CPID Spring Newsletter

SPRING 2017

IN THIS ISSUE

Special Interest Articles

Message From the Chair

It is with great pleasure that I assume the role of CPID chair for 2017. I became an ASQ member as a student, and while attending the Fall Technical Conference I was introduced to the CPID. From that point on, I have been actively involved with this division. There are countless benefits to being part of this division, but I have especially enjoyed the networking opportunities, leadership training, and technical support from other members. My goal as chair is to continue the great work already started by our previous member leaders, especially our past chair, Flor Castillo. Thank you, Flor, for all your hard work this past year and years prior.

This year's officers are Jennifer Van Mulllekom, chair-elect; Diane Schaub, secretary; and Ashley Childress, treasurer. I look forward to working with these leaders and countless other CPID volunteers to accomplish the goals we have set for 2017.

One of the CPID 2017 initiatives is to impact the world of quality on a more global scale, which aligns well with ASQ's 2020 goals. In support of this goal, CPID served as a sponsor for the fifth annual Stu Hunter Research Conference held at the Comwell Borupgaard Hotel located north of Copenhagen, Denmark, March 5 – 8, 2017. The Stu Hunter Research conference is patterned after the Gordon Conference and consists of six 90-minute talks, with each followed by extensive discussion. Some of the topics ranged from big data in industry to confirmation runs in design of experiments. David Edwards, a CPID member and associate professor at Virginia Commonwealth University, served as our CPID representative at the conference. All of the papers presented, along with the discussions, will be published in a special issue of *Quality Engineering*. Be on the lookout for this special issue!

The Fall Technical Conference (FTC) and the World Conference on Quality and Improvement (WCQI) continue to be two important events supported by CPID. The 2017 WCQI will be held in Charlotte, NC, May 1– 3. Come by our exhibit booth 819 if you are attending the conference!

The 2017 FTC will be held in Philadelphia, PA, October 4 – 6. The theme of this year's conference is Statistics: Powering a Revolution in Quality Improvement. We are proud to say that the co-chairs for the FTC conference are Brooke Marshall and Stephanie DeHart, two CPID members who are active member leaders in our division. Visit the conference website for more details **www.falltechnicalconference.org/**.

A final goal for 2017 is to lay the foundation for providing webinars to our members. Look for more information on webinars later in the year. Please contact me with any recommendations you have on topics to be covered in a webinar series or any suggestions you may have about improving our division. (**adriscoll@vt.edu**).

I look forward to working with our leadership team and each of you as we work to meet our 2017 goals.

Anne Driscoll
CPID Chair, 2017

Chemical and Process Industries Division
ASQ The Global Voice of Quality®

About the author

Dr. Joanne R. Wendelberger has been a member of the Statistical Sciences Group at Los Alamos National Laboratory since 1992. In 2016, she was promoted to a senior level scientist position, after serving in multiple leadership roles as an R&D manager for the Statistical Sciences Group and the Computer, Computational, and Statistical Sciences Division. She previously worked as a statistical consultant at the General Motors Research Laboratories. She received her Ph.D. in statistics from the University of Wisconsin in 1991, working with Professor George Box. Her research interests include statistical experiment design and test planning, statistical bounding and uncertainty quantification, materials degradation modeling, sampling and analysis for large-scale computation and visualization, probabilistic computing, and education modeling. She is a Fellow of the American Statistical Association (ASA) and a Senior member of ASQ. She has served as an associate editor for Technometrics *and as an ASQ representative on the* Technometrics *Management Committee. She has served as chair and program chair of the ASA Section on Physical & Engineering Sciences, president of the ASA Albuquerque Chapter, and as a member of several conference organization committees and awards committees.*

Understanding Today's Complex World

2016 W. J. Youden Memorial Address
Fall Technical Conference
Minneapolis, MN
October 6, 2016

Joanne R. Wendelberger
Los Alamos National Laboratory

Abstract

Shortly before his death, W. J. Youden (1900-1971), who was both a chemist and a statistician, completed the manuscript of *Risk, Choice, and Prediction*, published in 1974. As described in the *Complete Dictionary of Scientific Biography* (2008), this manuscript was meant, "for anyone … who wants to learn in a relatively painless way how the concept and techniques of statistics can help us better understand today's complex world." Today, we live in an increasingly complex world. In line with the 2016 Fall Technical Conference theme, "Statistics and Quality, the Twin Pillars of Excellence," statistics and quality professionals possess valuable knowledge, tools, and experience for understanding increasingly complex phenomena. Fundamental concepts associated with sampling, error analysis, and design of experiments have laid a foundation for the development and evolution of a variety of approaches for addressing these complex challenges using data in a structured and principled manner.

