

ASQ STATISTICS DIVISION *Newsletter*



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Chair's Message

by *Vijay Nair*
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This is my last chair's message for the Newsletter as my term will end on June 30. It is hard to imagine that it has been over 9 months since I took on the position.

The biggest event over the past year has been the celebration of the Division's 30th anniversary. A number of people have contributed to this, most notably Daksha Chokshi (my predecessor as chair) who conceived and initiated many of the activities and Bob Mitchell (two-time past chair and Division historian) who organized the past-chair recognition event at Minneapolis last May and authored the special publication on Division history. There were, of course,



George Box (middle), his wife Claire and Vijay, Madison, WI, January 2010

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Editor's Corner

by *Paul Prew*
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Paul Prew

Dear readers, I want to make it clear right up front --- I will be in compliance with the continuing ASQ edict that all editor's columns will remark upon the quality troubles experienced by Toyota. True, I'm not able to put my finger on the where I saw this decreed. But I'm confident that there must be one, as I cannot recall the last ASQ publication I read where the editor did not weigh in on Toyota and their quality troubles. So rest assured I will not be shirking my duty to pile on.

But first, a cute story that through some tortured logic I will link to an article appearing later in this newsletter.

Tarantulas and Toyotas

I regularly have the pleasure of accompanying my young sons to the local YMCA for Family Fun Super Sundays. Contrary to what some might guess, I do not at all resent having to walk out mid-third quarter to go and paste popsicle sticks to paper plates, thereby creating a mask/magic wand/future piece of litter blowing through the Y parking lot. One

Continued on page 4

VISION

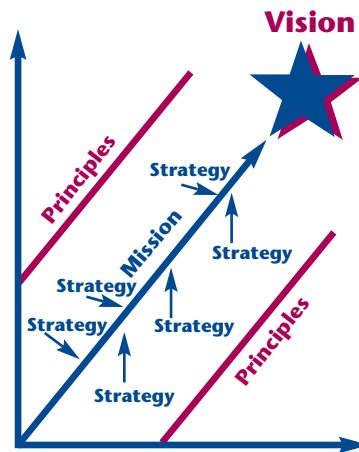
- We are the recognized leader in promoting statistical thinking and data-driven decision making for system improvement

MISSION

- Improve practitioners' understanding of statistical concepts and methods
- Be the source for the statistical components of the ASQ body of knowledge
- Support the growth and development of ASQ Statistics Division members and the quality community
- Nurture and grow a vibrant, engaged community of statistical practitioners
- Increase the marketability and influence of ASQ Statistics Division members
- Demonstrate the economic benefits of statistical thinking to organizational leaders and the community

STRATEGIES

1. Organize, enhance, and disseminate the Statistics Division's virtual resource center
2. Develop and deliver useful and useable communication vehicles.
3. Proactively engage the membership in the Division's decision making.
4. Foster career development of members.
5. Develop future leaders of the Division and the profession.
6. Develop and enhance alliances with appropriate organizations within and outside of ASQ.



DESIRED END STATE

- Our members will be proud to be part of the Statistics 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:
 - Greatest weight on intermediate level.
 - Nearly as much weight on basic level.
 - 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 perspective of quality management.
- Apply Statistical Thinking ourselves; that is, practice what we preach.
- Uphold professional ethics.
- Continuously improve.

MEETING GROUND RULES

- Respect and listen to all participants.
- No speeches.
- No "side-bar" discussions.
- Decisions by consensus, if possible.
- We will be open and honest, even if it hurts.
- Support your ideas, don't defend them.
- We will delegate word-smithing to small groups.
- All help facilitate, although we will have a formal leader, facilitator, scribe, and timekeeper (including at breakouts).
- We will rotate scribes.
- We will keep a separate flipchart for To-Do's.
- Mission, Vision, Principles, Strategy, Ground Rules should be visible.

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 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)

many others who contributed to the various events, all of whom deserve a special thanks.

The Division leadership group will hold a Tactical Planning meeting on the Sunday before the ASQ World Congress at St. Louis. Christine Anderson-Cook will lead the discussion in her capacity as incoming Chair. A summary of the discussions will be posted on the website soon after the meeting.

As always, any organization depends on the effort and goodwill of many volunteers. I was fortunate to have the opportunity to work with a number of outstanding member leaders. I want to thank all of them. I am pleased to let you know that Mindy Hotchkiss (currently Division Secretary) will become Chair-elect on July 1, and Richard "Herb" McGrath from Bowling Green State University will become Division Secretary. Bill Rodebaugh (Treasurer), Brian Sersion (Vice Chair of Communications) and William Brenneman (Vice Chair of Products & Services) have kindly agreed to continue in their positions. Christine will become Chair and yours truly will assume the position I have always coveted (Past Chair).

I would like to end this article by turning to a different topic - recognizing the 90th birthday of one of the icons of our profession. Professor George Box turned 90 on October 18, 2009. George is a legendary figure in Statistics and has made huge contributions to theory, methodology, and practice. His work has fundamentally changed the field of industrial statistics. The journal Quality Engineering (QE) marked the occasion through a special issue dedicated to him (Volume 22, Number 2, 2010). Several of George's collaborators and former students recall their interactions with George and discuss his contributions in this special issue.

