possible noise and start discussing questions of nonlinearity that should be considered. They show how these lists are reduced and key parameters to be controlled are selected. In short, they address questions that are often not even mentioned in a typical experimental design course.

They also present a step-by-step approach to planning the experiment. They teach orthogonal arrays because they are easy tools to use. Engineers can construct effective designs using these tools. They show engineers how to use interaction graphs as another simple tool to simplify allowing for interactions in the experiments. They show how to tailor the experimental plan to allow for a wide variety of possible experimental situations. They discuss in detail the running of an experiment. They go through real problems. They stress the necessity of mining the true cause of the problem.

Software

Another critical step in increasing the number of people using sound statistical methods to improve quality is to provide well-designed, easy-to-use software. Hooper (1986) and Godfrey (1985) describe reliability packages used in Bell Laboratories for reliability estimation and reliability prediction. These packages provide easy-to-use tools for engineers working on very hard problems. By developing these software packages, integrating them with the corporate component data bases, and providing hands-on experience in three-day workshops statisticians in Bell Labs were able to help create a large community of design engineers using modern methods for reliability prediction and estimation. The reliability prediction package is being integrated into the common CAD tools so that reliability prediction will become a routine step in product design.

Management Support

Another critical step in increasing the number of people using effective statistical methods for quality improvement is to build management support at all levels. Gary Brauer at Kodak has reported a superb process for developing widespread support for experimental design. Before process engineers can attend the eighteen-session experimental design course, their managers must attend a seven-hour management course. During this course one of the exercises is for small teams of managers to compete by optimizing the yield on a typical Kodak process. They are set up beautifully, and each team rushes through its one-variable-at-a-time experiment making many experimental runs and not get-
Cloning

A way of multiplying the number of applications that is far too little used is cloning. Many problems in a company are similar. Although rarely can the results be transferred lock, stock and barrel from one application to another, the steps used to obtain those results can be. Some companies have made the consideration of another applications mandatory. Florida Power & Light has a specific section on the final report form for quality improvement projects for the responsible manager to list other possible areas of application. The manager must also state how these are going to be explored. One of the main tasks of the quality council should be to assure similar applications throughout the company.

Recognition

An extremely effective way to maintain interest in quality improvement, to dramatically increase the rate of improvement, and to increase the efficiency of what is done is through high visibility, publicity and recognition. We should never underestimate the human being's need for recognition and a well-timed pat on the back. We should never underestimate how much we can learn from each other and from well-documented examples and case studies. Company newspaper articles, magazine and technical journal articles describing successful applications and significant payoffs are very effective ways of multiplying the number of applicants.

More and more companies are using videotape to document success stories. One company in Europe is videotaping every major quality improvement project from beginning to end. They tape the team leader at the start describing the problem to be tackled, the approach to be taken, the results expected and the time schedule. They do a process review taping in the middle to document what is working, what is easy, and what are the stumbling blocks. They then tape the final report: what was actually achieved, how long did it take, what lessons were learned, and how the project could have been done better. These tapes will provide this company with an incredibly powerful reference library for future teams.

Bell Laboratories uses a top management "Quality Day" seminar each October to keep the fires burning and share significant quality improvement projects. Directors from different parts of the labs report major successes and describe how they were achieved. A guest speaker describes how his company is managing quality improvement. This is serious stuff. The guest speakers so far have been Koby Kobayuchi, Chairman of NEC; John Young, President of H-P; Jamie Houghton, Chairman of Corning; and next Tuesday, Dave Kearns, Chairman of Xerox.

Electrolux, the giant Swedish company, has a meeting each year of the country and business unit Managing Directors from all over the world with Anders Scharp, the Managing Director. They review the year's quality goals and objectives and performance, publicly announce the coming year's quality goals and objectives, and reward the top performing companies. There are a few. Electrolux has attained a 21% per year.

Recognition can come in many ways. Lucky Gold Star in Korea rewards the top quality improvement team leaders with a two-week working vacation. They travel to Taiwan and Japan and meet the top quality improvement teams there and study what they are doing. On their return, they report to large meetings of Gold Star employees what they learned on their trip. In Singapore I saw one of the greatest recognition ceremonies I have seen. Philips Singapore has captured over 50% of the color television market in China in head-to-head competition with Japanese electronic giants. Team members of the design/manufacturing/distribution and sales team acted out in a skit (wooden shoes, Mao suits and all) the two abortive market entries and then the final successful approach. There was loud cheering and applause from the over 480 managers assembled for the management quality review days.

Of course, the best recognition is quick feedback to the originator of every idea, every improvement suggestion. And the best feedback is the implementation of the idea or suggestion. This is one key to Philips Taiwan's remarkable record of two implemented suggestions per employee per month last year. This year the goal is four implemented suggestions per employee per month.

THE COUNTRY

So far we've been talking about what individuals in a company and companies can do, but our problems in the United States are far bigger than that. What can we do as a country?

