

# **We Stand on the Shoulders of Giants Pioneers of Statistics in Industry**

**Ronald D. Snee, PhD  
Snee Associates, LLC**

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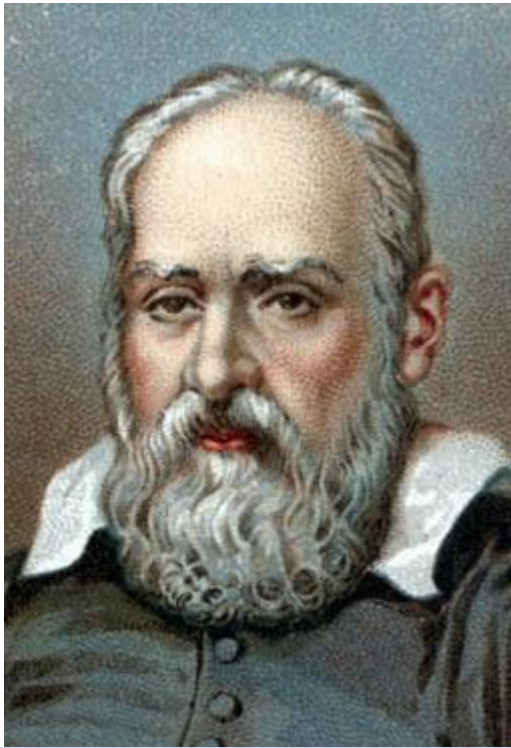
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# **Abstract**

**Industrial statistics has a rich and proud heritage. Initiated in the 1940s and picking up steam in the 1950s with establishment of industrial statistics groups in several companies including American Cyanamid, Western Electric, DuPont, Kodak and GE. It can be argued that we are in the third generation of the development of the profession.**

**Several pioneering industrial statistics organizations, initiated in the 1940s and 50s are profiled in this presentation. The focus is on the roots of the groups and the people involved, their contributions to their employers, to advancements in the field and the development of the profession. Synthesis of this information provides some unique insights into who we are, what we have accomplished and the needs and opportunities of the future.**

# Pioneers - Galileo; Katherine Johnson; Fred Smith



**Galileo**  
**Astronomer**



**Katherine Johnson**  
**NASA Mathematician**  
**1<sup>st</sup> Man in Space Flight**



**Fred Smith**  
**Founder, FEDEX**

**Person who is among the first to:**

- ≡ **Develop area of knowledge or activity**
- ≡ **Use or apply a new method, area of knowledge, or activity**

**You can often identify pioneers by**

- ≡ **Progress made**
- ≡ **“Number of arrows protruding from their back”**

# Realities of Late 1940s and 1950s

- ≡ **World War II was over**
  - = **Only manufacturing was in the United States**
- ≡ **R&D emphasized**
  - = **Chemical Industry focuses on product development**
- ≡ **Cold War had Begun**
  - = **Space Race – Russia launched Sputnik in 1957**
- ≡ **Digital computer arrived on the scene**
- ≡ **4 books on “Industrial Statistics” were available in 1950, 8 books in 1954**
- ≡ **“Experimental Designs in Industry” Conference at North Carolina State November 1956 (Victor Chew 1958)**

## Experimental Designs in Industry

Edited by  
VICTOR CHEW

*A Symposium held November 5-9, 1956  
at North Carolina State College*

*Conducted by the Institute of Statistics  
State College Section  
Raleigh, North Carolina*

*Sponsored by the Mathematics Division  
Air Force Office of Scientific Research  
Air Research and Development Command  
under Contract AF 18(603)-55*

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# Industrial Statistics – The Contributors