The article by Stu Hunter "George Box: Some reminiscences" (pages 113-114) provides an especially interesting historical perspective. Stu summarizes George Box's contributions as follows: "Let's review this



George Box and Genichi Taguchi, at Dr. Taguchi's house in Tokyo, May 1986

extraordinary list: the design of experiments, practical applications of Bayes, time series modeling, and modern statistical process control, ... evolutionary operation, Box-Cox transformation, robust methods, graphical analysis of variance, and 'all models are wrong but some are more useful than others' ... It is not possible to briefly describe the statistical contributions of George Box. They are, like the views of the Grand Canyon, simply too numerous and impressive."

The special issue includes articles reflecting on George's contributions as well as technical topics related to George's research interests. It is fun reading, and I encourage members to browse through a copy. You will also find the 1987 interview with George "A Conversation with George Box," by Morris DeGroot Statistical Science, (Aug., 1987, pp. 239-258) to be entertaining.

My own introduction to George came in May 1986 when a research team from University of Wisconsin and Bell Labs visited Japan to learn firsthand about quality practices in Japan. Our findings were reported in a 1988 Quality Progress article "Quality Practices in Japan." Dr. Genichi Taguchi graciously arranged for us to visit the companies, and this led to a much more fruitful exchange of ideas than one would normally expect. For me, one of the highlights of the trip was spending time with George and listening to his famous stories about statistics and statisticians. I still fondly recall the train trip from Kyoto to Tokyo, drinking beer in the dining car, and listening to his stories and jokes. Early on during the trip, I asked him what E.P. in his name G.E.P. stood for, and he responded 'Elvis Presley' with a straight face. I never could get an answer during the trip, and it was only later that I found out that EP = Edward Pelham.

It is an honor to have had the opportunity to interact with such a legendary statistician and great person. Please join me in wishing George a belated "Happy 90th Birthday."



Research study team from Bell Labs and University of Wisconsin with Genichi Taguchi (top left) in Tokyo, May 1986; Front row from left - Raghu Kacker, George Box, and Vijay Nair; middle row - Anne Shoemaker and Jeff Wu; back row - Madhav Phadke.

Editor's Corner

Continued from page 1

recent Sunday, though, sounded like my kind of fun: a special appearance by Reptile Guy. Reptile Guy would be providing live snakes and lizards for us to handle. We got even more excited when we arrived and saw tubs full of insects. Were we going to get to hand-feed the iguanas, chameleons, or the like?

No, it turned out that Reptile Guy had double-booked himself, so he had arranged for Dr. Bug to pinch-hit for him. And it was alright, Dr. Bug had a good show. The culmination of Dr. Bug's parade of creepy-crawlies would be the chance for everyone to hold a live tarantula.

The room got kind of quiet at that last bit of news.

A boy raised his hand.

"Are we going to die?"

Which is the same question I ask when offered a ride in a Toyota.

Tarantulas are not Bayesians

Turns out, the poison of the tarantula is so weak that people are unaffected. Their poison is designed to work on creatures that are weighed in grams, not pounds. People's fears about tarantulas are unfounded, their subjective beliefs at odds with the objective facts. We statistical types see ourselves as less prone to these types of misconceptions. We put ourselves squarely in the "objective" camp, followers of the scientific method.

So why did Science News pit those pillar of objectivity, scientific inquiry and statistical analysis, against one another? The "In Case You Missed It" column links to the article on this controversy. The article has an enlightening example of how Bayesian statistics might remedy some of the controversy. Bayesian statistics? To elaborate: in addition to basing statistical conclusions on the data collected purposely for an analysis, Bayesian analysis factors in "prior knowledge." "Prior knowledge," expressed as probabilities, acts like extra samples added to the collected data. Prior probabilities refine the statistical conclusions that can be inferred from the collected data.

This prior knowledge is sometimes termed a prior "belief." That word "belief" is where Bayesian methods have been controversial. It carries the taint of subjectivity. The tarantula example demonstrates how beliefs can run counter to the facts. Can all statistical users be trusted to separate out legitimate prior knowledge from wishful thinking, folklore, misconceptions? The article from Science News shows how prior knowledge, when properly incorporated, can in fact be essential to drawing the proper conclusions from data. The danger can lie in not using a prior. Particularly in the medical community, Bayesian statistics are gaining widespread acceptance. Read the article and see why.

Statistics Division Discussion Boards

by Brian Sersion

Great news! ASQ has improved the discussion boards and they are now open for business at the following location: <http://community.asq.org/forums/>. In April, I started working on migrating some of the old content from an archive to our new boards. There is some work left to be done but three years of content has already been moved over to the main Statistics discussion board, which ASQ calls a forum. We decided to organize our boards so that topics with less traffic are connected to the main board (ASQ calls them sub-forums). The boards are found under the **Communities and Networking** page of their Web site. Page down to the **Sections/ Divisions** section to find them. You must be logged in as a member to have access to the boards. If you find you are not connected automatically to your old preferences, you may need to subscribe again. Stay tuned for more information on the new features and functionality of the discussion boards.

I would like to take this opportunity to thank the dedicated volunteers, many of whom have been serving for years as moderators of our discussion boards:

- Timothy Folkerts - Statistics (forum)
- Gordon Clark - Statistical Thinking (sub-forum)
- Bob Mitchell - Statistical Process Control (sub-forum)
- Jonathon Andell - Six Sigma (sub-forum)
- James Lucas - Designed Experiments (sub-forum)

Now all I ask is that each of you join a discussion board now and post a topic this very minute. Don't all rush at once.



