Statistics - Aided Manufacturing: A Look into the Future
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Over seven years have passed since Ed Deming challenged the nation on prime-time television to adopt a new vision in the now famous NBC White Paper, "If Japan Can—Why Can't We?" Much has happened since then. I will review the changing environment, discuss some major technical and non-technical challenges, comment on how well we are meeting these challenges, and state my view of the statistician's role in all of this. As a starting point, I would like to recall some comments by Jack Youden, shown in Table 1. These are as valid today as when they were first written—over 30 years ago.

TABLE 1
A MESSAGE FROM THE PAST

- THE RESPONSIBILITY FOR ADOPTING STATISTICAL TECHNIQUES WILL OFTEN REST ON INDIVIDUALS WHO KNOW RELATIVELY LITTLE ABOUT THESE TECHNIQUES.
- THERE IS ONE SURE WAY FOR A COMPANY TO ACQUIRE A WELL-TRAINED STATISTICIAN. SELECT A _ (PROMISING) ENGINEER OR SCIENTIST _ AND SEND _ TO A STATISTICAL SCHOOL FOR A YEAR.
- MOST STATISTICAL PROCEDURES ARE QUITE SIMPLE AND INTUITIVELY ACCEPTABLE ONCE THEY HAVE BEEN POINTED OUT IN A PARTICULAR CONTEXT.
- A GOOD STATISTICAL DESIGN IS LIKE A BLUEPRINT FOR A CONSTRUCTION JOB.
- STATISTICAL TECHNIQUES ARE MOST PRODUCTIVE WHEN INCORPORATED INTO PROJECTS AT THE PLANNING STAGE.
- MUCH OF THE IMPACT OF A STATISTICAL QUALITY CONTROL CHART DEPENDS UPON ITS PRESENTATION.
- INDUSTRIAL APPLICATION OF STATISTICAL DESIGN REQUIRES MORE ACTIVE SUPPORT FROM MANAGEMENT.

SOURCE: STATISTICAL DESIGN: COLLECTION OF ARTICLES IN INDUSTRIAL AND ENGINEERING CHEMISTRY, BY W.J. YOUDEN, 1954-1959.

THE CHANGING ENVIRONMENT

Quality control practitioners need no reminder of the new environment. I have tried to summarize its major non-technical and technical aspects in Tables 2 and 3.

TABLE 2
THE CHANGING ENVIRONMENT: NON-TECHNICAL

	CONVENTIONAL QUALITY CONTROL	THE NEW VISION
MAJOR EMPHASIS	INSPECTION TO CULL OUT DEFECTS (REACT)	"UP FRONT" QC TO PREVENT BAD PRODUCT (ANTICIPATE)
WHOSE RESPONSIBILITY?	QC ENGINEER	EVERYBODY—LED BY TOP MANAGEMENT
AT WHAT POINT?	MAINLY ON FINISHED PRODUCT	CONTINUOUSLY THROUGHOUT THE PROCESS, INCLUDING DESIGN AND VENDOR
TECHNOLOGY	RELATIVELY SIMPLE	OFTEN HIGHLY COMPLEX
THE ARENA	MANUFACTURED GOODS	ALL GOODS AND SERVICES

A BASIC GOAL OF THE NEW VISION: UNDERSTAND AND BE RESPONSIVE TO CUSTOMER NEEDS—WHILE CONTINUOUSLY IMPROVING PRODUCTS AND PRODUCTIVITY

TABLE 3
THE CHANGING ENVIRONMENT: TECHNICAL

	CONVENTIONAL QUALITY CONTROL	THE NEW REALITIES
THE GOAL	"SQUEEZE" MAXIMUM INFORMATION FROM SPARSE DATA (DATA POOR)	"EXTRACT INFORMATION FROM VOLUMINOUS/CONTINUOUSLY CHANGING/FREQUENTLY AUTOMATED DATA BASE (DATA RICH)
THE MECHANICS	MANUAL: REQUIRES SIMPLICITY IN IMPLEMENTATION	COMPUTERIZED: REQUIRES SIMPLICITY IN INTERPRETATION (OFTEN BY LEAN STAFF)
A RESULT	CONCERN WITH STATISTICAL EFFICIENCY	CONCERN WITH COMPREHENSIVENESS AND ROBUSTNESS

THE CHALLENGE: OBTAIN AND COMMUNICATE THE KEY INFORMATION THAT WILL DRIVE QUALITY IMPROVEMENT

One of the consequences of the new passion for quality improvement is that it is all-pervasive. We become very sensitive to quality in our personal lives, and are intolerant of indifferent service when we experience it in, say, air travel, a doctor's office, or in our youngsters' schools. And, from these experiences, we resolve to do continuously better when we are the providers — rather than the receivers — of goods and services. (The desire for continuing quality improvement has also impacted this paper. I have gone through various versions in a continuing effort for quality improvement. The readers may rightfully question the value of the final product — but they can, at least, be assured that it is better than some of the earlier versions.)