Keywords

design of experiments, error analysis, quality, sampling, statistics, W. J. Youden

Introduction

I will begin my address with some background on W. J. Youden and why I chose my title, "Understanding Today's Complex World." I will then share my thoughts on the process of scientific exploration and discovery, focusing on three important concepts: sampling, error analysis, and statistical design of experiments. As we will see, the use of these concepts to address real problems has led to the evolution and advancement of statistical methods over time. Throughout my address, I will share some of my personal and professional experiences and insights.

I am deeply honored to have the opportunity to present the 2016 W. J. Youden Memorial Address. Just as W. J. Youden recognized the opportunity to use statistical methods to understand complex phenomena in the 20th century, statisticians and quality professionals today have the opportunity to contribute statistical knowledge and expertise to understanding today's complex phenomena and the accompanying explosion of data.

Background

W. J. Youden, who was originally from Australia, had a background in physical chemistry and chemical engineering. He came to the United States and joined the National Bureau of Standards in 1948. As described in the *Complete Dictionary of Scientific Biography* (2008), "By his publications and by his example, Youden contributed substantially to the achievement of objectivity in experimentation and to the establishment of more exact standards for drawing scientific conclusions." Throughout Youden's work, the enduring concepts of statistical sampling, error analysis, and statistical experiment design feature prominently. Among Youden's many technical contributions are the Youden square experiment design, work on analysis of systematic errors, interlaboratory testing, the Youden plot, the Youden index, restricted randomization, and the extreme rank test for outliers.

Youden's ideas have popped up throughout my life as a statistician. Early in my career, I was asked to serve as a member and later chair of the American Statistical Association W. J. Youden Award for Interlaboratory Testing Committee, which recognizes authors of publications that make outstanding contributions to the design and/or analysis of interlaboratory tests or describe ingenious approaches to the planning and evaluation of data from such tests. This experience exposed me to the statistical issues and approaches used in the area of interlaboratory testing. Later, I had the opportunity to serve as an issue nominator and judge for ASQ's Youden Prize, which is awarded to the best expository paper in *Technometrics*, recognizing the importance of communication of technical ideas. These experiences instilled in me an appreciation for both sound technical approaches and clear communication.

According to the *Complete Dictionary of Scientific Biography* (2008), Youden wrote a manuscript on *Risk, Choice, and Prediction* in 1962, later published in 1974, that he said was, "for anyone … who wants to learn in a relatively painless way how the concept and techniques of statistics can help us better understand today's complex world," and this inspired me to choose my title, "Understanding Today's Complex World."

Complexity

In many ways, our world is becoming increasingly complex. Complexity arises in diverse settings and has been defined in various ways. Often, complexity is defined in a manner that gives the impression that it is essentially impossible to model. The U.S. Army Operating Concept defines a complex environment to be "not only unknown, but unknowable and constantly changing." According to Neil Johnson (2009), "Even among scientists, there is no unique definition of complexity," and "Complexity science can be seen as the study of the phenomena which emerge from a collection of interacting objects." According to another perspective posted at en.wikiquote.org, "Understanding today's complex world of the future is a little like having bees live in your head," conveying a rather alarming situation.

Despite the difficulties posed by complexity, even if it is not possible to completely capture all of the intricate details of an interacting system precisely, that should not cause us to throw up our hands in despair. Instead, we should proceed cautiously, and in the spirit of George Box (1979), acknowledge that, "All models are wrong, but some are useful."

One might ask, "Where do quality and statistics fit in?" In the spirit of the 2016 Fall Technical Conference theme, "Statistics and Quality: Twin Pillars of Excellence," statisticians and quality professionals can contribute to the understanding of complex problems and accelerate scientific discovery by using their knowledge of statistical methods and models to understand and disentangle different components of interacting systems.

For the remainder of this discussion, I will focus on complexity in science and technology and the potential for accelerating scientific discovery using the tools of the statistics and quality fields.

The process of scientific exploration and discovery

In the process of scientific exploration and discovery, scientists seek improved knowledge over time, gathering data to confirm or refute proposed models. Statistics provides a rigorous framework for drawing inferences from scientific data, bringing together the key concepts of sampling, error analysis, and design of experiments.

To draw valid conclusions, we need to understand the distributions from which data arises. Analysis of errors requires an understanding of measurement processes, associated errors, and how they will interact and propagate. Given that complex problems generally involve limited resources, statistical experiment design methodology is needed to provide structured techniques for efficiently selecting sets of experimental runs from the space of possible experimental settings.

The fundamental concepts associated with sampling, error analysis, and design of experiments used in Youden's day have laid a foundation for understanding data in a structured and principled manner. These fundamental concepts continue to play an important role today in understanding complex relationships and behavior. Statistical methods built on these concepts are evolving and advancing over time to address increasingly complex problems. These ideas will now be discussed in further detail, along with their evolution to address modern challenges.

