

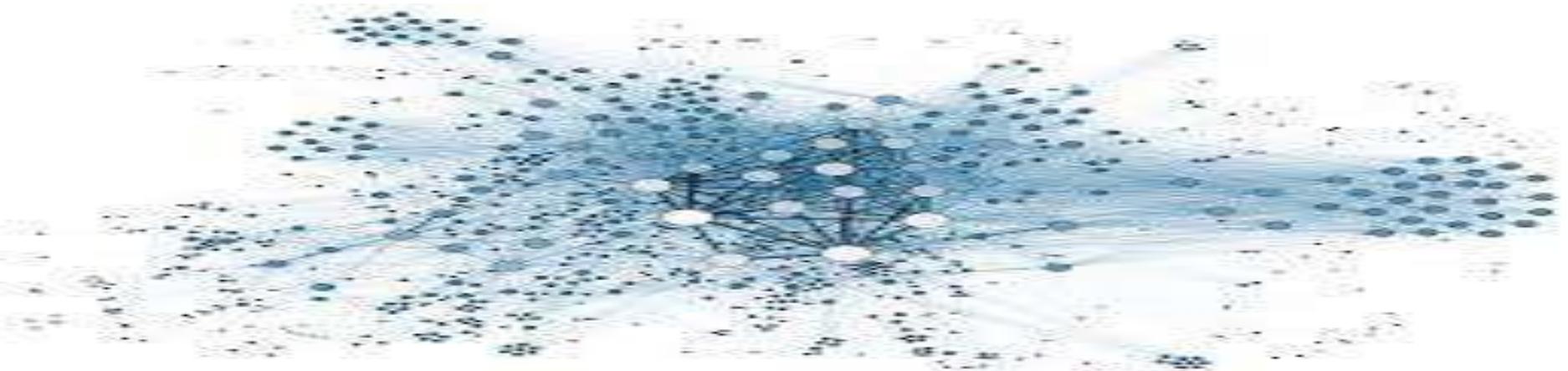


Long Island
Section 303



Quality 4.0

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Current & Future State of Applied Statistics



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Agenda

- Introduction
- Statistics Recent History
- Synopsis of the Articles
 - The future of Industrial Statistics
 - Statistical Thinking and Methods in Quality Improvement: A look to the Future
 - Methods for Business Improvement-What's on the Horizon
- Final Comments

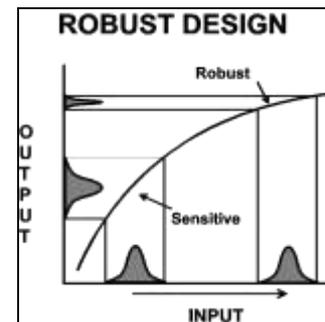
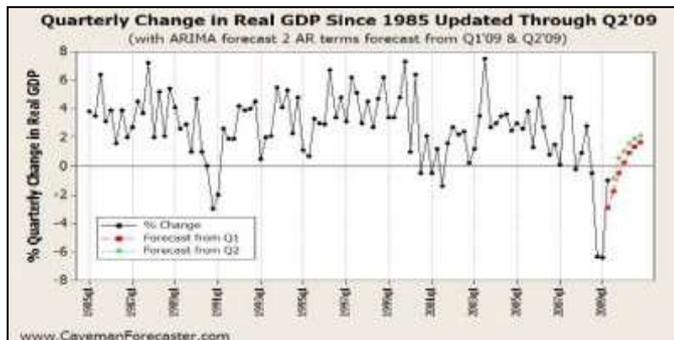
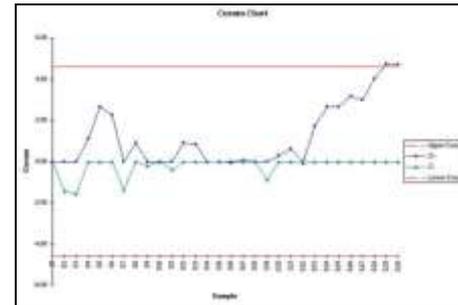
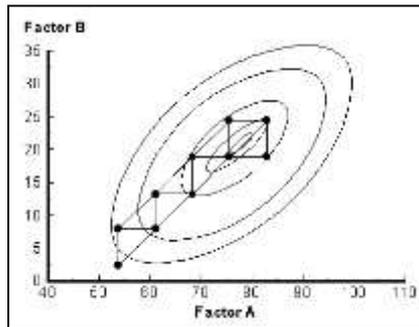
Introduction