"What is more important — the non-technical challenges, summarized in Table 2, or the technical ones of Table 3?" I posed this question to the 205 members of the American Statistical Association's Committee on Quality and Productivity — not exactly a random sample of quality practitioners, but yet a good source of knowledgeable opinion. Of the 107 respondents, 77% indicated that the primary challenges were non-technical. Moreover, an industry-based subset of those surveyed had an even stronger disposition to the non-technical (84%). Indeed, only 10% of the total group and 4% of the industry-based group felt technical issues were more important than non-technical ones. In light of these responses from statisticians one might only conjecture how a less technical group might respond.

As the "essay part" of the survey, I asked the 107 respondents to state what they regard to be the major challenges. And, as expected, I got about 107 different opinions. I have compiled these and would be pleased to make them available to interested readers.

What follows is the 108th opinion, which has benefited much, and taken generously, from the 107 that preceded it.

NON-TECHNICAL CHALLENGES

Various gurus, such as (in alphabetical order) Crosby, Deming, Feigenbaum, Golomski, and Juran, have spoken eloquently about the non-technical challenges. So have many of the previous Youden Addressers. I have little to add to their thoughts about the importance of management commitment, worker involvement, the need for a team effort, etc. Thus, I will try to add only a few specific observations from my own experience.

First, we need recognize that we have limited resources — there are just a few of us with much to do. Therefore, we need Pareto chart our activities to identify and concentrate on those with the biggest potential payoffs (even though they may not be the ones that are the most challenging technically).

Next, we must recognize the paramount importance of seeking out productive partners — ones who are receptive to new ideas, and who like ourselves, are activists. These partners should complement our own knowledge and provide us an improved understanding of the physical background of the problem. They, too, need be team players, and must have the clout to get things done. From hard experience, I know we can accomplish little in a vacuum. Without effective partners, the chances of success are remote — irrespective of how valiant our efforts!

We need to play an active role. This requires us to go out into the factory and "kick the tires," as one of my (many) past managers put it. We must understand the real problem— including the political ramifications. This may not necessarily be the same as the problem which our client might describe. Helping define the problem requires inputs from many people, including management. It is something that can rarely be done by telephone — and, certainly not by just talking to other statisticians.

We need be concerned with furthering quality improvement, irrespective of the degree to which it involves statistics. And we need capitalize on all opportunities to do an effective selling job. Tom Boardman urges that we always have available a 30-second "elevator speech" for use when we ride the elevator with our chief executive officer, and are asked, "Well, what's new in the number game?" That's our opportunity to promote, in understandable terms, significant opportunities for quality improvement — and their anticipated payoffs.

Also we need remember, that training in statistical process control is just a starting point — not an end goal. It helps provide needed background to practitioners and can lead to some useful visibility for us, but the payoff is in properly applying the ideas — not just talking about them.

As Deming and his associates have made clear, we must understand the limitations of traditional statistical inference. I have little use for hypothesis testing. Few if any, processes are ever created exactly equal, and whether or not we establish a statistically significant difference between them usually depends greatly on the size of the available samples. It is almost always more meaningful to make interval statements than to do significance tests. However, let's not get carried away by these either. We must remember Deming's warning about the difference between enumerative and analytic studies. In an enumerative study, we may sample a batch and draw conclusions about that particular batch. However, much of the time that's not the real problem. What we have is a prototype batch (of limited interest, per se) and we really wish to draw conclusions about future product. But many things will change in the future. So the statistical evaluation for the current batch tells only part of the story. As a result, statistical intervals provide only optimistic bounds (under the assumption that the past can be used to represent the future).

We also need to improve the introductory statistics courses to which our clients — past, current, and future — are subjected. As currently constituted, these often constitute one big strike against us. We fail to recognize, in our own enthusiasm, that some people might even think of statistics as boring! We must show the real world applications that make statistics exciting. As I have tried to indicate elsewhere [Hahn (1986)], we need to focus on the importance of properly planning investigations. We should emphasize graphical methods and basic concepts, and reduce the emphasis on formal methodolody and mathematics.

