ASQ STATISTICS DIVISION Newsletter ©

Volume 19, No. 2 **Spring, 2001**

Chair's Message

by Janice Shade

What are the attributes of a successful statistician? Is it statistical knowledge and passion for the subject? Is success determined by the amount of publications one has? Or is it the ability to communicate one's analysis?

Several articles have been written discussing the changing role of statisticians, all emphasizing the same fundamental idea: Communicating the benefit of using statistics and demonstrating the importance of data-based decisions to drive business opportunities. In broader terms this can be rephrased as the marketing of our profession to improve the bottom line.

What role should marketing have on statistics and data analysis? Some may say nothing. Some may say a great deal. So, let's look at the dictionary definitions. **Marketing.** "1. The act or process of buying and selling in the market. 2. The commercial functions involved in transferring goods from producer to consumer."

I'm particularly interested in the second definition. Although our "commercial functions" are more personal in nature, such as how we communicate and how we tie our results to business strategies, our technical knowledge and analyses are the goods. We are the producers, our clients are the consumers. Just as in marketing a product, if the marketing of our skills is not clearly communicated, or the proposed benefits of our work does not meet the expectations of our clients, we may not get a second chance to demonstrate the power of our product.

Time and time again, it's been said that management doesn't lose faith in statistics, it's that they don't see the benefit of using data to drive strategic decisions. Frustrations also arise because many statistical analyses are ignored. Even when our involvement results in a huge success story, statisticians feel management reaction is somewhat cavalier, as if the problem was so simple anyone could solve it. In this instance, the statistician feels he or she is still not appropriately recognized for their contributions.

There are several hypotheses as to why statisticians are not given a greater role. Some say that management is not properly prepared to grasp the results. Others say that the

Continued on page 3

Editor's Corner

by Karin K. Chu

In the past hundred years, the statistics community has experienced an increasing growth in both the understanding and appreciation of this once obscure branch of mathematics. With the new Millennium well on its way, we will be seeing a rising interest in expanding the horizon of statistical applications. This in turn has a profound impact on shaping the role of a successful statistician. To this end, we hope the Newsletter will contribute to bridging the diverse ideologies on defining a "successful statistician", we also hope to serve our readers both as a sounding board and a forum.

In this issue, we have reprinted, at the request of our readers, L. Nelson's article on the Swan & Hicks Quiz (1954), with reprint permission from the JQT (please see their web address on the back of the Newsletter). In addition, we also have a thought-

Continued on page 3

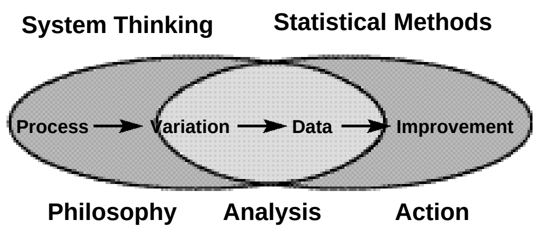
Inside This Issue

MISSION

- Promote Statistical Thinking for Quality and Productivity Improvement.
- Serve ASQ, business, industry, academia and government as a resource for effective use of Statistical Thinking for quality and productivity improvement.
    1. Our primary customers are Statistics Division members.
    2. Other key customers are:
        a. Management
        b. Users and potential users of Statistical Thinking
        c. Educators of the above customers
- Provide a focal point within ASQ for application-driven development and effective use of new statistical methods.
- Support the growth and development of ASQ Statistics Division members.

VISION

Statistical Thinking Everywhere



DESIRED DIVISION END-STATE

- Our members will be proud to be part of the Division.
- Our Division's operations will be a model for other organizations.
- We will be a widely influential authority on scientific approaches to quality and productivity improvement.

PRINCIPLES

- Our customers' needs will be continuously anticipated and met (i.e. customer focused rather than customer driven).
- Our market focus for products and services is weighted as follows:
    1. Greatest weight on intermediate level.
    2. Nearly as much weight on basic level.
    3. Much less weight on advanced level.
- Focus on a few key things.
- Balance short-term and long-term efforts.
- Value diversity (including geographical and occupational) of our membership.
- Be proactive.
- Recognize that we exist for our customers.
- View statistics from the broad view of quality management.
- Apply Statistical Thinking ourselves; that is, practice what we preach.
- Uphold professional ethics.
- Continuously improve.