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Communities & Networking

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Recent Posts Popular Topics

Home			
FAQ's			
Forums	Topics	Replies	Last Post
Rules/Guidelines Terms of Service within the ASQ community space	155	3	0 Monday, January 11, 2010 1:22 PM In: Etiquette Requirements By: webofferings
Discussion Board Information Need help? We're here for you!	155	10	0 Monday, May 03, 2010 6:19 PM In: The time stamp is wrong. By: webofferings
Discussion Board Suggestions & Feedback			

You Are Invited

FTC in Birmingham, AL



You are invited to attend the 54th Annual Fall Technical Conference to be held this year Oct 6-9 in Birmingham, Alabama. This conference is the premier forum to discuss topics at the interface of statistics and quality. The theme of this year's conference is "Quality and Statistics: The Engines of Success." The goal is to engage researchers and practitioners in a dialogue that leads to more effective use of statistics to improve quality. The conference will serve to bring innovations in statistical methodologies and quality tools to the forefront. You will have the opportunity to meet informally and exchange views with speakers and colleagues during breaks and in the hospitality suite.

Along with an exciting line-up of conference presentations, four short courses will be offered. They will include courses on logistic regression, reliability data analysis, data mining, and acceptance sampling. Check out the program brochure and get registration information online at <http://cba.ua.edu/ftc2010>.

Hope to see you there!

Shari Kraber
FTC Program Committee Rep, ASQ Stat Div.

Statistical Resources on the Web: The Reliability Information Analysis Center

<http://theRiac.org>
by Mindy Hotchkiss

This feature in the Statistics Division newsletter highlights resources available on the web of particular interest to industrial statisticians or quality and reliability engineers. Please feel free to contact me with any comments at mindy.hotchkiss@pwr.utc.com or if you know of any particularly useful sites or tools that you would like to recommend.

The Department of Defense has chartered a number of Information Analysis Centers (IACs) to serve as focal points for research and analysis in their areas of specialty. The Reliability Information Analysis Center (RIAC) is responsible for the engineering disciplines of Reliability, Maintainability, Quality, Supportability, and Interoperability (RMQSI). While the RIAC offers a number of products and services for sale, a wide variety of free resources are also available.

Information at an introductory level is available through the START (Selected Topics in Assurance Related Technologies) and RelTiques publications. Topics include basics concepts such as statistical confidence and distributions, as well as intermediate and advanced topics such as reliability growth modeling, Markov analysis, and applications for simulations. Each topic contains an overview of key terms, definitions, and notation, and provides references to relevant references for those looking for more.

The RMSQI Library is a searchable database of government reports and other publications. While only RIAC documents are accessible directly through this portal, abstracts and citation information are available with information on how to get access. A limited number of publications are provided for free under Demos and Downloads. The RIAC also publishes a free online journal, with archived material available back to 1998. Additional resources are available to government contractors and other institutions meeting certain eligibility criteria.

The RIAC is available at <http://theRiac.org>.

Thanks to Dr. Jorge Romeu of Syracuse University for recommending this site.

ASQ and Standards: How They Affect You!

Rudy Kittlitz

Rudy Kittlitz & Associates
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All of us in the USA are affected daily by various standards, such as ASTM, ANSI, and ISO, whether we realize it or not. While many are familiar with ISO 9000 requirements for quality management systems, things as diverse as the size and thickness of the credit card, dimensions of batteries, photographic film size, etc. were all established by the International Organization for Standards (ISO).

The ISO, headquartered in Geneva, Switzerland, was formed in 1946 to coordinate the standards activities around the world. There are 250 ISO committees and others added when the need arises. At present there are 159 participating countries. An ISO committee is usually composed of Sub-Committees (SC) and if a country is represented on that SC it has only one vote even if that country has several delegates present. Thus large countries and small countries are on a "level field" for voting. Thus, involvement in the early stages of standards development or revision is critical if a country wants to influence the end result.

In most countries, standards activity is funded by the government; however, this is not the case in the USA, where activity is entirely voluntary. The USA representative to ISO is the American National Standards Institute (ANSI) headquartered in New York City. The various organizations that work with ANSI are charged fees for participation. Since support and activity in the USA have been diminishing over recent years, opportunities are available for involvement.

The ASQ Standards Committee is responsible for development and approval of generic standards (not including product standards) and other documents. Committee membership includes representative from ASQ Divisions and General Interest members. At present Mark Johnson is the Statistics Division representative to this committee and I am the Chemical and Process Industries representative. However, we are always looking for new people to become involved. There's no particular background that is preferred, mainly an interest in standards is what's needed.

Members of industrial and business organization are also encouraged to participate in the standards development process. The ability to influence standards development allows for advanced planning and strategic development of new product and/or changes to existing products to facilitate strategic positioning in the market place. Since standards development is a slow process, usually taking several years, this provides a head start to those companies aware of upcoming changes. Involvement also levels the playing field for smaller companies, which have an equal voice with larger competitors, and provides an opportunity to benchmark best practices. This fosters national competitiveness in global markets.