We must make it easier for others to use statistical concepts effectively. Many of us are reluctant to do this. However, the ready availability of canned statistical software, gives us no choice. We can learn from Japan, where, I am told, everybody in industry understands statistics. For example, computer-aided experimental design is attracting much interest because it claims to make experimental planning easier, and removes dependence on the statistician. Since such programs are here to stay, we must steer our clients to the right ones for their needs, point out their limitations, and help make the programs more robust against misuse.

We must also reverse our reputation as poor communicators. One important part of communicating is listening to our customers' needs and problems. Then, we must provide short, clear answers in English — not statistical jargon. We need to play the game on our clients' turf and cannot expect them to play it on ours. Moreover, the value of our good ideas, though self-evident to us, may not be so to our clients. When we write a 20-page report on our findings, let's make sure that we include, on the first page, an executive summary of what's really important! (This might even generate interest in the remaining 19 pages!)

Yes! We do need to be technically knowledgeable. However, a good understanding of statistics is a necessary, but not sufficient, attribute of a successful applied statistician.

SOME TECHNICAL CHALLENGES

I would now like to make various comments, some provocative, on key technical challenges to meet the needs for continuing quality improvement and to narrow the gap between theory and practice.

BUILD ON TAGUCHI FERVOR

Taguchi has done us a great service by (among other things) focusing interest on the planning of investigations (more formally referred to as the design of experiments). He has emphasized the impc tance of finding those operating conditions that are most robust to variability — both during production and during the subsequent product use. A natural consequence of his advocacy of minimizing the (squared) deviation from target is the need to use measurement (or variable), rather than attribute, data. In this age of computers, it is often absurd to reduce quantitative measurements into go-no go form.

Taguchi has also further popularized the use of fractional factorial designs, albeit under a different name (orthogonal arrays), and in a slightly different form. We may quarrel with his de-emphasis of interactions. However, I look at highly fractionated plans as a means of searching the experimental space to find the sub-region with the biggest payback opportunities — and then exploring this sub-region fruther — rather than that of estimating effects or terms in a model.

We may disagree with some of the specifics of the Taguchi approach, such as the use of the signal-to-noise ratio, a some of his analyses. However, we need n. throw out the proverbial baby with the bathwater. As George Box and others have pointed out, we should take advantage of the useful ideas that Taguchi has provided us, and accept the challenge to make improvements where appropriate. Also, Taguchi and his associates surely provide us a good lesson on how to get the attention of our customers.

ADDRESS THE REALITIES OF STATISTICAL PROCESS CONTROL

The proper implementation of statistical process control provides another major technical challenge. In practice, few processes are exactly in statistical control. However, some come closer than others. Thus, whether or not a process is deemed to be in statistical control, depends not only on the process itself, but also on such extraneous factors as the type of control chart used, the group size, the sampling frequency, and how common cause variability is estimated. Moreover, the differentiation between "common cause" and "spe cause" sources of variability is not as clea. cut as most texts seem to suggest. (This is why one sometimes finds that when one succeeds in removing a special cause of variation, the common cause variation is also reduced.) For example, we recently dealt with measurements on groups of 5 units sampled consecutively at the end of a production process. The variability among units within such groups, at first glance, seems like a clearcut example of common cause variation. However, in looking further, we found that these five units were really fed by a number of parallel machines upstream, each of which, in turn, was sourced by a number of different incoming material lots. To obtain a more appropriate estimate of common cause variability, we proposed a specially planned investigation that involved taking consecutive units from the same upstream machine, and the same batch of raw material, as well as the same final machine. Not unexpectedly, this resulted in appreciably less "common cause" variability than that observed before.

There are also some further technical complications with which we need be concerned in applying statistical process control, especially in the chemical and process industries. Applications in these industries differ in many ways from the parts industries for which the Shewart methods were originally developed. Some of these differences, such as auto-correlations, are the consequence of automated (and essentially continuous) process measurements. These auto-correlations have always been there for continuous processes. When we take measurements every four hours, they are often of little concern. However, when an updated reading is obtained every second, they generally are.

I feel, moreover, that — especially in chemical processes — there are situations where legitimate batch-to-batch variability is present. In such cases, this should be included as part of the common cause variation [see Hahn and Cockrum (1987)]. Indeed, sometimes, we have a hierarchy of common cause effects with batch-to-batch variation just one part of that hierarchy.