STRATEGY

- Design and deliver selected useable products.
- Have a strong and vibrant Division infrastructure.
- Demonstrate the broad effectiveness of Statistical Thinking.
- Integrate Statistical Thinking into educational curricula.
- Develop a vibrant information communication system.
- Influence key decision makers.

Disclaimer

The technical content of material published in the ASQ Statistics Division Newsletter may not have been refereed to the same extent as the rigorous refereeing that is undergone for publication in **Technometrics** or **J.Q.T**. The objective of this newsletter is to be a forum for new ideas and to be open to differing points of view. The editor will strive to review all articles and to ask other statistics professionals to provide reviews of all content of this newsletter. We encourage readers with differing points of view to write to the editor and request an opportunity to present their views via a letter to the editor. The views expressed in material published in this newsletter represents the views of the author of the material, and may or may not represent the official views of the Statistics Division of ASQ.

Criteria for Basic Tools and Mini-Paper Columns

Basic Tools

Purpose: To inform/teach the "quality practitioner" about useful techniques that can be easily understood, applied and explained to others.

Criteria:
1. Application oriented/not theory
2. Non-technical in nature
3. Techniques that can be understood and applied by non-statisticians.
4. Approximately three to five pages or less in length (8 1/2" x 11" typewritten, single spaced.)
5. Should be presented in "how to use it" fashion.
6. Should include applicable examples.

Possible Topics:
New SPC techniques
Graphical techniques
Statistical thinking principles
"Rehash" established methods

Mini-Paper

Purpose: To provide insight into application-oriented techniques of significant value to quality professionals.

Criteria:
1. Application oriented.
2. More technical than Basic Tools, but contains no mathematical derivations.
3. Focus is on insight into why a technique is of value.
4. Approximately six to eight pages or less in length (8 1/2" x 11" typewritten, single spaced.)
   Longer articles may be submitted and published in two parts.
5. Not overly controversial.
6. Should include applicable examples.

General Information

Authors should have a conceptual understanding of the topic and should be willing to answer questions relating to the article through the newsletter. Authors do not have to be members of the Statistics Division.

Submissions may be made at any time to the Statistics Division Newsletter Editor. All articles will be reviewed. The editor reserves discretionary right in determination of which articles are published.

Acceptance of articles does not imply any agreement that a given article will be published.

CHAIR'S MESSAGE

Continued from page 1

results are poorly explained to management. Still others say that the analyses do not talk to dollars, the ultimate language of management and strategic decisions. Whatever the reason, the statistician is frustrated, and management is not impacted by the statistician's work.

Taking the marketing thought still further. What if our formalized statistics education only emphasizes the technical foundation in which we are so comfortable? Will this education produce the type of statistician in which business leaders will turn? Will our statisticians be able to cope in a world driven by marketing, and results that are constantly tied to the bottom line? Or are we setting ourselves up for a "Statisticians are from Mars, Business is from Venus" scenario?

How many statistics departments require business courses for graduation? How many conduct courses that teach client/statistician interface? Even in a liberal arts college, are students getting enough guidance on how to incorporate the knowledge learned from core elective courses into their future roles as statisticians? Is the knowledge from these courses reinforced during the technical courses so that our future statisticians see that technical competence alone does not automatically mean success?

For example, what should be done when we are asked to analyze data, in which we had no input in its collection? In today's environment, post mortem data analyses – on data collected with no formal objectives in mind at the time of collection – are commonplace. Many statisticians will say, "Don't venture down that path". But, if we say no, isn't it management's right and responsibility to find someone else to make directional recommendations, whether it be based on data, or gut feel? We all know the importance of proper design, but data dredging may give some credence as to where to begin. And perhaps involvement in a less than optimal situation may open the door for future studies where the statistician can take the leadership role in proper design criteria. But, how should a statistician approach such an analysis, without compromising the discipline? What qualities does the statistician need to assume a leadership role in a cross-functional team?