ASQ, through ANSI, has the secretariats for:

- IEC/TC 56 on Dependability
- ISO/TC 69 on Applications of Statistical Methods
- ISO/TC 176 on Quality Management and Quality Assurance
- ISO/TC 207 on Environmental Management
- ISO/TMB/WG on Social Responsibility
- Each of these has US Technical Advisory Groups known as US TAGs and represents the USA in the international community. There are many other TAGS where ASQ does not have Secretariats. ASTM and ASME are two organizations that may hold Secretariats. An ANSI document spells out the details of a secretariat's responsibilities in several pages, but I'll list a few points:
 - ANSI is the USA organization that deals directly with ISO
 - If ANSI accepts a Secretariat it can delegate it to an external organization, but ANSI is still responsible
- The external organization has documented technical and administrative competence

ASQ and Standards: How They Affect You!

(continued from page 6)

ANSI Accredited Standards Committee (ASC) Z1 Subcommittees are:

- Z1 SC on Dependability
 - Z1 SC on Applications of Statistical Methods
 - Z1 SC on Quality Management and Quality Assurance
 - Z1 SC on Environmental Management
 - Z1 SC on Auditing of Management Systems.
- The Subcommittees of ASC Z1 serve as the USA consensus bodies in each respective area for adoption of ISO standards for the USA.

Given the importance of international standards in these disciplines and important work by other nationally accredited standards development organizations, the various Z1 SCs collaborate with related organizations, the US TAGs, in the U.S. Standards Group on Quality, Environment, Dependability, Statistics, and Social Responsibility (QEDSS). Here's an example of how the Z1 SC on Applications of Statistical Methods is important. In Acceptance Standards, both attribute and variables, many are familiar with the old Military Standards. The Z1.4 and Z1.9 are the compatible standards today. As ISO/TC 69 develops International Standards they are evaluated by the Z1 SC on Statistics for adopting as ANSI/ASQ standards.

Work on International Standards is generally conducted at an annual week-long meeting somewhere in the world, but interim meetings may occur also. At these face-to-face meetings it is vital that the USA, through ANSI, is represented by Experts. Processing of new or revised standards takes several years, but by participating in this work the USA Expert can immediately and directly influence its content and be aware of "what's coming in the near future." The ASQ "Standards Team" provides excellent orientation and guidance to the involved individuals for this work. The ASQ "Standards Team" personnel are employed by ASQ for administrative duties. Although I am Chair of the US TAG to ISO/TC 69, the official contact of the US TAG with ANSI is the ASQ "Standards Team."

ISO/TC 69 includes the following subcommittees and working groups (WGs):

- SC 1 on Terminology and symbols
- SC 4 on Application of statistical methods in process management
- SC 5 on Acceptance sampling
- SC 6 on Measurement methods and results
- SC 7 on Six Sigma
- SC 8 on Quality Function Development
- WG 3 on Statistical interpretation of data
- WG 9 on Random sampling generation

Essentially all of the SCs have several WGs to work on various standards. Some of the current work at recent international meetings includes:

- SC1/WG2: Discussion of changes made for ISO 3534-3 on Design of Experiments terms.
- SC4: CUSUM and acceptance control charts standards moving toward ballot as Draft International Standards (DIS).
- SC5/WG2: Reviewed Sampling procedures for inspection by attributes (e.g., 2859 series).
- SC7/WG1: 1st Draft complete of Technical Report (TR) on Response surface methodology.
- SC7/WG2: TR on Attribute Agreement Analysis approved, going to publication
- SC7/WG3: Two standards on DMAIC methodology (Part1) and another on tools to support the DMAIC methodology (Part 2) were approved, will be circulated as DIS standards.
- WG3: Recent work on detection and treatment of outliers is out for ballot.

If you have expertise in these areas, this is an excellent way to share your work and experience in a way that will influence the world, as well as to network with other known experts in the field. I challenge you all to seriously consider joining this interesting work!

MINI PAPER

Reducing Variation During Design

Dr. Wayne A. Taylor
Chairman – Taylor Enterprises, Inc.

INTRODUCTION

Design offers the first and best opportunity for reducing variation. To illustrate the strategies and tools required, consider the task of designing a new pump. Suppose we are faced with the task of designing a pump capable of delivering solution at a constant rate of 10 ml/min. Customer usage requires that the flow rate remain between 9 and 11 ml/min. The first step is to develop a general design concept. Suppose, we decide to use a piston to push the solution. This concept requires a motor to drive the piston and two valves to control the direction of the flow. Next we need to determine all the specifics such as “How far should the piston travel?” and “How fast should the motor turn?” To accomplish this task, we need to make a list of all the factors affecting flow rate. Three obvious factors are the piston radius (R), the stroke length (L), and the motor speed (S). Another possible factor is the amount of backflow through the valves (B). Other factors might also be considered such as the solution viscosity. But, for purpose of example, we will limit ourselves to the first four factors. They are shown to the left in Figure 1. They will be referred to as the input variables. Flow rate will be referred to as the output variable.