Sampling

Sampling theory gives us a sound mathematical structure to understand and probe statistical populations. Many different types of sampling procedures have been proposed to address different types of sampling scenarios. Traditionally, attention has focused primarily on relatively simple sampling scenarios such as simple random sampling, stratified random sampling, and systematic sampling. Over the years, many other types of sampling have been studied and implemented.

In order to employ effective sampling approaches, it is import to understand the population to be sampled, the sampling objective, and practical constraints. Table 1 provides a list of selected sampling methods that have been developed to address different types of sampling situations. As we see here, many different sampling strategies have been developed and applied as increasingly complex problems have arisen, leading to new advances in the field of statistics.

Table 1: Selected Sampling Methods

Simple Random Sampling
Stratified Random Sampling
Systematic Sampling
Subsampling
Judgment Sampling
Convenience Sampling
Biased Sampling
Latin Hypercube Sampling
Markov Chain Monte Carlo

Youden's work on experimentation and measurement (1962) includes a number of experiments involving weighing, including an experiment where he weighed pennies to determine the distribution of weight values and to compare the weights to a specification. This example reminds me of a practical application of weighing methods that I encountered in one of my first summer jobs—conducting inventory at Harley Davidson. At that time, an annual manual inventory was conducted to determine how many items were on hand of every type of part used in the assembly of motorcycles. Many items were simply counted by hand. For boxed items stacked on pallets, simple arithmetic calculations could be used to quickly determine the total number of items. For large quantities of small items, estimates of total quantities were determined by weighing both a small countable sample and the total quantity available, and then calculating an estimated total. Many years later, I read an article by Stefan Steiner and Jock McKay (2004) on scale-counting that appeared in *Technometrics*, providing a thorough statistical treatment of weighing methods that was the winner of ASQ's Wilcoxon Prize for the best practical applications paper. In recent years, many time-consuming manual inventories have been replaced by automated inventory systems. Just as manual weighing methods improved upon hand counting, automated inventory systems bring a new level of accuracy in counting and timely transfer of information for multiple business needs.

Today's problems often involve large and complex data. Observations may take the form of curves, spectra, or more general types of functions. Sometimes, a functional approach can be useful in understanding statistical problems. I was once asked to evaluate some data where an unusual measurement had been observed. An initial assessment based on a small sample led to the conclusion that, "This was a nonproblem." However, this result relied on several assumptions that were difficult to validate. Additional measurements were recommended, and the selection of units for measurement took into account historical functional data. This approach explored the space defined by the first couple principle components of the functional responses. The new samples led to the identification of an issue that was more prevalent than originally thought.

When problems become larger and more complex, it becomes increasingly important to develop and apply sampling, design, and analysis methods that can provide representative samples and effective analysis results. With the rise of computational models and sophisticated Bayesian estimation schemes, substantial growth has occurred in the use of techniques such as Latin hypercube sampling for choosing runs in studies of large computational models, as described in McKay et al. (1979), and Markov chain Monte Carlo methods for Bayesian estimation, as discussed in Gelman et al. (1995).

Error Analysis

Understanding measurement error has long been a concern of both statisticians and metrologists. Extensive work in this area was conducted at the National Bureau of Standards, today known as the National Institute of Standards and Technology. Understanding data often requires careful analysis of the measurement process used to collect the data. As discussed by Vardeman et al. (2010) in *The American Statistician*, failure to consider errors associated with the measurement process can result in misleading analyses, even for simple basic statistical methods such as comparisons and linear regression.

Despite its importance, measurement error is often simply ignored. The interaction of sources of physical variation with the data collection plan will ultimately determine what can be learned from the data. Unfortunately, the implications of measurement error are rarely given much emphasis in standard statistics courses.

While the field of statistics focuses on uncertainty, the field of metrology focuses on measurement. These two fields really go hand in hand, and both perspectives are important to understanding the different sources of variability present when analyzing measurements made on samples drawn from a specified population. Probability theory defines the concept of a distribution, which can then be used to describe empirical variation and uncertainty. In an article in *Journal of Quality Technology*, Vardeman et al. (2014) propose a simple thought process for understanding measurement error that begins by modeling a single measurand, then considers multiple measurements from a stable process or fixed population, and then progresses to analysis of data obtained from multiple measurement methods.

In the presence of measurement error, we aim to measure a variable x, but what we observe is actually the sum of the desired variable and an associated measurement error. The overall error includes an intrinsic variation in the underlying variable as well as an added source of variability associated with measurement error. This type of assessment can be extended to more complicated situations including multiple measurements and multiple measuring devices.