**Industrial  
Organizations**

**NC State  
Iowa State  
VA Tech  
Rutgers  
Wisconsin**

**Academics**

**Nat'l Bureau of Stds  
Oak Ridge  
Battelle Northwest  
Aberdeen Proving  
Grounds**

**Government  
Groups**

**Cuthbert Daniel  
Bill Golomski**

**Consultants**



# **Eight Pioneering Industrial Organizations**

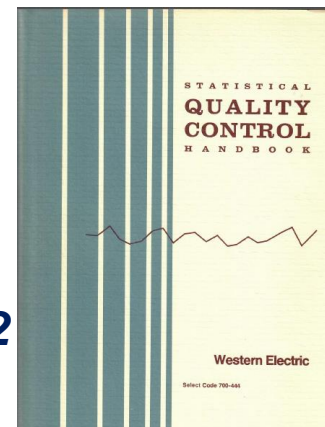
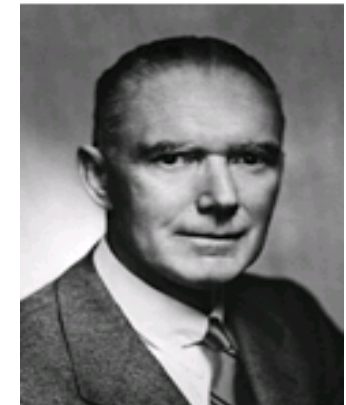
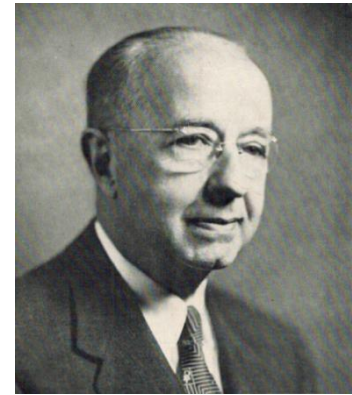
- ≡ **Western Electric and Bell Labs 1923**
- ≡ **DuPont 1950**
- ≡ **3M 1954**
- ≡ **Procter and Gamble 1954**
- ≡ **American Cyanamid 1954**
- ≡ **General Foods 1955**
- ≡ **General Electric 1955**
- ≡ **Kodak 1957**



**We Stand on the Shoulders of Giants**

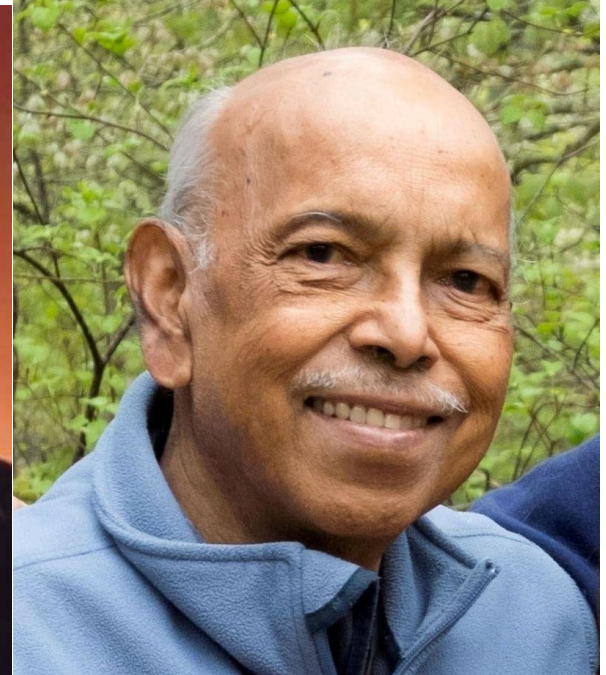
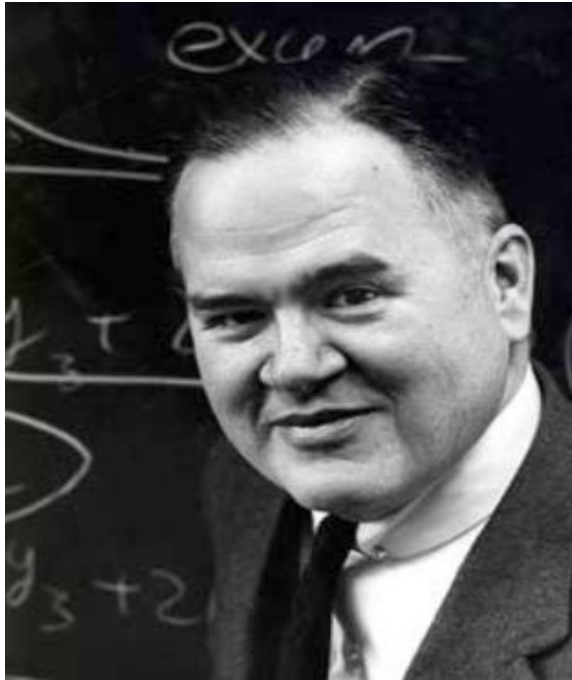
# Western Electric - 1924