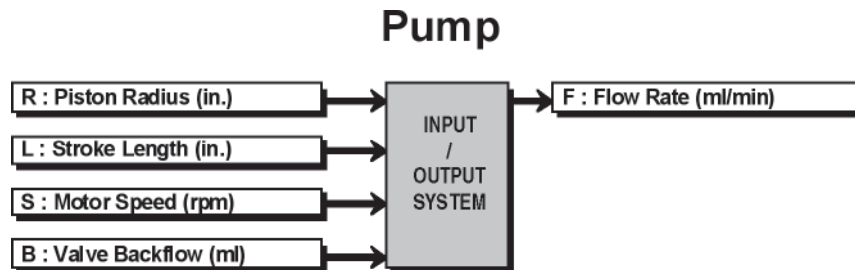


Figure 1: Factors Affecting Flow Rate

It is the output for which we desire to reduce the variation. This is accomplished through the establishments of requirements for the inputs. This requires knowledge of how the inputs behave and how the inputs effect the output. Based on this information we can predict how the outputs will behave.

VARIATION TRANSMISSION ANALYSIS

We will start with how the inputs effect the output. For our pump, it is possible to derive the following equation for flow rate:

$$F = (16.388\pi R^2L - B)S \quad (\text{Eq. 1})$$

The term πR^2L is the volume of a cylinder of radius R and length L. This volume of solution is displaced each piston stroke. This is multiplied by 16.388 to convert the volume from cubic inches to milliliters. The backflow per stroke B is then subtracted and the result multiplied by the motor speed S to give the flow rate F in ml/min. While the equation is readily available in this example, in many cases screening experiments and response surface studies are required to identify the key input variables and to obtain an empirical equation.

Based on Equation 1, the flow rate average and standard deviation can be determined as a function of the averages and standard deviations of the inputs. Let μ_F and σ_F denote the average and standard deviation of flow rate. Then the resulting formulas are:

$$\mu_F = (51.48\mu_R^2\mu_L - \mu_B)\mu_S + 51.48\mu_L\mu_S\sigma_R^2 \quad (\text{Eq. 2})$$

$$\sigma_F = \sqrt{\begin{aligned} & (102.96\mu_R\mu_L\mu_S)^2\sigma_R^2 + (51.48\mu_R^2\mu_S)^2\sigma_L^2 + \mu_S^2\sigma_B^2 \\ & + (51.48\mu_R^2\mu_L - \mu_B)^2\sigma_S^2 + \frac{1}{2}(102.96\mu_L\mu_S)^2\sigma_R^4 \\ & + ((102.96\mu_R\mu_S)^2 + (102.96\mu_S)(51.48\mu_R^2\mu_S))\sigma_R^2\sigma_L^2 \\ & + ((102.96\mu_R\mu_L)^2 + (102.96\mu_L)(51.48\mu_R^2\mu_L - \mu_B))\sigma_R^2\sigma_S^2 \\ & + (51.48\mu_R^2)^2\sigma_L^2\sigma_S^2 + \sigma_B^2\sigma_S^2 \end{aligned}} \quad (\text{Eq. 3})$$

Reducing Variation During Design

(continued from page 8)

These equations were obtained using the methods detailed in Taylor (1991), Cox (1986) and Evans (1975). These approaches have a variety of names including statistical tolerance analysis and propagation of errors. The term variation transmission analysis will be used here to collectively refer to the different methods of predicting the behavior of the output.

SPECIFYING TOLERANCES

The last thing required is information on how the inputs behave. This might require calling the motor supplier to determine the capability of their process in controlling motor rpm. The valve supplier might also have to be contacted to determine the average and standard deviation of valve backflow. One might also have to call the plant to obtain process capability information on drilling the piston hole. In many cases one will have choices as to the components and processes to use. In this case one should start with the low-cost components and processes for the initial design. Changes can be made later if necessary. Table 1 shows the information collected.

Table 1: Data Collected From Plants and Suppliers

Input	Average	Standard Deviation
Piston Radius (R)	–	0.0005"
Stroke Length (L)	–	0.0017"
Motor Speed (S)	–	0.17 rpm
Backflow (B)	0.05 ml	0.005 ml

To ensure the design is manufacturable, initial requirements will be established based on these low cost tolerances. These requirements are shown in Table 2. These requirements are specified as process tolerances. Process tolerances specify a minimum and maximum value for the average and a maximum standard deviation. They specify requirements for the processes producing the components rather than for the individual components themselves. This facilitates the communication of design requirements to the plants and prevents differences in interpretation. The maximum standard deviations were set equal to the standard deviations in Table 1 while the tolerances for the averages were set equal to ± 1.5 standard deviations. In addition, targets must be selected for piston radius (R), stroke length (L), and motor speed (S). Initial values of $R = 0.1$ " and $L = 0.5$ " were selected based on judgment. Equation 1 was then used to calculate the required motor speed.

Table 2: Process Tolerances for Inputs

Input	Targets for Average	Tolerance for Average	Maximum Standard Deviation
Piston Radius (R)	0.1"	± 0.00075 "	0.0005"
Stroke Length (L)	0.5"	± 0.0025 "	0.0017"
Motor Speed (S)	48.2 rpm	± 0.25 rpm	0.17 rpm
Backflow (B)	0.05 ml	± 0.0075 ml	0.005 ml

Reducing Variation During Design

(continued from page 9)

For the process tolerances given in Table 2, Equations 2 and 3 were used to determine the resulting process tolerance for flow rate (F). The results are shown in Figure 2. In addition, worse-case values of C_p and C_{pk} are given along with the six sigma product tolerance. The six sigma product tolerance represents an interval containing all but 3.4 units per million. We want the six sigma product tolerance to fit between the specification limits which is equivalent to C_{pk} exceeding 1.5.