When carrying out statistical analyses, an important concept to understand is that sample variances are inherently much more variable than sample means. While working on my Ph.D. thesis with George Box, he instructed me to go look at how many samples would be needed to obtain a coefficient of variation of 5 percent for the variance of a normal distribution as shown in Wendelberger (2010). I was shocked to find that 801 samples were needed, and this made a huge impression on me. Analysis methods that rely on estimates of variability often ignore the inherent variability in sample variances.

Fortunately, in some situations, we can turn to transformations and apply a log transformation to stabilize variances as suggested by Bartlett and Kendall (1946). This idea was extended to more general power transformations by Box and Cox (1964), a result that is widely used in diverse application areas. I recall seeing an article posted on the bulletin board in the University of Wisconsin-Madison Statistics Department in the early 1980s showing that the Box and Cox paper was on a list of the 10 most-cited scientific references, truly an amazing feat, having impact not just in statistics, but also in the broader scientific community.

Ultimately, when we are presented with uncertainty in measured data, this will have an impact not just on the analysis of the measured values themselves, but also on subsequent analyses, where the measured data is used as input to models, and the associated variation is transmitted to the resulting model outputs.

In recent years, increasing interest in different sources of uncertainty has led to the interdisciplinary field of uncertainty quantification, which focuses on understanding uncertainty throughout the modeling process.

As defined in National Research Council (2012), uncertainty quantification is:

"the process of quantifying uncertainties associated with model calculations of true, physical quantities of interest, with the goals of accounting for all sources of uncertainty and quantifying the contributions of specific sources to the overall uncertainty."

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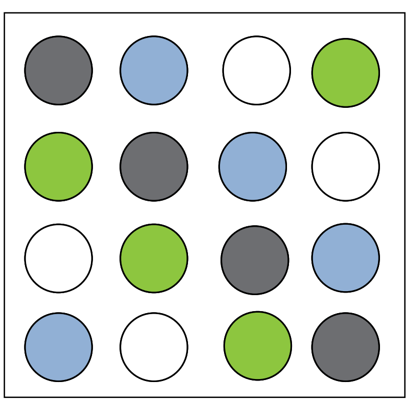
Modern statistics and uncertainty quantification draw on many statistical ideas that have evolved over the past century. In scientific modeling, analysis of outputs from computer models has become increasingly important. Statistical techniques such as Gaussian process modeling, first applied to computer experiments by Sacks et al. (1989), are now in common use for approximating the behavior of complex computer codes and associated discrepancy of these models from observed data. Gaussian process modeling is essentially an evolution of classical response surface modeling, where Gaussian processes are used in place of the typical low-order polynomials, and discrepancy functions build upon and extend the idea of residual analysis.

Design of Experiments

Statistical experiment design methodology provides structured approaches for efficiently selecting sets of experimental runs from the space of possible experimental settings for both physical and computational experiments.

Figure 1: Latin Square



Each color appears exactly once in each row and column.

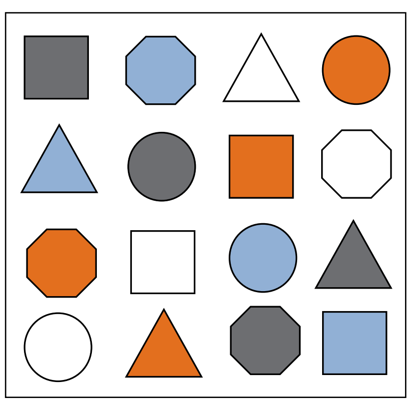
Latin Squares and Graeco-Latin Squares

My first introduction to experiment design was a puzzle I received at an early age. The challenge provided by this puzzle was to arrange 16 colored shapes on a 4 x 4 grid such that each row and column contained each color and shape exactly once. I later learned that this puzzle was actually a 4 x 4 Graeco-Latin square. A somewhat simpler arrangement is a Latin square where a single characteristic, such as color, appears exactly once in each row and column. Figures 1 and 2 display a 4 x 4 Latin square and a 4 x 4 Graeco-Latin square, which represent examples of experiment design layouts that can be used in designing experiments with a single four-level variable or two four-level variables.

Youden Squares

Another type of layout closely related to the Latin square is the Youden square, which is actually not a square but a rectangle. Youden squares can be used to generate balanced incomplete block designs. An interesting property of a Youden square (or Latin rectangle) is that it can be converted to a Latin square by adding a column.

Figure 2: Graeco-Latin Square



Each color and shape appears exactly once in each row and column.