These are some of the questions the Statistics Division is asking. The answers are not only important to us, but to the survival of our discipline. The Statistics Division is unique because our members come from very diverse backgrounds. Whether academia or industry, formally trained or not, the members all share the same interest: Analyzing data. Over the years, the Division has tried to balance the sanctity of sound statistical analysis with the present day environment of, "What can you tell from this data set. We need the answer now". Sometimes, we teeter a little too far to one side. Then we hear comments such as, "Too much jargon" and "Stop dubbing it down". There is a lot of validity in these comments, and a healthy conversation can help to merge both perspectives.

The Statistics Division is in the unique position to shepherd the task of bridging the gap between business needs and technical expertise. We have the expertise in our membership base to begin to understand the frustrations and shortcomings of our statisticians in the workplace, and what potential enhancements to our curriculum are needed to make us more influential in strategic business decisions.

Many letters of support have been received regarding the decisions made during the October Long Range Planning Session. Much interest has been generated on the initiatives to identify the core attributes of a successful statistician, and the formation of a business/academic advisory board. (Thank you for your thoughts and support. We cannot do it without you, and we want to have your input to make sure we are spending your membership dollars wisely!)

No letters of disapproval were received, but I would be very naive to think that there are no members that disagreed with our approach. I'm particularly interested in hearing from you. Your thoughts will help maintain that balance that we so desperately need to keep.

Regards to all,
Janice

EDITOR'S CORNER

Continued from page 1

provoking article on how to achieve a successful implementation of SPC and avoid common potential obstacles. We hope you will enjoy reading them.

The statistics division of ASQ is currently considering the proposal to move our Newsletter to the ASQ web page. We would like to solicit your feedback on this idea, please contact any of the statistics division officer or myself. We will also be surveying your thoughts on this at the statistics booth at the AQC in May. We look forward to hearing from you!

This is my first edition of the statistics newsletter. My involvement with the AQC has been on the Division/ Section level. I had my first encounter with AQC at the FTC a few years back while still a graduate student. I am currently a Senior Statistician with Intel Corporation. The transition from an academic environment to that of industrial did not occur effortlessly; however, having had previous exposure through events such as FTC and various AQC sponsored activities helped to prepare me for my new role as an industrial statistician.

In the days to come, I look forward to working with the AQC stats team on maintaining and further improving the Newsletter. As always, your comments and suggestions are welcome and appreciated. Thanks!

Sincerely,
Karin K. Chu

INSIDE THIS ISSUE
Letters to the Editor

Dear Editor,

I joined the Statistics Division for one reason: to learn. I just read the Youden Address (Geoff Vining) and want you to know that I am one satisfied customer. Thank you.

Steve Byers, CQM, CQA
Chair, Columbia Basin Section

Dear Editor,

I felt very encouraged after reading the notes from the Long Range Planning meeting, documented in the Winter, 2001 Statistics Division Newsletter. I am a degreed engineer who has been working in the quality field since 1993. During that time I have come to be the focal point for statistical studies in my company, although I've had limited formal training (my role has emerged over the years primarily due to the fact that I enjoy conducting data analyses). In my role I've conducted several types of studies, such as capability studies, gage studies, regression analyses and designed experiments. The issue that I have is that since there is no formal statistics department within my corporation, I don't have anyone to ask questions of when conducting data analyses. I am searching for a mentor-someone I can collaborate with to ensure the tools and methods I'm using are appropriate, and that all assumptions are considered. I've enrolled in a Statistics Graduate program at a local university, but am finding that the program seems quite theoretical, and includes computational math in addition to traditional and applied statistics. I believe this degree will be useful, but in addition I was thinking: wouldn't it be great if there were some kind of industry-academia partnership that matched up statisticians from academia with those from industry. This type of partnership wouldn't require a lot of time on the part of either group, because we wouldn't be looking for anyone to single-handedly "solve" a particular problem; rather, it would be more of a collaboration. Although there would likely be no actual compensation involved, I believe such a partnership would have non-monetary benefits to both industrial and academic statisticians: for the former, there would be a pool of advice and guidance that may not otherwise be available, especially in small or mid-sized companies; for the latter, the needs of industry might be better communicated, from which future papers, courses, or research papers could be developed.

Based on the articles in this past newsletter it appears that the general consensus is that there is a need for collaboration between industry and academia. My proposal is that we take full advantage of the diverse membership within the Statistics division to start opening up the lines of communication between industry and academia. In addition to the immediate and obvious benefits that could be realized in validating industrial analyses, this type of partnership could foster relationships that would make it easier to achieve the elements of the Statistical Division's Vision and overcome the Underlying Contradictions.