We can develop strong quality improvement programs in our federal and state governments. We can follow the lead of America's strongest companies and find ways to eliminate the waste, the rework, the scrap, the unnecessary in every branch of government, every agency, every office. We can stop building weapons systems that don't work, roads that crumble after two years of traffic, computer systems that lengthen report cycles and increase data errors.

This summer the first annual Federal Quality Conference was held in Washington, DC. Over 1100 top federal executives attended. Three agencies received awards and were designated role models for their pioneering work in quality improvement. It was an excellent first step on a very long journey. A Federal Quality Institute is being formed to help promote the use of good quality improvement methods throughout the federal government. The commissioners of key bureaus such as the IRS and the bureau of Labor Statistics are taking leadership roles in a major change process. Top executives in the Coast Guard and Veterans Administration are developing sound programs.

We can build strong programs in our universities to make available to students, faculty, and society modern methods for quality improvement. Wisconsin has established a solid leadership position with its Center for Quality and Productivity Improvement. Fordham has made a major change in its Business School with a remarkable focus on quality management. Columbia has created strong programs in the Business School and through the American Assembly. Harvard is providing needed leadership for healthcare quality as are medical schools at UCLA, University of North Carolina, Johns Hopkins and Rochester.

Our professional societies and trade
associations can provide resources and a needed focus for much of the activity in quality management and improvement. The American Society of Engineering Educators, the Institute of Industrial Engineers, and the Institute of Electrical and Electronics Engineers have all created special committees or activities in quality management. The American Electronics Association is selecting graduate students in engineering and computer science each year, training them in Japanese and placing them in Japanese research labs for one-year assignments. The National Science Foundation is sponsoring special courses at MIT in reading technical Japanese for electrical engineers and computer scientists.

But there is no more powerful force for quality in the United States than the recently created Malcolm Baldridge National Quality Award. This year sixty-six companies applied for the award. Seventy examiners, twenty-one senior examiners, and nine judges studied these applications with great care. High-scoring applicants were selected for site visits where examiners and senior examiners probed in depth for three days to understand the company's quality system. At a White House ceremony next month the winners will be announced. The thoroughness of the application procedure, the care with which companies prepared their applications and prepared for the site visits, the carefully managed review process, and the interest displayed throughout the nation all indicate that the winners of the National Quality Award will be role models for other companies to study, will be leaders in a competitive resurgence, and will be symbols of America's ability to compete and its willingness to compete.

SUMMARY

How can we compete? As individuals, as companies and as a country we can maximize our return on every investment. We can maximize the value of every problem we tackle, we can maximize the probability we solve each problem, we can maximize the probability every solution is implemented, we can maximize the length of time every gain is held, and we can continuously increase the number of applications every day.

As revolutionaries we can worry more about what is done, and less about who does it. We can worry more about how much is done, and less about how it is done. We can worry more about the bottom line and less about the credit line.

And as Dr. Juran told a group of quality managers at a meeting two weeks ago, "just get on with it. Do something. You've spent more than enough time talking about what you are going to do."

PERSONAL NOTE

I would like to close with a personal note. I never knew Jack Youden, but I have always admired his clear, common sense way of writing and his way of thinking about statistics. I do have one rather indirect Jack Youden story. Twenty years ago I started graduate school in an attempt to become a statistician. Each year during summer break and at Christmas I would visit my parents. My father was "retired." After 37 years of government and industry research and development in genetics he had become the head of the Biology and Chemistry Department at a small college in North Carolina.

My father would quiz me on statistics during each visit. He would pose some design problem from genetics and ask something he wanted to know about ANOVA or regression. I would give him a rather blank look and try to switch the subject to Lebesque measure or uniform minimum variance unbiased estimators. He would always ask, "Don't they teach you any applied statistics?"

One day he was explaining something to me about experimental design and he started describing a short course he had taken one summer at the University of Maryland while he was working at the Department of Agriculture Research Center. He felt I probably would not have heard of the instructor because he was more of a geneticist than a statistician. The instructor was R. A. Fisher. He said that he had a lot of trouble understanding the lectures, but fortunately he was car pooling to class with a statistician from the Boyce Thompson Institute for Plant Research who often visited the Department of Agriculture Research Center. The statistician would explain everything Fisher had said in clear terms on the way home. This statistician, with the wonderful knack of explaining everything so clearly to a scientist in his own terms was, of course, Jack Youden.

My father was so questioning of my statistics courses because he thought statistics should be an applied science. He kept saying, "It's no good if you don't use it. Why don't they have you out in the real world solving real problems?" I would just like to say to my father after all these years, "We're getting there." We are finally realizing statistics grows stronger with every use and application. That the value of statistical methods, especially in industry, is growing every day with every new experiment, with every new data set analyzed, with every model. We've come a long way in the past fifteen years. It was very heartening to see the survey results in Gerry Hahn's Youden address last year (Hahn, 1987). Seventy-nine percent of the industry respondents thought that statisticians' contributions were greater than five years ago. Eighty-four percent through that commitment to quality improvement in North America is greater now than five years ago.