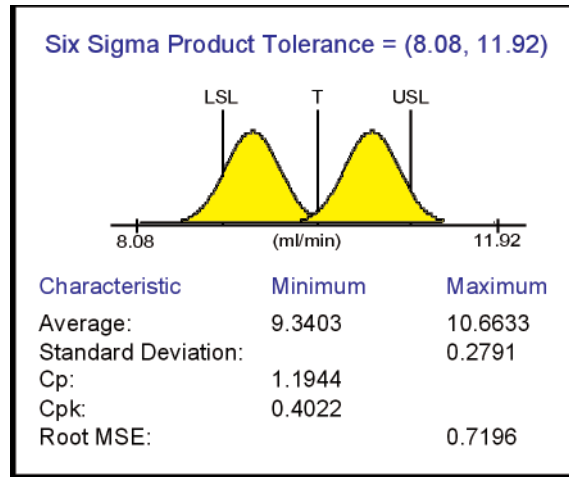


Figure 2: Flow Rate Variation Based on Table 2

ROBUST DESIGN THROUGH SELECTION OF OPTIMAL TARGETS

One way of reducing the flow rate variation is through robustness. Robustness is obtained by designing the pump to be less sensitive to the variation of the inputs. Therefore, the inputs continue to vary, but less of this variation is transmitted to the output. As a result, the output varies less. Robust design is accomplished through the setting of the inputs' targets. Equation 3 clearly indicates that the targets effect the variation. Since it is generally less costly to adjust targets than tighten tolerances, building in robustness is the preferred method of reducing variation.

There are many different combinations of the inputs' targets that result in a flow rate of 10 ml/min. Lengthening the stroke length can be offset by decreasing the piston radius or reducing the motor speed. However, as Equation 3 demonstrates, the inputs' targets also effect the variation. Of those targets resulting in an average flow rate of 10 ml/min, the set of targets that minimizes the flow rate variation is desired.

A robust pump design can be obtained by determining the targets of the inputs maximizing the minimum C_{pk} . For the pump, the optimal set of targets for the inputs are:

$$R = 0.1735" \quad L = 0.4125" \quad S = 16.96 \text{ rpm}$$

The resulting flow rate variation is shown in Figure 3. The new predicted product tolerance is much closer to the spec. limits and the minimum C_{pk} is closer to 1.5. However, further improvements are still required. At this point, further improvements can only be made through tightening tolerances.

Reducing Variation During Design

(continued from page 10)

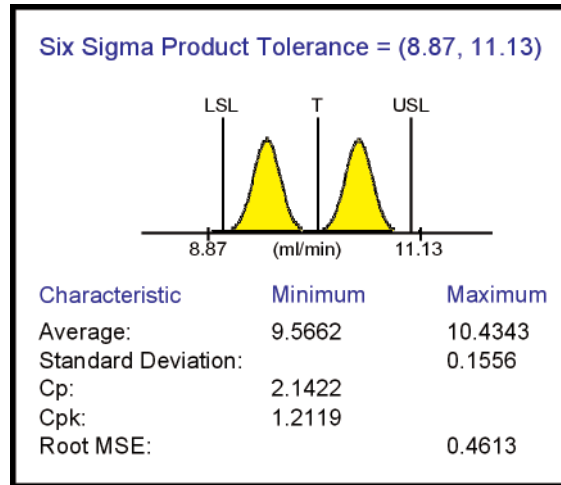


Figure 3: Flow Rate Variation Using Optimal Targets

TIGHTENING TOLERANCES

Which tolerance or tolerances should we tighten and by how much? To start to answer this question, it is useful to investigate the effects of tightening the different tolerances. Table 3 shows the effect of reducing the tolerance to zero for each of the inputs. Tightening the motor speed and backflow tolerances have the largest effects.

Table 3: Flow Rate Process Tolerances After Tightening Tolerances

Change	Resulting Product Tolerance	Percent Reduction In Width
Piston Radius tolerance set to 0	(9.023, 10.973)	13.7%
Stroke Length tolerance set to 0	(8.967, 11.034)	8.5%
Motor Speed tolerance set to 0	(9.192, 10.800)	28.8%
Backflow tolerance set to 0	(9.112, 10.884)	21.6%

Which tolerance one decides to tighten also depends on the costs involved. Tightening the motor speed tolerance requires the substitution of a \$20 motor for the current \$5 motor. Tightening the valve tolerance requires the use of a \$2 valve instead of the current \$1 valve. In this case the best option is to use the \$2 valve. This valve has an average backflow of 0.05 ml with a standard deviation of 0.0025 ml. A tolerance for the average of $0.05 * 0.00375$ ml and maximum standard deviation of 0.0025 ml will be used for its process tolerance.

The current targets were selected to be optimal for the low-cost tolerances. After making a change in the tolerances, the targets should be reoptimized. The new set of targets are:

$$R = 0.1520" \quad L = 0.4236" \quad S = 22.04 \text{ rpm}$$

The resulting flow rate variation is shown in Figure 4. The predicted product tolerance fits inside the spec. limits and the minimum C_{pk} exceeds 1.5. The pump design now meets the six sigma criteria.