- ≡ **Walter A Shewhart**  
Head, Department of Quality Theory
  - = Control Chart (memo 1924)
  - = *Economic Control of Quality of Manufactured Product (1931)*
- ≡ **Harold F. Dodge**  
Head, Department of Quality Methods
  - = Acceptance Sampling
  - = *Sampling Inspection Tables*, Harold Dodge and Harry Romig (1944)
  - = Honorary Member of ASQC
- ≡ **Bonnie B. Small**
  - = *Western Electric Quality Control Handbook, (1956), Reprinted in 1982*
  - = Ellis R. Ott Award 1992



# Bell Labs

## John Tukey, Martin Wilk and Ram Gnanadesikan



**Made Graphics and Visualization “Respectable”**

**“The Greatest Value of a Picture Is that It Forces Us to Notice  
What We Never Expected to See”      John W. Tukey**



# DuPont - 1950

## Arthur E. Hoerl (1950)

- ≡ Outstanding Problem Solver
- ≡ Ridge Regression (with R. W. Kennard)
- ≡ “Least Squares results didn't make sense; you would have to turn some "dial" way beyond what common sense told you, or turn it to some (impossible) "negative" value”.... A. E. Hoerl



## Donald W. Marquardt (1953)

- ≡ Manager Applied Statistics, Mid 1960s – 1991
  - ≡ Led DuPont' ISO Implementation
  - ≡ Nonlinear Estimation Algorithm (1963)  
“Marquardt's Compromise”



## ≡ Robert W. Kennard (1955)

- = Manager Math, Stat and Online Systems Groups
- = Computer Aided Design of Experiments (1969)
- = Outstanding leader and manager



# 3M – 1954



- ≡ Otto Kral – Leader, Promoter, evangelist, .....
- ≡ Large group of statisticians today at 3M
- ≡ Multiple contributions to 3M quality and R&D
- ≡ Statisticians had impact on many of 3M products

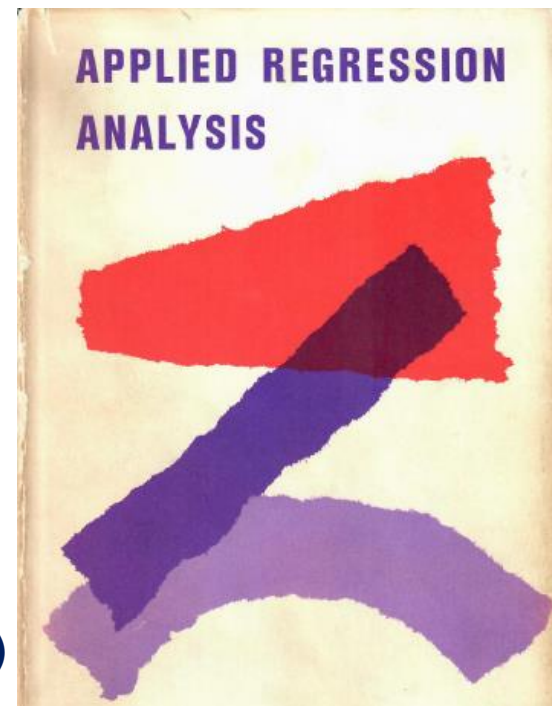
- ≡ Otto was born in Czechoslovakia, **educated in chemistry**
- ≡ He was **a driver for the use of statistics within 3M**, often very demanding, very focused, and saying what was on his mind. Otto was a legend. Everyone had opinion of Otto, both positive and negative.
- ≡ He established a **strong foundation for the use of statistics within 3M** realizing substantial business value.
- ≡ He was **a person of many interests**. He enjoyed growing grapes and making wine among other things.