Thank you.

Heidi Zierden
Quality Systems Engineer
Sheldahl, Incorporated

AQC STATISTICS DIVISION ACTIVITY ITINERARY

May 5	**1:30 p.m.-4:30 p.m.**	**Re-structuring the Organization**
May 5	**7:00 p.m.-11:00 p.m.**	**Cohesiveness for Meeting Participants**
May 6	**7:30 a.m.-4:30 p.m.**	**2001-2002 Planning Session**
May 6	**7:00 p.m.-9:00 p.m.**	**Advisory Board Meeting**
May 7	**7:30 p.m.-9:30 p.m.**	**Open Business Meeting**

STATISTICAL THINKING

Statistical Thinking is a philosophy of learning and action based on the following fundamental principles:

- All work occurs in a system of interconnected processes,
- Variation exists in all processes, and
- Understanding and reducing variation are keys to success.

Statistical Thinking is a way of thinking, a thought process, rather than a method for calculating. The Statistics Division Vision "Statistical Thinking Everywhere" incorporates the interaction and strong interdependence between the philosophy of Statistical Thinking and the body of knowledge called Statistical Methods.

BASIC TOOLS

(reprint courtesy of JQT)

TECHNICAL AIDS

by Lloyd S. Nelson

Test on Quality Control Statistics and Concepts

Nearly fifty years ago Swan and Hicks (1954) published a list of thirty multiple-choice questions designed to test the reader's knowledge of quality control statistics. On the assumption that few present-day practitioners have seen this article I have selected, and occasionally edited, twenty of the questions for those who would like to test their "IQ in QC." Answers are given in Table 1, but the question numbers have been randomized to make it difficult for peeking to pay off.

1. If control charting shows that the number of nonconforming items in various lots is in control, we can conclude that
   a. The manufacturing process was in control
   b. The product was well mixed before dividing into lots
   c. Either a or b is true
   d. All lots should be accepted
2. Probability paper can be used
   a. To inspect a distribution for normality
   b. For control charting
   c. To reduce the importance of extreme values
   d. None of the above
3. If drawing tolerances and the natural tolerances of a process operating under the normal law are the same, then the control limits for X-bar will be
   a. The tolerance limits
   b. The tolerance limits times n
   c. The tolerance limits divided by n
   d. The tolerance limits divided by $\sqrt{n}$
4. The sum of the deviations of a group of measures from their mean divided by the number of measures equals
   a. σ
   b. σ^2
   c. Zero
   d. X-bar
5. X-bar control charts to examine the variation between averages of samples can be drawn by plotting
   a. Subgroup totals
   b. Subgroup ranges
   c. Subgroup sigmas
   d. Subgroup size
6. MIL-STD-105 is used for
   a. Establishing control limits
   b. Setting tolerances
   c. Accepting material
   d. Inspecting threads
7. A.O.Q.L means
   a. Average outgoing quality level
   b. Average outgoing quality limit
   c. Average outside quality limit
   d. Anticipated optimum quality level
8. The probability of drawing at random exactly one nonconforming unit in a sample of 5 from a lot of 50 containing 20 percent nonconforming is $\boldsymbol{C}^{50}_{5}$ divided into
   a. $\boldsymbol{C}^{49}_{50}\ \boldsymbol{C}^{5}_{1}$
   b. $\boldsymbol{C}^{40}_{20}\ \boldsymbol{C}^{5}_{1}$
   c. $\boldsymbol{C}^{40}_{4}\ \boldsymbol{C}^{20}_{1}$
   d. $\boldsymbol{C}^{40}_{4}\ \boldsymbol{C}^{10}_{1}$
9. A p chart is used when data consist of
   a. Variables
   b. Attributes
   c. Standard deviations
   d. Weights
10. In setting up a control chart for a certain process, sigma is found to be 11 units. Repeated measurements of the same part, using the same technique on which the chart is based, show a standard error of measurement of 5 units. The best estimate of the true standard deviation of the process is nearest to
    a. 6 units
    b. 10 units
    c. 11 units
    d. 12 units
11. The standard deviation of the Poisson distribution is given by
    a. $\sqrt{pq}$
    b. $\sqrt{c}$
    c. $\sqrt{(\Sigma pq)}$
    d. None of these
12. When A and B are distributed independently, σ_{A-B} is equal to
    a. $\sigma_A + \sigma_B$
    b. $\sigma_A - \sigma_B$
    c. $\sqrt{\sigma_A^2 + \sigma_B^2}$
    d. $\sqrt{\sigma_A^2 - \sigma_B^2}$
13. When measurements show a lack of statistical control, the standard error of the mean
    a. Is related to confidence limits
    b. Is a measure of process variability
    c. Is simple to compute
    d. Has no meaning
14. If nothing is known concerning the pattern of variation of a set of numbers, we can calculate the standard deviation of the set of numbers and state that the sample mean ±3 times the calculated standard deviation will include at least
    a. 88.9 percent of the population
    b. 95 percent of the population
    c. 99.7 percent of the population
    d. 100 percent of the population
15. A block has a height specification of 1.000" ± 0.015". Three blocks are stacked to make an assembly. The difference in height between the largest and smallest of 100 such assemblies is nearest to
    a. 0.030"
    b. 0.060"
    c. 0.090"
    d. More information is needed before an answer can be given