- The objectives of this presentation are:
 - Discuss the present and future of statistics from the engineering and statisticians point of view
 - Introduce some suggestions about the future of the statistical thinking and the emergence of a possible new engineering branch: Statistical Engineering
 - Present what could be the possible trend in quality improvement methodologies

Statistics Recent History

- 1950-1980

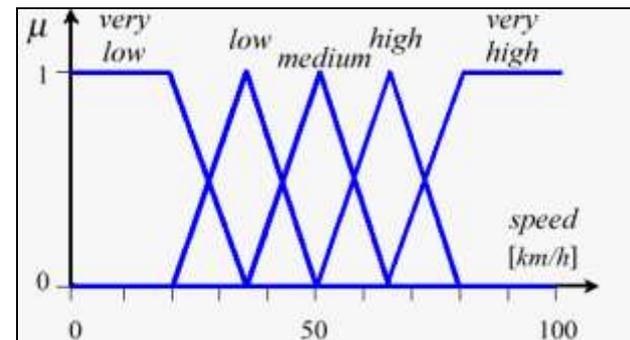
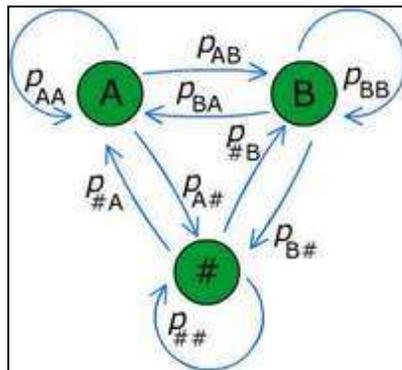
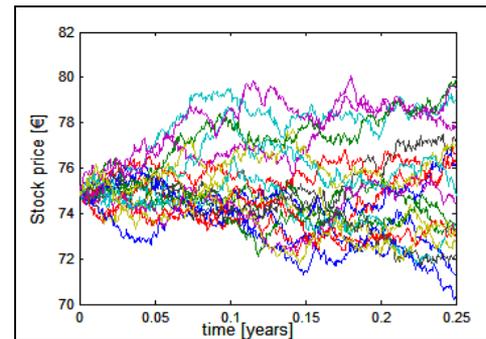
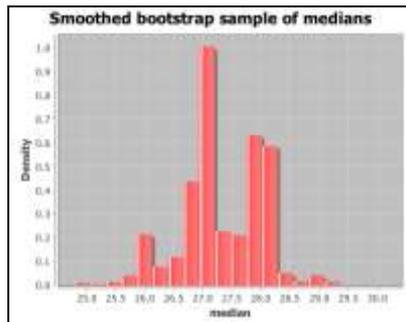
-1957: EVOP	-1965: Fast Fourier Transform and Mixture Designs
-1959: CUSUM chart	-1970: ARIMA Models
-1964: Data Transformation	-1977: Box and Whisker plots
-1980: Robust product design by an engineer from Far East, Genichi Taguchi	



Statistics Recent History (cont' d)

- 1980-Present

-Bayesian statistics	-Meta analysis and augmented experimental designs
-Jackknife and Bootstrap	-Multivariate time series analysis
-Markov Chains, Monte Carlo simulations, Gibbs Sampling	Spatial modeling, wavelets, fuzzy sets and data mining



The future of Industrial Statistics



*1. How is statistics contributing to industry in the present?
How will it change over the next 5–10 years?*



Statistics in the Present

- Statistics is being used more than ever before by practitioners, due to what has been referred to as its “democratization.” Some factors that promoted this phenomena are the following:
 - *Computer technology marches on*
 - *Improved statistical and related methodology*
 - *Improved science*
 - *Broadening our role*
 - *Management recognition*



Statistics in the Near Future

- **Biotechnology**

- Regulatory scrutiny
- Safety
- Minimum variability
 - Statistics can make significant contributions; none of these is more important than designed experiments
- Reasonable cost.

- **Informatics**

- Information retrieval
- Recommender systems
- Data mining
 - The challenges associated with the massive data sets being accumulated in areas as diverse as computer chip manufacturing, finance, insurance, marketing, and health administration.



2. What distinguishes Six Sigma from previous strategies?



Six Sigma

- Industry has become more competitive and innovative by applying Six Sigma tools and methodologies.
- Uses a “project-by-project” approach married to an almost algorithmic and rigorous problem-solving approach: the (DMAIC) discipline.
- Has moved from an operational focus to incorporate many other aspects of a business such as HR and Finance
- Provides a framework within which modern statistical quality control, quality improvement, and reliability can be made operational in the industrial context.
- It uses the best people in the organization as the catalysts for change.
- And it fully integrates the financial arm of the business to ensure that economic benefits are real.