Statistics, quality and the bottom line. We can survive. We can compete. We are on our way. We have a long way to go, but it sure is going to be fun!
## References


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### Characteristic Sensitivity

_by Dean C. Holle_

The use of statistical process control charting is beginning to be an absolute necessity in today's manufacturing environment. Competition — the driving force of manufacturing — has resulted in increased efforts toward the ever-present goal of achieving greater productivity at lower cost. SPC is a good tool to help us along this path.

Many companies are beginning to require SPC charting from their suppliers as a prerequisite of doing business. Some even specify the characteristics the supplier will track, and the statistical methods to be used, even while the project is still in the conceptual phase. At this point we begin to see too much of a good thing.

Not all characteristics are fit to be charted. An effective SPC charting plan for a specific process will identify when a process is no longer performing to a theoretical model which was previously established. The selection of the characteristic that will be tracked is very important. A poor choice may show a natural plot, even when major process variation is present. This is the sort of thing that causes a recently implemented SPC program to lose credibility and support.

What is needed is a method for selecting a characteristic which will show variation when it occurs. If you would like to apply SPC charting methods to your established process, but you don't know which characteristic to use, try this rather simple selection procedure which we have developed, and which works well for us;

1. Make a list of all likely candidate SPC characteristics. Among other things, consider the items that are critical to the customer, anything that the manufacturing department feels is a good process indicator, or anything that the quality department can show to be historically variable. You may want to eliminate items that are difficult, destructive, or expensive to test, or items where the gauging method is not reliable.

2. Collect samples from the "natural" process. When the manufacturing department feels the process is running well, collect 25 to 30 consecutive samples. Mark these as "natural."

3. Collect samples from the process while it is in an "unnatural" state. Immediately after the "natural" samples have been collected and identified, deliberately alter the process. The process parameters to be altered, and the magnitude to which they will be altered should be left up to the judgment of the manufacturing department. Basically those parameters which are hard to control, and therefore are the most likely to vary during normal production, should be considered. Try about six different process variations, (more if you are ambitious). Collect samples from each process alteration, and mark these samples as the "unnatural" samples. You may also wish to note which process alteration each sample represents.

**NOTE:**

*Perform steps 4 through 7 individually for each of the characteristics that are being tested.*

4. Measure and record the results for the "natural" group, and the "unnatural" group. Perform destructive tests if any last.

5. Calculate \( \bar{x}_N \) and \( S_X \) using only the data from the "natural" group.

6. Use the worksheet to complete the formula below. This will determine the "Characteristic Sensitivity" index, (CS index).

\[
\text{CS index} = \frac{N}{\sum_{i=1}^{N} \frac{\bar{x}_N - x_i}{3S_X}}
\]

Where: \( \bar{x} \) = The average value for the characteristic being tested from the "natural" sample.

Where: \( S_X \) = The estimate of standard deviation for the characteristic being tested calculated from the "natural" sample.

Where: \( N \) = The number of "unnatural" samples that were collected.

Where \( x_i \) = The individual measurement for the characteristic being tested from the "unnatural" sample.

7. Evaluate the results using the following criteria:

Any characteristic with a CS index of 1.0 would indicate the "unnatural" data has variation, (on average) exactly three \( S_X \) from "normal" \( \bar{x} \), and as such is an unpredictable indicator of process variation.
Any characteristic with a CS index higher than 1.00 would indicate the "unnatural" data has more variation, (on average) than \( S \) from "normal" \( \bar{X} \), and as such a greater tendency to indicate process variation when it occurs.

Any characteristic with a CS index lower than 1.00 would indicate the "unnatural" data has less variation, (on average) than three \( S \) from "normal" \( \bar{X} \). This data is virtually indistinguishable from the data in the "normal" distribution, and as such would be a very poor choice to track process variation.

Therefore:

- CS index \( > 1.00 \). Good choice of use in SPC charting.
- CS index = 1.00. Marginal choice of use in SPC charting.
- CS index \( < 1.00 \). Poor choice of use in SPC charting.

8. Done.

Using the CS index you should be better able to choose the best characteristic for the charting to be done, and therefore get the best performance from your SPC program. If you have any questions please do hesitate to call.

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Editor's Note: The author is, I believe, trying to select those characteristics which are most sensitive to changes in the process. This has merit. I am not sure what the sampling distribution of his statistic CS would be, and why 1.00 is a cutoff. Were I going to do this, I would see more point in calculating the U statistic:

\[
U = \frac{\sum (x_i - \bar{X})^2}{N}
\]

and selecting those characteristics with high U values.

The next two columns contains the blank work sheet to aid you in compiling data from Steps 4 through 7.
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