Magic Squares

Latin squares, Graeco-Latin squares, and Youden squares are all related to magic squares, which have existed for several hundred years. In a magic square, the entries are typically represented as numbers, and the row sums and column sums are all equal. In a perfect square, in addition to having all row and column sums equal, the diagonal sums are also equal. Figure 3 displays a perfect magic square, where the row, column, and diagonal sums are all equal. I constructed this magic square during a beach vacation, when I was thinking about a problem I was working on with an artist involving assessment of color maps used to assign colors to different values for scientific visualization. An experiment plan was needed that would assign different color maps to each subject in the study to evaluate the impact of the color maps on the subjects' performance on tasks involving color perception.

Figure 3: Magic Square at the Beach

(created and photographed by J. R. Wendelberger)

Each number occurs exactly once in each row, column, and diagonal.

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Magic squares have a long and interesting history. According to Block and Taveres (2009), magic squares first appeared in ancient Chinese literature over 4,000 years ago, where a mythical emperor observed marks on a tortoise, with the counts being the same for each of the rows, columns, and diagonals. A magic square was reported in India in the first century A.D. German artist and printmaker, Albrecht Dürer, included a magic square in a 1514 engraving. In 1783, Swiss mathematician and physicist Leonhard Euler introduced the Latin square as an N x N grid, with the numbers 1 through N appearing exactly once in each row and column. Equivalently, these labels can be represented by colors, as in the puzzles described earlier.

Sudoku

Today's popular Sudoku puzzles, commonly found in newspapers, magazines, puzzle books, online websites, and electronic games, represent an evolution of the design patterns introduced earlier. According to Block and Taveres (2009), American puzzle designer Howard Garns is credited with initiating the 9 x 9 grid puzzle with nine 3 x 3 sub-grids that was first published in a puzzle magazine and called number place. The game mumber place was renamed Sudoku by Maki Kaji and popularized in Japan beginning in 1984. Note that the rapid and successful popularization of Sudoku is reminiscent of the quality revolution that took place after W. Edwards Deming brought statistical process control methods to Japan. Another puzzle game called Kakuro involves the insertion of the numbers 1-9 into a black and white pattern so that rows and columns add up to specified sums.

In recent years, statistical researchers have studied the mathematical properties of Sudoku puzzles and developed Sudoku-based experiment designs. Xu, Haaland, and Qian (2001) have developed space-filling designs that achieve maximum uniformity in univariate and bivariate margins. Xu, Qian, and Lu (2016) have extended these ideas to produce space-filling designs for data pooling that include overlaps and provide uniformity in univariate and bivariate margins for a complete design, sub-designs, and overlaps. Advances in our understanding of design patterns support the development of new statistical designs to address increasingly complex problems.

Experiment Designs for Diverse Problems

As we look back at how the field of statistical experiment design expanded beyond traditional two-way layouts motivated by agricultural experiments, we see the evolution of the ongoing search for balanced patterns to efficiently obtain information about multiple experimental factors. Table 2 lists a number of different types of statistical experiment designs that have been developed. A variety of types of experiment plans have been proposed to address diverse types of problems. Note, for example, the progression over time that has occurred with the development of factorials and fractional factorials, as described by Box, Hunter, and Hunter (2005), and the recent work on definitive screening designs by Jones and Nachtsheim (2011). The evolution of design strategies over time was also noted by Dennis Lin in his (2010) Fall Technical Conference Youden Memorial address.

Table 2: Selected Experiment Design Approaches

Latin Square	Definitive Screening
Graeco-Latin Square	Adaptive Design
Youden Square	Bayesian Design
Full Factorial	Functional Response Surface
Fractional Factorial	Composite Design
Plackett-Burman	High Throughput Screening
Mixed Level	Compressive Sensing
Orthogonal Array	Covering Arrays
Near-Orthogonal Array	Genetic Algorithms

The use of mathematical arrays for designing experiments is certainly not limited to statisticians. In recent years, there has been great interest by mathematicians in compressive sensing techniques that attempt to find small systems of equations designed to extract specified information, often by invoking principles of linear algebra, optimization, and penalty constraints. Similarly, genetic algorithms inspired by biological systems have been used to generate novel approaches for constructing experimental designs. See for example, Hamada et al. (2001) and Lin et al. (2015).

Compressive Sensing

Figure 4 illustrates a problem involving weights of coins described by Bryan and Leise (2013) to illustrate the basic idea of compressive sensing. There are seven coins, and one is suspected of being a different mass. Note that each column gives the binary representation of the index associated with each of the seven coins. It turns out that the bad coin can be identified with three weighings proscribed by the binary representation. Mathematically, this type of problem can be solved as a linear optimization problem subject to a constraint. Let $\Phi x = b$, where b is assumed to have at most *k* nonzero components, and then find x, such that *min* $||x||_1$ is achieved subject to $||\Phi x - b||_2 \le \varepsilon$.