Reported by Pete Jacobs, 3M

# Procter and Gamble 1954

Harry Smith, Jr.

- = Ram Gnanadesikan, John Comer,
- = Scott Michaels (Robust Design 1964)
- ≡ Applied Regression Analysis
  - = ASQC Chemical Division Short Course
  - = First regression book, Draper and Smith (1966)
- ≡ Editor of *Technometrics*
- ≡ ASQ Shewhart Medal 1993
- ≡ World Renowned Dog Judge
  - ≡ Westminster Kennel Club and others
  - ≡ Judged “All Breeds”



# American Cyanamid 1954

## Stu Hunter at Headquarters in NYC

- ≡ Founding Editor of *Technometrics*
- ≡ ASQ Chemical Division Courses on RSM and Factorial Experiments
- ≡ Honorary Member of ASQ

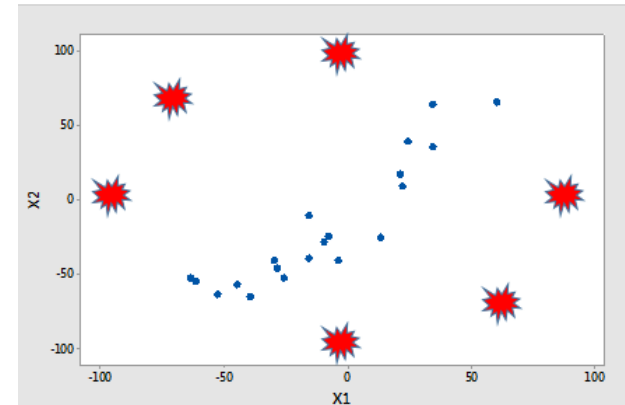


## Truman L. Koehler – Systems Analysis Leader - Bound Brook, NJ Plant (1957)

- ≡ EVOP Successful due to hands-on application of chemical engineers
- ≡ Computer Color Matching – Industry Standard
- ≡ President and CEO, Sandoz Chemical Corp



## Otto Dykstra, Jr. – Group Leader “Augmentation of Experimental Data” (*Technometrics* 1966, 1971)



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# Computer Color Matching by American Cyanamid Became an Industry Standard



**“The Dyes People Fought the Idea – Provided No Help but Plenty of - “It Will Never Work... North Light and a Trained Dye Technologist Will Never Be Replaced” ...**

**They Adopted CMM when Systems Analysis Showed That it Worked”**

**T. L. Koehler**



# American Cyanamid 1954 (cont'd)

## Lederle Labs

### ≡ Frank Wilcoxon

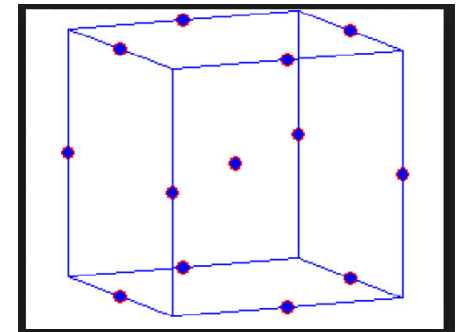
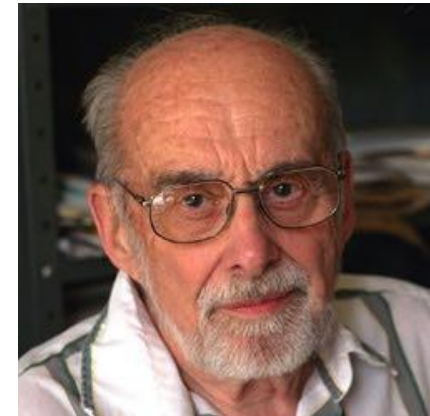
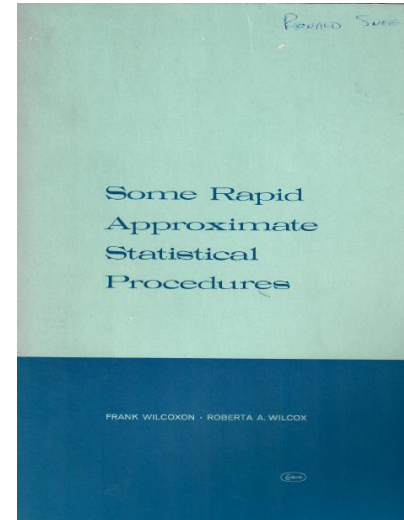
- = Nonparametric Methods
- = Need for quickness led to the Wilcoxon tests (1949)
- = ASQ Frank Wilcoxon Award