3. How will developments in computing, software and data management tools affect industrial statistics in the next 10 years?



Statistical Software Improvements

- Statistical software and tools will never replace the need for statisticians in industry.
- Statistical Software let practitioners become more involved and allow statisticians to focus on bigger and better things.
- Statistical software needs to provide the power and flexibility of our most effective systems combined with user friendliness and guidance and improved human–computer interfaces.
- There is a need of make practitioner-oriented software maximally robust against misapplication.
- Is necessary to build into the software statements of the underlying assumptions and to encourage flexibility
- Statisticians also need to continue to provide training, especially in statistical concepts and statistical thinking.



4. What major new problem areas arising in industrial applications are not getting sufficient attention from the research community?



New Technological and Engineering Statistical Drivers

- Cheap and powerful computing hardware
- Powerful and easy-to-use statistical software and statistical graphics
- Easy and cheap transfer and storage of massive amounts of data
- The proliferation of sensor technology, including digital photography
- Environmental monitoring and preservation
- Energy conservation
- Medical imaging
- Nanotechnology
- Systems diagnosis and decision-making.
- Visualization (and image processing).



New Challenges in the Horizon

- The design, modeling and analysis of computer experiments.
- Engineers and scientists are making widespread use of computer models in product and process design and development.
- The increased availability of large amounts of data and the continuing development of physical/chemical/biological models
 - image technologies within biological research and drug development.
- Massive multivariate and time series type data sets
- There has been a surge of challenges associated with the Internet, high-speed data networks, and massive data storage devices.

5. There has been a steady shift of Western economies from a manufacturing base to a service and information base. What new statistical problems have arisen?

New Statistical Opportunities from Service Sector

- Almost all services apply computers for scheduling, accounting, and other administrative tasks.
- New problems relate to the enormous amounts of business and industrial data requiring analysis, particularly from newer areas, such as health services, tourism, network traffic, and more
- Another area is the medical device industry. Medical device safety is an escalating concern, and tolerance for defects, product failures, calibration and reliability problems is very low.



6. *What are the major challenges for industrial statistics and for industrial statisticians?*



Challenges in the Industrial Sector

- *Massive data analysis*
- *Measurement and systems of measurement*
- *Integration with related fields.*
 - *The emergence of fields* closely related to statistics (e.g., artificial intelligence) has created experts in such areas, generally with backgrounds in computer science or electrical engineering.
- *Recognize the preeminence of data gathering*
- To create better statistical methods, especially more intuitive and easier-to-understand

7. What are the key skills needed to work successfully as a statistician in industry?



Key skills needed by an statistician in industry

- Communication the most important skill.
- Sound technical knowledge
 - A passion for solving real problems
 - Good listening skills and the ability to size up a situation
 - “Out-of-the-box” thinking
 - Team player and leadership abilities
 - Enthusiasm and appropriate level of self-confidence
 - Interest in application areas and the ability to learn quickly
 - Flexibility and adaptability to change
 - Willingness to work hard
 - High integrity
 - Skill in adapting knowledge to the problem at hand
- A combination of training in linear models, regression, generalized linear models, design of experiments, time series analysis, robustness, and statistical process control; familiarity with multivariate methods, statistical graphics and data visualization.



8. *What needs to be done to train statisticians for successful careers in industry?*



Needs in Core Statistics Curriculum

- At least two semesters of mathematical statistics,
- At least two semesters of statistical modeling
- In-depth use of *both SAS and the S language (either R or S-PLUS)*, including the development of functions in the S language, plus exposure to Excel, JMP and/or MINITAB.
- A creative project, thesis, and/or a course in consulting, or corresponding internship experience
- Exposure to the practical use of Bayesian methods
- Basic understanding of management in general and quality management principles in particular
- Plenty of practical experience analyzing real data
- Place more emphasis on data gathering and planning of studies.