Figure 4 Compressive Sensing

Bryan and Leise (2013) describe a problem involving seven coins, one of which is suspected to have an aberrant weight. By writing out the index assigned to each coin in binary, it is possible to develop a design that requires only three weighings, corresponding to sum of the weights of the coins in the three rows, to detect a single aberrant weight coin.

	1	0	1	0	1	0	1
Φ =	0	1	1	0	0	1	1
	0	0	0	1	1	1	1

Covering Arrays

Another area closely related to experiment design is the idea of covering arrays. Covering arrays are used in software engineering to test software that can have large numbers of configurations. A subset of configurations is selected for testing so that for any subset of *t* variables, all combinations of the settings of the t variables occur in the test plan.

Kleitman and Spencer (1973) and a NIST website provide further information on covering rays.

Designing Experiments in Practice

My personal fascination with patterns and arrangements continues to this day and has influenced and motivated much of my statistical work. When designing real-world experiments, there are often practical considerations and constraints that must be taken into account, as discussed in Wendelberger et al. (2009). Often, the challenges of a practical design problem can motivate new advances. The need to generate a mixed level design for a physical experiment eventually led to the development of an algorithm for generating orthogonal and near-orthogonal arrays for main effects screening, described in Lekivetz (2015). This algorithm goes beyond traditional hand calculations and can be used for relatively large computer experiments. Each experiment seems to have its own nuances and opportunities for innovation. As an example, recall the importance of understanding error structure, and consider the common situation where the settings of the experimental variables cannot be obtained exactly. Approaches for addressing variability in controlled experimental variables and the associated uncertainty that can arise in designed experiments may be found in Wendelberger (2010, 2015). When developing designs in practice, specific departures from the usual assumptions require careful thought, and often some ingenuity, to determine appropriate types of designs and corresponding analyses.

Summary and Conclusions

In summary, we see that our complex world creates opportunities for statisticians and quality professionals to contribute to increasingly difficult analysis challenges. At the heart of solving complex problems, we see the key concepts of sampling, error analysis, and experiment design playing a prominent role. As new problems arise, sampling, design, and analysis methods can be built on these concepts to address the increasing complexity of diverse interdisciplinary challenges.

Acknowledgments

In closing, I would like to thank the Youden Committee and the Fall Technical Conference Program Committee for inviting me to give this year's Youden address. I'd also like to recognize the impact of my graduate advisor, George Box, and the University of Wisconsin Statistics Department for providing me with my initial introduction and training in statistics and quality, and all of my colleagues in the Statistical Sciences Group at Los Alamos National Laboratory who have influenced my career.

I'd also like to thank my family: my parents Don and Marie Roth (both trained as chemists), my husband Jim, who is a statistician, my daughter Barbara, who recently defended her Ph.D. thesis on statistical methods for FMRI, my daughter Laura, who is contemplating a career in statistics, and my daughter Beth, who is working in the healthcare field, making a difference in people's quality of life through the use of scientific studies supported by data and statistical analysis. In addition, my family has had a number of mathematically oriented pets over the years, including a dog named Spline, and gerbils, Kakuro and Sudoku, shown in Figure 5, who were named after the mathematical puzzle games known by the same names.

Figure 5 Sudoku and Kakuro

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2017 World Conference on Quality and Improvement

When and Where:

- May 1 – 3, 2017
- Charlotte Convention Center, Charlotte, NC
- Website: **asq.org/wcqi**

Focus Areas:

- Risk and Change
- Quality Fundamentals
- Focus on the Customer
- Quality as a Competitive Advantage
- Operational Excellence

Meet CPID

- CPID will host a joint social with the Statistics Division on Monday, May 1, 6:00 p.m. – 8:00 p.m. at Blackfinn Ameripub Charlotte (210 E. Trade St. Suite 120-B, Charlotte, NC 28202). Hope to see you there!
- CPID open member meeting: Sunday, April 30, 4:00 p.m. – 5:00 p.m. at Sheraton/Le Meridien Governor's Ballroom 3
- CPID exhibit hall booth: 819
- Exhibitor show dates: Sunday, April 30 – Tuesday, May 2, 2017

Exhibitor Show Times

Day	Date	Time
Sunday	April 30	6:30 p.m. – 8:30 p.m.
Monday	May 1	9:00 a.m. – 5:00 p.m.
Tuesday	May 2	9:00 a.m. – 4:00 p.m.