### ≡ Charles W. Dunnett

- = Dunnett's multiple comparison test for comparison to a Control (1955)
- = Moved to McMaster University
- = Statistical Society of Canada Gold Medalist 1986

## Connecticut Cyanamid R&D – Donald W. Behnken

- = Box-Behnken Designs (Technometrics 1960)
- = Gordon Conference Chair



# General Foods 1955

- ≡ Mavis B. Carroll – Apply Statistics to Improving the Coffee Process
- ≡ Paired comparisons – Bradley-Terry model
  - = Otto Dykstra developed theory
- ≡ DOE in R&D and Manuf
- ≡ Frequent use of consultants – Cuthbert Daniel, Harry Smith, Stu Hunter, Ralph Bradley

Women's College of NJ  
Member of Basketball Team  
“All 5’1” of Her”



# General Electric 1955

- ≡ **Lloyd S. Nelson – Louisville, KY (Early 1950s)**
  - = Founder of *Journal of Quality Technology*
  - = Mentor to many JQT Editors and others
  - = Honorary Member of ASQ
  
- ≡ **Gerry Hahn – Schenectady (1955)**
  - = Started Statistics Group in R&D in 1973
  - = Noted Leader and Prolific Author
  - = ASA Gerald J. Hahn Quality and Productivity Achievement Award
  - = ASQ Shewhart and Distinguished Service Medals
  
- ≡ **Ed Schilling – Cleveland (1969)**
  - = *Acceptance Sampling In Quality Control* (1982)
  - = ASQ Shewhart and Distinguished Service Medals





# Kodak – 1957

## ≡ Richard A. Freund – Statistical Quality Control

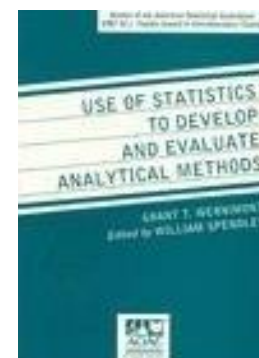
= “Acceptance Control Charts” – Combines Process Control; and Capability (1957)

= Shewhart Medalist and ASQ President



## ≡ Grant T. Wernimont

*Use of Statistics to Develop and Evaluate Analytical Methods (1985)*

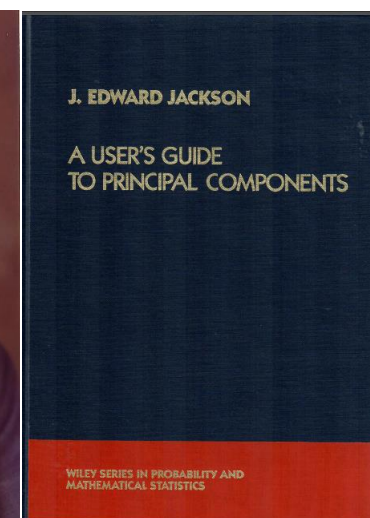


## ≡ J. Edward Jackson – *A Users Guide to Principal Component Analysis* (1991)

≡ ASQ Fellow and Hunter Award 1994,

≡ Modelling of Film Quality Response Curves – Jackson, Lawton and Sylvestre

≡ Kodak employed a large group of statisticians well into the 1990s



# Some Other Pioneering Groups

## ≡ Pharmaceuticals

- = Smith, Kline and French (S. Michael Free, Jr)
- = Merck (Joseph L. Ciminera)

## ≡ Petroleum

- = Amoco (John W. Gorman)
- = Esso (Murray A. Efroysom)

## ≡ Chemical

- = Monsanto (John D. Hinchey)

## ≡ Food

- = Swift and Co. (Horace P. Andrews)



# Company Impacts - Some Examples

## ≡ General Foods

- = Multiple Paired Comparisons became a standard in market research at General Foods

## ≡ American Cyanamid

- = Computer Color Matching – Industry Standard
- = EVOP and RSM saved millions (\$\$)

## ≡ DuPont Product Quality Management

- = Dacron – Improved quality, Saved \$30MM, returned to market leadership

## ≡ Kodak - Film Quality Modelling

- ≡ 3M Hall of Products – “Statisticians made important contributions to the successful development, commercialization, and production of most of these products” Pete Jacobs, 3M .