Continued on page 7

MINI PAPER

Some Suggestions for Successful Statistical Process Control

Introduction

Statistical process control (SPC) is recognized as an essential tool for any factory, but not every implementation of SPC has been successful. Three common reasons that statistical process control systems fail are described below: personnel issues, methodological errors and inadequate system maintenance. Preventative actions are suggested for each of these failure causes.

Personnel Issues

SPC failures are often rooted in a lack of support from people essential to its success. Management, engineering, supervision, and line workers must all do their part to make SPC work.

Supervisors are essential to SPC because they direct the actions of workers who actually use the system. Supervisors have legitimate concerns about the impact of an SPC implementation project on the productivity of their workers, and these concerns must be addressed to win their support. Acknowledge the fact that SPC may add to their workload: some time will be required to train operators, make measurements, and chase an occasional false alarm. Sell SPC to supervisors on the basis of its productivity benefits: equipment will be available for production more because less unnecessary adjustment (tampering) will occur; equipment in repair will be restored to production faster because trouble-shooting will be more effective; and problems that formerly would have developed into crises will be detected and resolved before any production time is lost. Supervisors have historically been rewarded mainly for meeting production goals. These often conflict with SPC goals, so incentive systems may need to be revised to reward both SPC performance and production.

Floor personnel – machine operators and technicians – are absolutely essential to successful SPC because they are the ones who take and record measurements, maintain control charts, and make decisions regarding process stability. They are also the first to diagnose equipment problems and attempt to bring equipment up to production again. Floor personnel will embrace SPC if only a few prerequisites are met.

First, give them a complete process control system that is easy to use: measurements, summary statistics, control charts, decision rules, and a troubleshooting guide (out of control action plan, or OCAP). This last component of a complete SPC implementation will remove the most frustrating part of most workers' job: waiting for someone else to come fix the equipment (push the reset button on the tool, for example) when they could do it themselves. Well-written OCAPs have been demonstrated to give the tool operators the ability to fix the equipment independently over 75% of the time. Troubleshooting experience is also a career development opportunity for the operators.

Second, pay careful attention to operator training. Train every detail of system use, but teach only those technical aspects of the system that will affect their work. Operators do not need to compute tail probabilities of the normal distribution; they only need to know that a control rule violation indicates something is seriously wrong with the process. Take the time to explain why SPC is being implemented, and what benefits can be expected from it.

Third, address valid worker concerns about SPC. One likely concern is that taking measurements, control charting and other SPC tasks will consume time they could be using to process operate tools. Address this concern by advertising some benefits of SPC such as better equipment utilization and productivity, and ensure that supervisors positively reinforce SPC-related work. Some will be concerned that false alarms will sap productivity; make sure that everyone understands the physical relationships between process monitors and process quality, and emphasize that control limits and decisions rules are carefully chosen to limit false alarms. Some workers, more experienced ones in particular, might worry that their special process knowledge and trouble-shooting skills will no longer be needed when all workers have access to an OCAP. Engage these process experts to develop troubleshooting guides and train their coworkers, and make them part of the continuous improvement process.