Reducing Variation During Design

(continued from page 11)

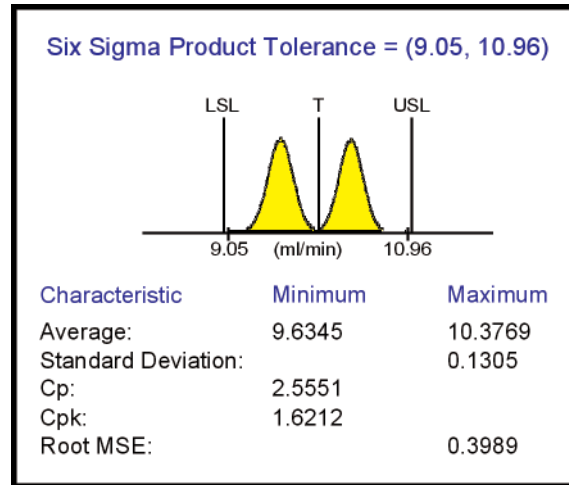


Figure 4: Flow Rate Variation Using The \$2 Valve

SUMMARY

The above example illustrates the following strategies:

- (1) Knowledge of how the inputs behave and how the inputs effect the output is the key to reducing variation during design. - Otherwise trial and error is necessary.
- (2) The use of robust design by considering variation while setting targets. - Instead variation reduction is commonly accomplished through tightening of tolerances which drives up costs.
- (3) Obtaining manufacturable products by starting with low-cost tolerances and selectively tightening tolerances based of specific component and process changes. - Instead tight tolerances are commonly specified for all the inputs to insure design performance. Manufacturability is only considered late in the design.
- (4) Using process tolerances to clarify the designer's intent when setting tolerances. - Instead product tolerances are commonly specified based on both statistical tolerancing and worse-case tolerance without clear guidance on how to interpret them.

Implementing these strategies requires that variation begin to be addressed in the earliest stages of design where changes are less costly. Otherwise, the opportunity to design in robustness and to base the design on manufacturing capability is lost. If variation is not addressed early in design, variation must be reduced later by tightening tolerances which drives up costs.

REFERENCE LIST

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- Evans, D. H. (1975). *Statistical Tolerancing:: The State of the Art*. *Journal of Quality Technology* 7 (1): 1-12.
- Taylor, W. A. (1991). *Optimization and Variation Reduction in Quality*. New York: McGraw-Hill

Dr. Taylor is the founder and chairman of Taylor Enterprises, Inc. (variation.com) where he is responsible for the development of the VarTran[®], Change-Point Analyzer, and Sampling Plan Analyzer software packages as well as providing consulting and training on the Six Sigma approach and tools including Robust Design, Tolerance Analysis, Design of Experiments, SPC, Acceptance Sampling, and Statistics. He is an ASQ Fellow and a member of the Statistics Division. Questions or comments can be sent to info@variation.com.



IN CASE YOU MISSED IT

⇒ **Odds Are, It's Wrong: Science fails to face the shortcomings of statistics**

Article by Tom Siegried, ScienceNews magazine

This article addresses a handful of criticisms, some you will find more interesting, some less. The concluding item is on Bayesian reasoning. The article illustrates this matter using the example of steroid testing in baseball players, but other studies have shown a similar problem with doctors mis-interpreting tests for cancer. After reading this article, see if you can do better than doctors in answering this question --- if a test for cancer is correct 90% of the time, and your test comes back positive, what's the probability you have cancer? Less than half of doctors can get it right (the Bayesians do).

http://www.sciencenews.org/view/feature/id/57091/title/Odds_are,_its_wrong

Note from the Chair, Vijay Nair:

"This article created a lot of controversy... a few of us worked on writing a rebuttal which is posted on the American Statistical Association's website. Here is the link:

<http://amstat.org/news/pdfs/OddsAreltsWrong.pdf>

See also:

<http://www.sciencenews.org/view/generic/id/58594/title/Feedback>

⇒ **Elements of Statistical Learning**

Data mining is a field that's growing more important for statisticians. The business world is quite taken with its promise. Everyone's got records just idling away in their database, why not apply ever-cheaper computing power to find if they hold any profitable patterns? Data mining holds the promise of getting something for nothing. Computer scientists have been the leaders in the field, with statisticians working to assimilate the methods alongside their traditional toolset. Arguably the text *The Elements of Statistical Learning* has been the touchstone for statisticians who want to understand data mining. Last year the 2nd edition of this book came out, and the galleys have been posted at Stanford University. Using the link below is your chance to get something for nothing. Note, the word is "Elements," not "Elementary," and this text is used commonly in graduate-level courses.

<http://www-stat.stanford.edu/~hastie/Papers/ESLII.pdf>

⇒ **Grammar of Graphics --- web app for plotting data**

Some readers are no doubt familiar with the open source statistics language R. R has been praised for its deep graphic capabilities, but because R is command-line driven (as opposed), it has a steeper learning curve than GUI-driven software. There's a state of the art graphics package for R called "ggplot2" that has been ported to a GUI-driven web application. This web app is hosted at UCLA and can be found at the link below.

<http://rweb.stat.ucla.edu/ggplot2/>

Below is the short description by the author, but to really understand the appeal of this application, follow the link.