9. *What statistical training should we be giving to managers, scientists, and engineers?*



Statistical Training for Managers and Engineers

- Convey the excitement and power of statistics.
- Divide the time approximately equally between basic concepts, methods applicability of methods, and data gathering and planning of studies.
- Focus on what statistics can and cannot do.
- Show the use and misuse of popular software.
- Do not teach formulas and theory, but do stress underlying assumptions and limitations.
- Use simulation to get across ideas.
- Relate concepts to current issues in the news.
- Understand the basic statistical *concepts*
- Statistical models, including linear and nonlinear regression models

10. *What should the statistical community do to promote collaboration with engineers, scientists and managers on industrial problems?*



Suggestions to Improve the Collaboration among Statisticians, Engineers and Managers

- Create a journal, perhaps principally online, on applications of statistics in industry
- A yearly conference to permit interaction between and among practitioners and applied statisticians
- Publicizing success stories is certainly valuable.
- Forge relationships at university by participating in professional societies meetings and seminars
- Post university, participate in conferences, workshops and seminars as individuals and collaborating societies
- Seek to publish articles in their journals and newsletters



Statistical Thinking and Methods in Quality Improvement: A Look to the Future



Statistics is Both a Science and an Engineering Discipline

- Statisticians have viewed their discipline as a pure science, rather than also an engineering discipline.
- During the decades of the 1950s-1970s, society needed the discipline of statistics to be primarily a pure science.
- In the twenty-first century it seems that society needs statistics to be primarily an engineering discipline, with a secondary focus on statistics as a pure science

Statistics is Both a Science and an Engineering Discipline

- Statistical engineering is the study of how to best utilize statistical concepts, methods, and tools and integrate them with information technology and other relevant sciences to generate improved results.
- If statisticians in quality improvement had viewed their field as being an engineering discipline as well as a pure science, then
 - Methodologies such as data mining, machine learning, and even Six Sigma would have been fertile ground for theoretical research by academic statisticians.

Focus on Statistical Engineering Will Produce Great Benefits

- They offer three specific suggestions for consideration, relative to enhancing our focus on statistical engineering
 - Legitimizing statistical engineering as an academic research discipline
 - Embedding statistical thinking and methods in the processes used to run our organizations.
 - Utilizing statistical engineering to help our employers deal with the current financial crisis.



Legitimizing Statistical Engineering as an Academic Research Discipline

- A supporting statistical engineering curriculum should include:
 - Problem-solving courses using data-based methods such as Lean Six Sigma, including comparisons of alternative approaches.
 - Courses focusing on how to integrate statistical and other tools to solve problems and make improvements.
 - Courses on the practice and theory of the techniques themselves.
 - Statistical internships at the university or local businesses for students and faculty alike.
 - Courses or seminars on how to design and implement statistical training systems.
 - An overall balanced emphasis on statistical thinking as well as statistical methods

Statistical Engineering to Tackle the Financial Crisis

- It is time to reinvigorate a focus on continuous improvement including the use of Lean Six Sigma to select and guide improvement projects.
- Every organization can have a cash cow in the form of continuous improvement
 - Developing disciplined methodologies based on sound statistical science to address this opportunity
- To successfully take advantage of improvement opportunities we need a problem solving and process improvement methodology that
 - works in a wide variety of situations and cultures,
 - is easy to learn and easy to apply, and
 - has a few key tools that are linked and sequenced
 - with each other, as part of an overall improvement framework.



Statistical Engineering to Tackle the Financial Crisis (cont' d)

- The DMAIC process improvement framework from Six Sigma has all of these characteristics and is arguably the most effective and widely used problem solving and process improvement framework in the world today.
- Do not doubt that through theoretical research in statistical engineering even more effective methodologies will be discovered and developed.
- A strong reinvigoration of Lean Six Sigma is needed now to help organizations find a new source of cash.



Methods for Business Improvement- What's on the Horizon



The Need to Improve

- Global Competition and information technology are forcing changes in all aspects of our society: business, government, education, health care, etc.
 - This new paradigm presents businesses with some pressing needs including:
 - Faster market introduction of products
 - Processes that are more compliant with federal, state and local standards
 - Delivery of products and services to customers on time in-full
 - Improved throughput, cost/unit, capacity and margins
 - Improved yields-fewer defects and less rework or scrap
 - Increased equipment uptime and better plant utilization
 - Robust products, processes and analytical methods.



Some Important Trends

- Many companies are working to utilize the strengths of both Lean Manufacturing and Six Sigma
 - Lean principles to improve process flow
 - Six Sigma to reduce process variation, improve process control and achieve process optimization
- There are also opportunities to also integrate the benefits of Baldrige assessment and ISO 9000 with these approaches to business improvement.
- Major bottom-line savings are being generated by improvements in processes such as billing, accounts receivables, human resources, legal, finance and travel
- There is as much opportunities to improve outside manufacturing as there is within manufacturing.