# **Major Technical Advances Made by Statisticians Working in Industry**

- ≡ Control Charts – Shewhart – Western Electric**
- ≡ Acceptance Sampling - Dodge and Romig – Western Electric**
- ≡ Graphical Display – Tukey, Wilk and Gnanadesikan - Bell Labs**
- ≡ Stepwise Regression – Efroymson - Esso**
- ≡ Nonlinear Estimation – Marquardt - DuPont**
- ≡ Ridge Regression – Hoerl and Kennard - DuPont**
- ≡ Computer-Aided Design of Experiments – Kennard - DuPont**
- ≡ Nonparametric Methods – Wilcoxon – Lederle Labs**
- ≡ Augmentation of Experiments – Dykstra – American Cyanamid**

**These Pioneers Faced Important Problems that  
Had Not Been Addressed in the Literature and  
Made Seminal Advances**

# Building the Profession

- ≡ **Gordon Research Conference on Statistics in Chemistry and Chemical Engineering – 1951**
- ≡ **ASQC Chemical Division – 1952**
- ≡ **ASA Section on Physical and Engineering Sciences - 1954**
- ≡ **Fall Technical Conference – 1957**
- ≡ ***Technometrics* – 1959**
- ≡ **Short Courses on Statistical Methods**
  - = **ASQC Chemical Division – Late 1950s**
- ≡ **Books on Statistical Methods in the 1950s**
- ≡ ***Journal of Quality Technology* – 1970**

**Industrial Statisticians Made Numerous  
Important Contributions to the Profession**

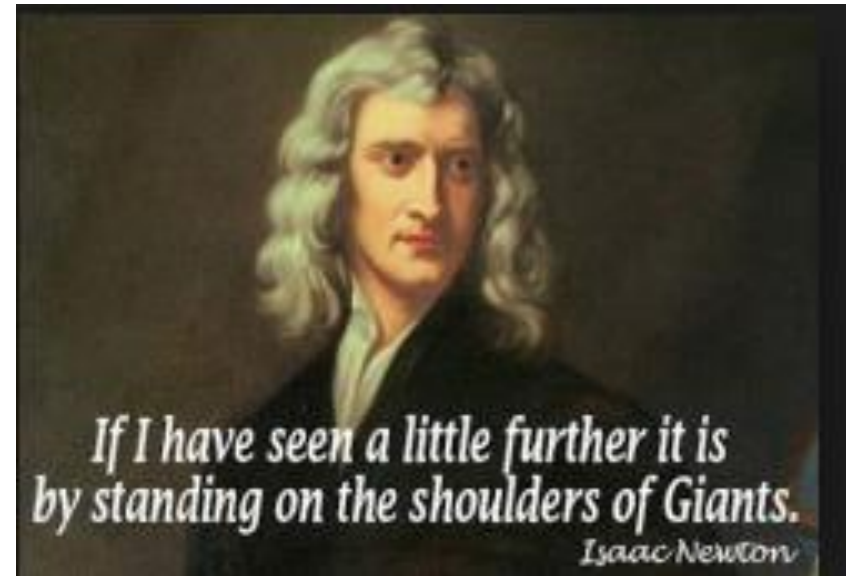
# Some Learnings

- ≡ **Pioneers of Industrial Statistics**
  - = **Developed solutions to problems they faced**
  - = **Championed statistics, Passionate about the value**
  - = **Willing to take chances**
  - = **Enjoyed a good time**
- ≡ **Things change – people stay the same**
  - = **“.... Human nature never changes”**. Ken Burns
- ≡ **A priority – getting management leadership and support**
- ≡ **Statisticians have to be relevant to exist – not a right**
- ≡ **Important problems generally lead to important advances**
- ≡ **Statisticians can be effective leaders and managers**
- ≡ **Many pioneering statisticians started in other fields;  
Biology, Chemistry, Engineering, Physics, Math,.....**