"yeroon.net/ggplot2 is a web interface for Hadley Wickham's R package *ggplot2*. It is used as a tool for rapid prototyping, exploratory graphical analysis and education of statistics and R. The interface is written completely in javascript, therefore there is no need to install anything on the client side: a standard browser will do."

TREASURER'S REPORT

Actual July 2009 - March 2010

Revenue (received)	Approved 2009-2010 Budget	July '09 - Mar '10 Actual
Dues	\$50,000	\$28,944
Retail Sales	\$500	\$0
Interest/Royalties	\$1,100	\$264
Teleclass Revenue	\$0	\$0
WCQI Tutorials	\$0	\$0
FTC Short Courses	\$2,500	\$645
Narrated Slideshows	\$1,000	\$524
Miscellaneous	\$0	\$166
Total	\$55,100	\$30,544

Expenses

DAC/WAC Meetings (Nov, May)	\$0	\$0
<i>Travel, Hotel</i>	\$0	\$0
WCQI Tactical Meeting (May)	\$10,500	\$3,143
<i>WCQI Meeting/Hospitality</i>	\$3,500	\$2,669
<i>WCQI Travel</i>	\$7,000	\$474
Operational Planning (July)	\$0	\$0
<i>Travel, Hotel, Meals</i>	\$0	\$0
FTC Council Meeting (Oct)	\$13,100	\$14,012
<i>FTC Meeting/Hospitality</i>	\$5,000	\$6,012
<i>FTC Travel</i>	\$7,000	\$5,313
<i>30th Promotional Items</i>	\$1,100	\$2,688
Long Range Planning (3 -5 yrs)	\$0	\$0
<i>LRP Meeting/Hospitality</i>	\$0	\$0
<i>LRP Travel</i>	\$0	\$0
Planning Comm	\$23,600	\$17,155
Auditing Comm	\$0	\$0
Bylaws Comm	\$0	\$0
Certification Comm	\$0	\$0
Examining Comm	\$0	\$0
WCQI Exhibitor Fees	\$2,000	\$300
WCQI Promotional Items	\$0	\$0
WCQI Recognition Event	\$0	\$0
Membership Comm	\$2,000	\$300
Regular Newsletter (3)	\$2,500	\$1,270
<i>Printing (Layout, pdf files)</i>	\$2,000	\$1,270
<i>Postage/Misc</i>	\$500	\$0
Special Publication (every year)	\$9,500	\$8,396
<i>Sp Pub Printing</i>	\$6,000	\$4,960
<i>Sp Pub Postage</i>	\$2,000	\$3,436
<i>Sp Pub Reprints</i>	\$1,000	\$0
<i>Sp Pub Honorarium</i>	\$500	\$0
Narrated Slideshows	\$300	\$375
Newsletter Comm	\$12,300	\$10,041

Expenses (con't.)	Approved 2009-2010 Budget	July '09 - Mar '10 Actual
Nominating Comm	\$0	\$0
Programs Comm	\$0	\$0
Publications Comm	\$0	\$0
Standards Comm	\$3,500	\$3,388
Promotions Comm	\$0	\$0
Committees Sub-Total	\$41,400	\$30,883

New Member Mailings	\$500	\$0
Technology Related (Web, Apps)	\$4,500	\$1,140
Teleconferences	\$500	\$540
Outreach Projects	\$2,200	\$1,330
Communications Related Sub-Total	\$7,700	\$3,010

Hunter/Nelson Awards (plaque)	\$500	\$341
Hunter Awardee Honorarium (travel)	\$1,000	\$286
Youden Speaker (travel)	\$500	\$0
FTC Student Grants	\$2,000	\$268
ASQ Testimonials (\$60 each)	\$300	\$300
Service Awards (WCQI, FTC Reps)	\$700	\$0
Outgoing Chair's Gift	\$500	\$0
Awards Sub-Total	\$5,500	\$1,195

Miscellaneous	\$500	\$1,000
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Total Expenses	\$55,100	\$36,088
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Ott Scholarship		
Assets		
Scholarship Fund (Mar 31)	\$170,000	\$236,406
Expenses		
Scholarship (2)	\$10,000	\$10,000

<i>WCQI expenses are from the 2009 event.</i>
<i>Oct 31 Money Market Balance = \$51,609</i>
<i>Oct 31 ASQ Reserve Fund Investment = \$184,309</i>
<i>Miscellaneous Spending is for Content Review for website.</i>

STATISTICS DIVISION COMMITTEE ROSTER

Members of STAT Council

2009-2010

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	Bill Rodebaugh	Treasurer	billrsbti@aaim.com	215-743-0406
	Mindy Hotchkiss	Secretary	mindy.hotchkiss@pwr.utc.com	561-796-8146
	Daksha Chokshi	Past Chair	daksha.chokshi@pwr.utc.com	561-796-8373
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Examining				
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Chair	Christine Anderson-Cook	Chair-Elect	c-and-cook@lanl.gov	505-662-7733
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Non-Voting Member	Bob Brill	FTC Short Course Chair 2010	robert.brill@icl-pplp.com	785-749-8124
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UPCOMING NEWSLETTER DEADLINES FOR SUBMISSIONS

Issue	Vol.	No.	Due Date
Fall 2010	29	1	August 31, 2010
Winter 2011	29	2	Nov. 30, 2010