One role of upper management during SPC implementation is to fund infrastructure and resources. Some resources are tangible and expensive such as measurement equipment, automation to interface with shop-floor production systems, and SPC software to make the mechanics of the system transparent to users. One critical resource is the people who will lead the implementation, i.e. select the software, choose process monitors, determine control limits and decision rules. Whoever does this must be statistically proficient, and must also be allowed sufficient time to devote to the work. Do not expect a lone engineer to undertake an important job like this in his spare time.

Another critical role of management is to provide encouragement and remove organizational barriers to success. New incentive systems balancing production goals with SPC performance must be honored; rewards for nonproductive activity will be a novel practice in some factories, so it may take time for people to become convinced such rewards will really be granted. The questions managers ask provide clues to their true level of understanding and commitment to SPC. A manager oblivious to SPC will focus questions on output quotas. One with a limit understanding of quality will ask if the product is within specification limits. A manager newly introduced to SPC will ask if the process in control, while one more familiar with the real goals of SPC will inquire if the process is on target.

Methodological Errors

Many problems in SPC arise because the wrong parameters are being measured. The most apparent process measurements are process outcomes, but these output parameters often provide little useful information about the process itself, or they may be measured so long after the process has occurred that they have no value as a means of process control. To alleviate these issues, use design of experiments to characterize the process, and select monitors that are proven influences on critical process outcomes.

Measurement equipment and methods must assure adequate measurement capability for all process monitors. Measurement requirements and procedures can be very demanding, and a simple R&R (repeatability and reliability) study might not be sufficient to understand the measurement process. Measurement processes must be characterized and optimized just like any other process; see Chapter 4 of Drain (1997) for more details on measurement capability issues.

Decision rules should be sufficient to detect significant problems, but false alarms need to be rare. Control limits computed using within-group ranges (the classic method, and the one embedded in most SPC software) can be too tight for a process with a significant batch-to-batch component of variance. Using too many decision rules – the entire suite of Western Electric Corporation rules, for example – can raise the level of false alarms to around five per-cent. Unless all of these rules are actually

Continued on page 7

MINI PAPER

Continued from page 6

necessary, and unless some beneficial reaction can be defined for each rule violation, tampering will result. One of the worst ways to define control limits is to use specification limits instead. This will almost certainly result in either constant tampering with the process (for a process with low capability), or totally ignoring the process (for a process with high capability). These problems can be avoided by following the advice of expert authors on the subject, Montgomery (1996) for example, and by checking decision rules in simulations with actual process data.

System Maintenance

A statistical process control system is itself a process; it requires monitoring and maintenance. Four simple SPC system monitors are shown below with typical goals:

Monitor	Goal
1. Percent of time measurements are taken when they are supposed to be	100%
2. Percent of time the process appears to be in control	98%
3. Percent of time the OCAP is used in a out-of-control situation	100%
4. Percent of time operators can restore the tool to productivity (using the OCAP) without engineering intervention	at least 75%

Monitor 1 is absolutely necessary, if the measurements are not being taken, the system cannot possibly work. Monitor 2 provides a check on both control limit correctness and process stability. Monitor 3 is an essential compliance monitor; if the OCAP is not being used, unregulated and possibly destructive troubleshooting is introducing variance into the process. Monitor 4 must be kept high, or workers will try to fix equipment more expediently their own way.

SPC system maintenance requires that all its components be kept in good repair. Measurement capability should be checked routinely, and reassessed if process changes are made or targets are changed. Control limits should be examined after any process change or when Monitor 2 is far from target, and about four times a year otherwise. OCAPs should be revised whenever their effectiveness drops below goal, or when floor personnel find ways to make troubleshooting more efficient or effective.

Perpetual management reinforcement of SPC usage is essential to system health. If this is not supplied, people have little incentive to take measurements or exercise any other parts of the system. Other barriers to consistent SPC use can be understood by examining reasons for the breakdown, see Mager and Pipe (1997) for an excellent flow-chart used to diagnose and correct human behavior problems in organizations.

Conclusion

SPC can make nearly any process more productive and profitable, but SPC implementation is not always successful. Most SPC failures seem to be caused by non-technical problems: personnel resistance to implementation, organizational barriers, or lack of attention to system maintenance once it is working. SPC problems can be avoided by careful attention to these liabilities, and by assuring that those who implement SPC systems are properly educated and resourced for the job.