Program

With more than 100 sessions focusing on the 2017 theme, Grow Your Influence: In the Profession, Through the Organization, and Around the World, browse through the program by day, level, focus area, and session type to find exactly what you need. Then create your own personal schedule to customize your conference experience! The program is categorized according to level: Basic, Intermediate, and Advanced; and according to session type: Concurrent Session, Workshop, and After 5 Session. You can find the full program at: **asq.org/wcqi/program.aspx**

2017 WCQI Pricing details can be found at: **asq.org/wcqi/pricing.aspx**

ASQ

2017 WCQI

Keynote Speakers

Monday, May 1, 8:00 a.m. – 9:45 a.m.

Jeremy Gutsche

Award-Winning Author, Journalist, and Radio and TV Personality Entrepreneur, CEO and Innovation Expert

Monday, May 1, 4:15 p.m. – 5:15 p.m.

Dr. Sebastian Wernicke

Chief Data Scientist at One Logic

Tuesday, May 2, 8:00 a.m. – 9:00 a.m.

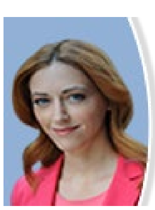
Geoff Colvin

Senior Editor-at-Large, Fortune Magazine*; Best-Selling Author/Commentator on Business and Economic Issues*

Tuesday, May 2, 1:15 p.m. – 2:15 p.m.

Celeste Headlee

Journalist, NPR, PBS, and CNN. Author, Heard Mentality: An A to Z Guide to Taking Your Radio Show or Podcast from Idea to Hit



Wednesday, May 3, 10:45 a.m. – noon

Kelly McGonigal

Lecturer, Stanford University. Author, The Upside of Stress *and* The Willpower Instinct

Training/Courses

The following training courses are available in connection to the conference. More information about course content, pricing, and schedule is available at the conference website.

- **Reliability Engineering**
- **Certified Manager of Quality/Organizational Excellence Certification Preparation**
- **Lean Enterprise**
- **Corrective and Preventive Action**
- **Cost of Quality: Finance for Continuous Improvement**
- **ASQ's Quality 101**
- **Lean Kaizen: A Simplified Approach to Process Improvement**
- **Certified Quality Auditor Certification Preparation**

Sponsors

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After 5 Sessions Sponsor

BOEING — Executive Roundtable Sponsor

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NORTHROP GRUMMAN — Mobile App Sponsor

ASQ

Welcome to the 61st Annual Fall Technical Conference, 2017!

Statistics: Powering a Revolution in Quality Improvement

October 5 – 6, 2017 at Sheraton Society Hill, Philadelphia, PA

The 61st Fall Technical Conference will be held in Philadelphia, PA, October 5 – 6, 2017. This year, the theme of the conference is "Statistics: Powering a Revolution in Quality Improvement." The program committee has put together an outstanding group of sessions including topics in design of experiments, measurement assessment, statistical process control, and big data. Also, the program will include another great SPES special session on Friday afternoon.

Short Courses

In addition to the conference program, four short courses will be offered on Wednesday, October 4, 2017.

We look forward to seeing you all in Philadelphia!

Stephanie DeHart and Brooke Marshall
FTC Co-Chairs, 2017

Please visit the conference website for complete information on the program, hotel, short courses, and Philadelphia.

www.falltechnicalconference.org

General FTC Co-Chairs

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Merck & Co.
215-652-2424
j.brooke.marshall@gmail.com

Stephanie P. DeHart
Eastman Chemical Company
423-229-1730
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Program Committee

ASQ: STAT (Chair)
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Aerojet Rocketdyne
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ASA: SPES
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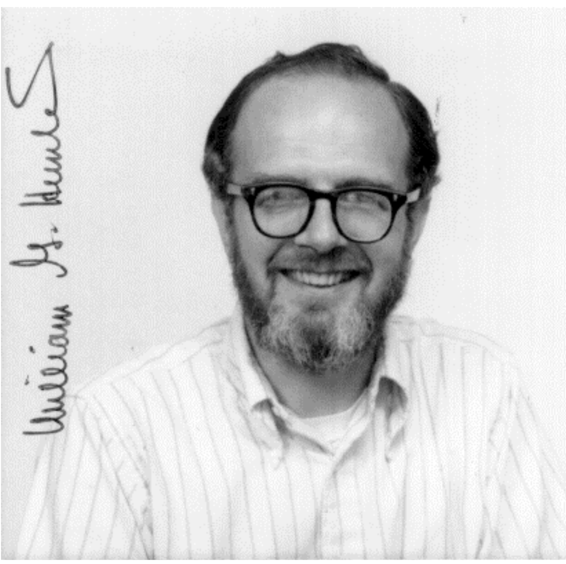
Nominations Sought for 2017 William G. Hunter Award

The ASQ Statistics Division is pleased to announce that nominations are now open for its William G. Hunter Award for 2017.