# What Did It Mean to Be a Pioneering Industrial Statistician?

**Promoting a methodology that:**

- ≡ **Was not well developed or known**
- ≡ **They had;**
  - = **little or no formal training in**
  - = **little experience in using it**
- ≡ **They experienced resistance –**  
**A natural human behavior**
- ≡ **Initially had few successes to point to**
- ≡ **Recognized need to get support and leadership of management**
- ≡ **Career was dependent on their success**





# How Does Any of This Apply to Me?

Our profession faces some new challenges, ..... opportunities.

## **Challenges** of our Current Realities:

- = The road ahead is not clear
- = Some leading industrial statistics groups are in decline
  - **Question: Is a Central Statistics Group right for today?**
- = We have new “competitors”; Data Science, Analytics, .....

## **Opportunities** we can take advantage of:

- ≡ Growing awareness of the strategic **importance of DATA**
  - ≡ Role and value of Big Data?
- ≡ Need for solutions to **large, complex unstructured problems**
  - ≡ Role and value of Statistical Engineering?

**Sometimes a Challenge is An Opportunity in Disguise**

# **A New Generation of Pioneers is Needed**

**We know that Gerry Hahn, and the other pioneers, would never back down from an important challenge.**

## **Bottom Line**

- = The road is not clear**
- = There are many hazards**
- = Problems are important to society and our profession**
- = View is well worth the climb**

**Are We Up To the Task?**

# Acknowledgements

**Steve Bailey**

**Galen Britz**

**Pam Humbaugh**

**Ken Chatto**

**Otto Dykstra**

**Blan Godfrey**

**Gerry Hahn**

**Lynne Hare**

**Doug Hlavacek**

**Roger Hoerl**

**Stu Hunter**

**Pete Jacobs**

**Truman Koehler**

**Tom Murphy**

**Dean Neubauer**

**Dick Scott**

**Frank Sinibaldi**

**Bob Starbuck**

**Ken Stephens**

**John Wetz**

**The Encouragement, Guidance and Information  
Provided by these Leaders of the Profession is  
Greatly Appreciated**

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**For Further Information,  
Please Contact:**

**Ronald D. Snee, PhD  
Snee Associates, LLC  
Newark, DE**

**(610) 213-5595**

**Ron@SneeAssociates.com**

**Please visit our website at:  
[www.SneeAssociates.com](http://www.SneeAssociates.com)**



# About the Speaker .....



**Ron Snee is Founder and President of Snee Associates, LLC, a firm dedicated to the successful implementation of process and organizational improvement initiatives. He provides guidance to senior executives in their pursuit of improved business performance using Quality by Design, Lean Six Sigma and other data-based improvement approaches that produce bottom line results. He has played a leadership role in 32 major improvement initiatives for firms such as Merck, Novartis, Human Genome Sciences, Celgene, Boehringer-Ingelheim and Kraft Foods.**

**Ron also serves as Adjunct Professor in the Temple University and Rutgers University Pharmaceutical Programs**

**Prior to entering the consulting field he worked at DuPont for 24 years in a variety of assignments including pharmaceuticals, statistical studies, manager of statistical, software and engineering professionals and process improvement.**

**He received his BA from Washington and Jefferson College and MS and PhD degrees from Rutgers University. He is an academician in the International Academy for Quality and Fellow of the American Society of Quality, American Statistical Association, and American Association for the Advancement of Science.**

**Ron is an Honorary Member of ASQ and has been awarded its Shewhart, Grant and Distinguished Service Medals, and ASA's Deming Lecture, Dixon Statistical Consulting Excellence and Gerald J. Hahn Quality and Productivity Achievement Awards as well as numerous other awards and honors. He is a frequent speaker and has published six books and more than 300 papers in the fields of performance improvement, quality, management, and statistics.**