Also, we need recognize the inherent difference between the usual attribute control charts and variable control charts. In particular, for a p chart and a c chart, the values of p and c define the common cause variability (because the distribution mean defines the distribution variation). In contact, for an X-bar chart, the data from the process itself is generally used to separately estimate the process mean and variation. This difference has some important practical consequences.

The preceding comments are not meant to put down the control chart. It is still one of the most important analytical tools available to the quality analyst, even though it may not be the simple cure-all that some advocates may suggest. My purpose is merely to promote sobriety and selectivity in its use. One of the major virtues of the Shewhart chart is that it leads to a plot of observed data against time. So, instead of paying too much attention to the control limits — whose determination may be somewhat arbitrary — I recommend that we shift emphasis to assuring that the data are plotted in the most informative manner. This includes the capability of plotting the results over selected time windows of varying length, allowing side-by-side comparisons of parallel processes, etc.

GUIDE THE SEARCH FOR ROOT CAUSES OF VARIATION

A major goal in the continuing effort to reduce process variability is to identify and then eliminate root causes of variation. This, however, requires that the right data are collected in the first place. We play an important up-front role by providing guidance to help make sure that the needed data are obtained. This includes a careful study of the process to determine when and where to take measurements, and how many measurements are needed. For example, for a chemical process, we recently desired to evaluate the apparent impact of raw materials, feeding into the hopper, on product performance. However, we found that the material measurements that were available really pertained to the material at incoming inspection and cor related poorly with those for the material in the hopper. Thus, statistical analyses are unlikely to bear fruit until more pertinent data is obtained.

We need also push for adequate "memory." Many systems retain information on what was happening during the past week, and even the past month, but the information about that happened a year, or even a few months ago, is difficult to retrieve, or lost entirely.

However, such information, even in summary form, is often important to have readily accessible.

Similarly, we should urge, wherever possible, that samples of current material and product be retained for potential future evaluation. On numerous occasions, changes in observed performance leads us to question the reasons for the change; for example, are the changes in product performance due to raw material, process, or measurement error, or some combination of these? Assuming material properties do not change over time, it is often invaluable to have some past product against which the performance of current product can be compared directly. In most programs with which I have been involved, past product was unavailable. In many of these cases, the retention of even small amounts of such product and/or material could have paid handsome dividends.

We need also push for pro-activeness in searching for the root causes of variability. This means that we should not hesitate to propose special studies or experiments — either on-line or off-line — when this is what is necessary to get the needed information. Such studies might be directed at measuring the "bottom-line" root cause variability, and at evaluating the impact on both average performance and variability of various process or materials variables. In on-line studies, especially in the chemical industry, we need to recognize the potential existence of the "master-chef" — the knowledgeable operator, who adjusts the process, based upon a review of the available data, current goals, and past experience. This phenomenon can create havoc, if not properly recognized, in any statistical evaluations.

RESPOND TO THE NEEDS OF A COMPUTERIZED, DATA-RICH ENVIRONMENT

More and more factories are becoming fully automated, as computer-integrated manufacturing continues to play an ever-increasing role. This often means automated data gathering with essentially a continuous flow of process and performance data. In fact, for many processes, the data-gathering capabilities have far outstripped the ability to digest the information and to appropriately act thereon.

This presents a challenge if there has ever been one! The methodology developed for a data-poor environment is no longer relevant, but what do we have to put in its place? Clearly, time series methods will become of ever-increasing importance. So will the ability to develop incisive summary statistics and comparative graphical displays from vast volumes of multivariate data.

With essentially continuous and instantaneous data flow, our mission will more and more be to identify and help correct problems BEFORE they occur. And, as the volume of data multiplies with increased automation, the available staff to process it is often diminished! Thus, we will need systems that provide computer-aided alarms to trigger corrective action at various levels of the organization — from the process engineer to the plant manager. In this case, we had better properly control the false alarm rate if we wish to maintain credibility! This will require us to reconsider the relative merits of signaling an out of control situation (i.e., a statistically significant change from past performance) — something that is often easily detectable with large masses of data — versus merely identifying a change that is of practical importance.