References:

Drain (1997) David Drain, Statistical Methods for Industrial Process Control, Chapman & Hall, 1997.

Mager and Pipe (1997) Robert F. Mager, Peter Pipe, Analyzing Performance Problems, third edition, 1997, The Center for Effective Performance, Inc.

Montgomery (1996) Douglas Montgomery, Introduction to Statistical Quality Control, Third Edition, John Wiley & Sons, 1996.

Biography:

David Drain has been a Senior Statistician at Intel Corporation in Arizona for the past thirteen years where he has been involved with Statistical Process Control and Experiment Design. Mr. Drain has an MS. in Applied Statistics from Bowling Green State University, and is presently working toward a Ph.D. in Industrial Engineering at Arizona State University.

Acknowledgements:

The author is indebted to Mike Zaccardi and Dwayne Pepper, who were kind enough to share their experiences with him.

BASIC TOOLS

Continued from page 5

16. It is sometimes economical to permit a process that is being monitored by an X-bar, R chart to go out of control when
    a. Individual R's exceed R-bar
    b. Cost of inspection is high
    c. Six sigma is appreciably less than the difference between specification limits
    d. The X-bar control limits are inside the drawing tolerance limits
17. A p-chart based on samples taken from each box of a large shipment of parts can be used to test
    a. The homogeneity of the shipment
    b. Whether or not the parts are produced under control
    c. Whether or not the parts are within specification
    d. None of the above
18. As compared with a single point outside a 3σ limit two points in succession between a 2σ and a 3σ limit on an X-bar control chart for means are
    a. A more significant indication of an assignable cause
    b. An equally significant indication of an assignable cause
    c. A less significant indication of an assignable cause
    d. Unimportant
19. A cumulative frequency distribution is called
    a. An operating characteristic
    b. A histogram
    c. A frequency polygon
    d. An ogive
20. A consumer's risk of 10% means that
    a. The probability that a sampling plan will reject "good" material is 10%
    b. The probability that a sampling plan will accept "poor" material is 10%
    c. The acceptable quality level of the lot is 10%
    d. The unacceptable quality level of the lot is 10%.

Reference

Swan, R. O. and Hicks, C. R. (1954). "What's Your IQ in QC". Industrial Quality Control Vol. X, No, 6, pp. 84-87.

TABLE 1. Answers

a	b	c	d
14	10	6	13
2	9	16	3
5	20	1	15
18	7	12	19
17	11	4	8

The ASQ Statistics Division Newsletteris published quarterly by the Statistics Division of the American Society for Quality.

All communications regarding this publication, **EXCLUDING CHANGE OF ADDRESS**, should be addressed to:

Karin K. Chu, Editor
ASQ Statistics Division Newsletter
4500 S. Dobson #0C2-136
Chandler, AZ 85248-4907
Phone: (480) 715-7658
Email: karin.k.chu@intel.com

Other communications relating to the Statistics Division of ASQ should be addressed to:

Don Williams
Bldg. 230-3F-05, 3M Center
Maplewood, MN 55144
Phone: (651) 736-8684.
Fax: (651) 733-8124

Communications regarding **change of address** should be sent to ASQ at:

American Society for Quality
P.O. Box 3005
Milwaukee, WI 53201-3005

This will change the address for all publications you receive from ASQ including the newsletter. You can also handle this by phone (414) 272-8575 or (800) 248-1946.

UPCOMING NEWSLETTER DEADLINES FOR SUBMISSIONS

Issue	Vol.	No.	Due Date
Fall	19	3	Aug. 1, 2001
Winter	20	1	Dec. 1, 2001

STATISTICS DIVISION
AMERICAN SOCIETY FOR QUALITY
c/o Karin K. Chu
4500 S. Dobson #0C2-126
Chandler, AZ 85248-4907

Non-Profit Org.
U.S. Postage
PAID
Cedarburg, WI
Permit No. 199

VISIT THE STATISTICS DIVISION WEBSITE:
http://www.asqstatdiv.org

Other Periodicals for Applied Statistics
Journal of Quality Technology: http://www.asq.org/pub/jqt/

Printed on Recycled Paper