William G. Hunter was the founding chair of the Statistics Division of the American Society for Quality Control (now ASQ). His leadership as a communicator, consultant, educator, innovator, and his ability to integrate statistical thinking into many disciplines serve as exemplary models for the division's members.

Objective: The Statistics Division established the William G. Hunter Award in 1987 to encourage and promote outstanding accomplishments during a career in the broad field of applied statistics, and to recognize implementers who get results.

Qualifications: Any outstanding leader in the field of applied statistics, regardless of ASQ or ASQ Statistics Division membership status, is qualified. Candidates must have demonstrated a high level of professionalism, significant contributions to the field, and a history of inspirational leadership. A person may be nominated many times, but can win the award only once.

Procedure: The nominator must have the permission of the person being nominated and letters from at least two other people supporting the nomination. Claims of accomplishments must be supported with objective evidence. Examples include publication lists and letters from peers. Nominators are encouraged to read the accompanying article, "William G. Hunter: An Innovator and Catalyst for Quality Improvement," written by George Box in 1993 **(http://williamghunter.net/george-box-articles/william-hunter-an-innovator-and-catalyst-for-quality-improvement)** to get a better idea of the characteristics this award seeks to recognize.

Nominations: Nominations for the current year will be accepted until June 30. Those received following June 30 will be held until the following year. A committee of past leaders of the Statistics Division selects the winner. The award is presented at the Fall Technical Conference in October.

The award criteria and nomination form can be downloaded from the "Awards" page of the ASQ Statistics Division website **(http://asq.org/statistics/about/awards-statistics.html)** or may be obtained by contacting Necip Doganaksoy **(necipdoganaksoy@siena.edu)**.

ASQ

CPID Leadership, 2017

Chemical and Process Industries Division
ASQ The Global Voice of Quality®

CPID's Mission: The Chemical and Process Industries Division facilitates the interchange of ideas, tools, practices, and solutions necessary to address real chemical and process industry problems.

CPID's Vision: To be the customer-centered volunteer organization which is the primary and most credible global resource for quality improvement and management practices in the chemical and process industries.

LEADERSHIP POSITION	NAME	EMAIL
Chair	Anne Driscoll	*adriscoll@vt.edu*
Chair-Elect	Jennifer Van Mullekom	*vanmuljh@vt.edu*
Secretary	Diane Schaub	*caveltie@gmail.com*
Treasurer	Ashley Childress	*anchildress@eastman.com*
Nominating Chair (Past Chair)	Flor Castillo	*facas@mac.com*
Audit Chair (Past Chair 2)	Brooke Marshall	*j.brooke.marshall@gmail.com*
Examining Committee Chair	Malcolm Hazel	*malchazel@gmail.com*
Membership Chair/VoC Chair	Jennifer Kensler	*jennifer.kensler@shell.com*
Communications Chair (newsletter/internet/website)	Sarah Burke	*seburke89@gmail.com*
Education Chair	Dotty Sempolinski	*sempolinskide@gmail.com*
Shewell Awards Chair	Malcolm Hazel	*malchazel@gmail.com*
Wilcoxon/Youden Awards Chair	David Edwards	*dedwards7@vcu.edu*
Standards Committee Representative	Brenda Bishop	*brend821@msn.com*
FTC Steering Committee Representative	Kevin White	*kwhite@eastman.com*
FTC 2017 General Co-Chairs	Brooke Marshall and Stephanie DeHart	*j.brooke.marshall@gmail.com* *stephanie.pickle@gmail.com*
FTC 2017 Technical Program Representative	Sarah Burke	*seburke89@gmail.com*
FTC 2017 Short Course Representative	Maria Weese	*weeseml@miamioh.edu*

Call for Nominations

The Chemical and Process Industries Division is announcing a call for nominations for the elected positions of chair-elect, secretary, and treasurer. The term of these elected positions is from January 1, 2018 through December 31, 2018.

Nominations from the general division membership require the submission of a nomination petition, signed by at least 10 Regular members and should be submitted to Diane Schaub, CPID secretary **(caveltie@gmail.com)** by Friday, September 15, 2017.

If you have any questions regarding this nomination or if you are interested in a non-elected position, please contact Flor Castillo, CPID nomination chair **(facas@mac.com)**.

How to get involved?

For more information about the division, please visit our website **(asq.org/cpi)**. We encourage you to stay connected to the division by joining us on **LinkedIn**.

If you have any questions or suggestions for the division or would like to increase your involvement with the division, please contact Jennifer Kensler, membership/VoC chair, at: **jennifer.kensler@shell.com** or Anne Driscoll, 2017 CPID chair, at: **adriscoll@vt.edu**.

Newsletter Editor:
Sarah Burke (**seburke89@gmail.com**)

ASQ