INTEGRATE SPC AND AUTOMATIC CONTROL THEORY

As MacGregor (1987) has pointed out, the statistical quality analyst and the automatic control theory specialist, rather than being oblivious of one another (or operating in a competitive mode), need unite to further the common goal of continuous quality improvement! The term "statistical process control" is itself a misnomer, as Stu Hunter and others have pointed out. It might better be referred to as "statistical monitoring," since its major purpose is to signal significant changes from the past. In contrast, automatic control theory is concerned with how to adjust a process, often with the goal of coming as close as possible to its target value. This is frequently our real goal. In contrast, we have found that, at least in some applications, process changes are made only when "out of control" performance has been demonstrated by a control chart. However, this may be far from an optimum (or even a good) approach when there is no direct cost for process adjustment, as is often the case for many chemical processes. Instead, how to best proceed depends upon such things as the underlying model, our knowledge of how changes in process conditions impact performance, process dyndamics, etc.

All of this has been long recognized [see Box, Jenkins and MacGregor (1974)]. However, it is more pertinent today than ever before in light of both our renewed interest in quality improvement, and the increased availability of automated data collection schemes.

Incidentally, classical statistical process control (or monitoring) has a place even when automatic control is used. In a recent application, dealing with a modern machining factory, we applied statistical process monitoring to the inputs and outputs of an automatic process control scheme. This, among other things, helps assure that the automatic control continues to do its job, and help prevent it exceeding its capabilities.

GUIDE PRODUCT LIFE ANALYSIS

Product life and in-servicce reliability are important quality performance characteristics that warrant our attention. Failure to recognize this can have disastrous consequences. However, product life analysis presents some technical challenges different from those encountered in other applications. Foremost among these is the obvious fact that it takes time to measure product life. (Exactly how much time depends on the product. Thus, five years of operating experience can be obtained more rapidly on a product that is used only infrequently, such as a toaster, than, say, a steam turbine, which may be in almost constant use.) To obtain information faster, testing is frequently conducted under accelerated conditions, e.g., high temperature, increased voltage, etc. However, accelerated testing requires:

- An appropriate physical model to relate performance at the accelerated stress to normal in-service conditions,
- A proper test plan,
- A valid analysis of the resulting data.

Moreover, the analysis of product life data — accelerated or not — is further complicated by the following:

- The normal distribution is often not an appropriate model for the random variation. Instead, the less familiar Weibull distribution, or some other specialized representation, may be required.
- The available data are often censored (due to unfailed units),
- It is frequently desired to estimate distribution percentiles or survival probabilities to a specified age.

None of these problems are insurmountable. However, they do require the use of special methods with which most engineers, and many statisticians, are not familiar. [See Hahn and Meeker (1984) for some books in this specialized area].

HOW ARE WE DOING?

In the Survey of the ASA Committee on Quality and Productivity, referred to earlier, I also asked the respondents to characterize our progress on various fr[...] The results, which speak for themselves, are summarized in Table 4. Again, I'd be pleased to provide further details upon request.

TABLE 4

SUMMARY OF FINDINGS

- 66% (60% AMONG INDUSTRIAL RESPONDENTS) FELT THAT THERE IS A MIXED COMMITMENT TO QUALITY IMPROVEMENT IN NORTH AMERICAN INDUSTRY TODAY
- 78% (84%) FELT COMMITMENT WAS GREATER THAN 5 YEARS AGO
- 63% (70%) FELT STATISTICIANS' CONTRIBUTION IS MIXED
- 70% (79%) FELT STATISTICIANS' CONTRIBUTION WAS GREATER THAN 5 YEARS AGO
- 39% (47%) FELT STATISTICIANS' CONTRIBUTION WAS GREATER THAN EXPECTED 5 YEARS AGO
- 37% (28%) FELT STATISTICIANS' CONTRIBUTION WAS LESS THAN EXPECTED 5 YEARS AGO

THE STATISTICIAN'S ROLE

Many of us have faced what I like to call "the Deming contradiction." Ed Deming talks fervently about the key role of statistics and statisticians. Yet, when we examine his specific proposals, such as his 14 points and his "deadly sins," we might conclude that these have very little to [...] with statistics, as we know it. And that, [...] course, is the point. Dr. Deming calls for statisticians very different from those trained by conventional methods. Whether or not such persons are still really statisticians, is more a matter of definition than of essence. Clearly, Deming's concept are very much in line with the observation of the majority of our respondents that today's challenges tend to be more non-technical than technical.

Deming and his associates also claim that statisticians are uniquely suited to lead the transformation of the Western management style. I think that's somewhat of an overstatement. I don't think that I or most of my colleagues (even with different training) have the knowledge or the hutzpah to tell management what their style should be. On the other hand, I do agree that we must look at the big picture and that we need be an important part of the quality improvement team.

What then are our major contributions? I have summarized the major areas, as I see them, in Table 5. My views are encasulated in the words of one of the respondents to my survey, who said, "We don't hold all the cards, but we sure hold some pretty good ones!"

TABLE 5

THE STATISTICIAN'S ROLE: A PERSONAL VIEW

- FACING THE DEMING CONTRADICTION
  - DEMING ET AL TALK ABOUT KEY ROLE OF STATISTICIANS
  - MANY OF DEMING'S CONCEPTS HAVE LITTLE TO DO WITH STATISTICS

  DEMING'S VISION CALLS FOR A VERY DIFFERENT STATISTICIAN
- ARE WE UNIQUELY SUITED TO LEAD "THE TRANSFORMATION OF AMERICAN MANAGEMENT STYLE?"
  - PROBABLY NOT
  - BUT WE CAN PLAY AN IMPORTANT ROLE ON THE QUALITY IMPROVEMENT TEAM

CONCLUDING REMARKS

The quest for quality is now an integral part of our lives. It, and the needs of our customers, enters all aspects of our work. We have made some progress, and so has Western industry as a whole — but so too have our off-shore competitors! We still have a long way to go (especially when we realize that quality improvement is a never-ending goal). The non-technical challenges are of paramount importance. There are some significant technical challenges also, but we should not limit our attention to these. The value of our work will be measured by its long-term impact, and not by the sophistication of the underlying mathematics. The new computer-intensive environment provides many opportunities. As we move further from a data-poor to a data-rich environment, we will become more and more absorbed by the challenges of compressing data to gain information and of anticipating and correcting problems before they occur. The future indeed, looks exciting!

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Editor's Note: Deb Hopen is editor of the C.&P.I. Division Newsletter. The ASA Committee on Quality and Productivity referred to herein has now been approved for section status — see article elsewhere in this issue.

ASA Q&P Update

by David Fluharty, Chair

As indicated in the last issue of the Statistics Division Newsletter, each issue will contain a summary of recent activity of the American Statistical Association's Quality and Productivity Committee. In the last several months there have been three major developments:

- The Committee has achieved permanent Section status within ASA (equivalent of an ASQC Division) with 1,200 members — quadrouple its previous membership. As a section, Q&P will be sponsoring sessions at major ASA meetings, particularly the Joint Statistical Meetings in August.
- The annual Joint Statistical Meetings in New Orleans provided an opportunity for a number of people to become actively involved in work of the new Section's committees and for these committees to make plans for the coming year.
- Because of these huge influx of members and volunteers the primary locus of activity has shifted to the working committees described below. More reliance will be placed on ASA's **Amstat News** to provide members with ongoing information.

One of the most dramatic decisions taken was by the Education Committee which has narrowed its focus. It will 1) support efforts of engineering educators who are trying to get statistical and quality tools into engineering education, 2) help to broaden the support for a Q&P component of the business school statistics curriculum, and 3) point out the common areas of interest between the two. This group's efforts will be designed to augment two major efforts in these areas, a) that of the Accreditation Board for Engineering and Technology which will sponsor a Conference on Statistics in Engineering Education January 11-13, 1989 in New Orleans, and b) the annual Conference on Making Statistics More Effective in Schools of Business.

The Research Committee will attempt to identify areas in quality and productivity where new research is needed, disseminate this information to statistics community to foster this research, and sponsor forums to bring researchers and practitioners together. This group is exploring the possibility of publishing an annual report of research highlights of the prior year.

With increasing complexity of processes and products (including software) improving reliability becomes increasingly important. Unfortunately the tools of reliability analysis which can assist in this effort have not received as much recent attention as other quality technologies. The Reliability Committee will work for broader adoption of these methodologies.

The Awareness Committee has developed a draft of a brochure to spark the interest of managers and executives in the uses of statistical tools. It is also exploring a means to make key printed material, such as major speeches by leading corporation executives, available. Finally, with the theme of quality and productivity, the 1990 ASA Winter Conference will provide an outstanding opportunity for increased awareness.

The Publications committee will be working with the **Journal of Quality Technology** on another special case study issue for January 1990. It is also investigating the possibility of an annual award for a case study.

Finally, committees on specific application areas are being formed. The first is Health Care Delivery. Another group will attempt to improve communications on Q&P issues among Latin American statisticians. In addition, a general Applications Committee will serve to coordinate the interests of people in specific applications areas which do not yet have enough active