Holistic Approach to Improvement

- Lean, Baldrige, ISO 9000 and Six Sigma are all effective approaches to improvement, but for maximum benefit these disparate strands need to be woven into a single fabric
- The methodology must work in all aspects of the business- billing, logistics, HR, manufacturing, R&D, etc.
- Some factors needed for successful improvement are the following:
 - Top management support and involvement
 - Top talent
 - Supportive infrastructure
 - Personnel-Champions, Improvement Metrics, Team Leaders, etc.
 - Management Systems
 - Improvement methodology

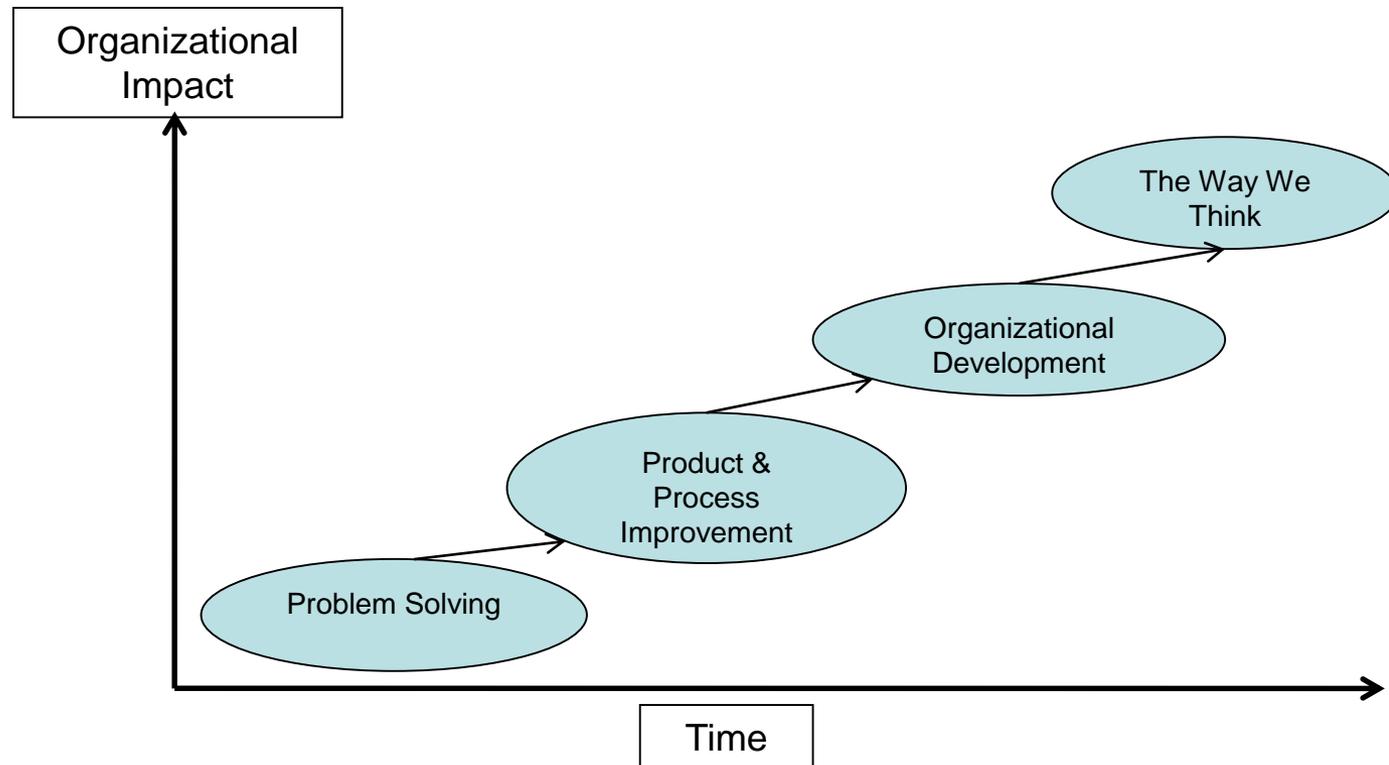


Holistic Approach Characteristics

- Putting all those factors together suggest that a holistic approach to improvement should have the following characteristics
 - Works in all areas of the business-all functions, all processes
 - Works in all cultures, providing a common language and tool set
 - Can address all measures of performance-quality, cost, delivery, customer satisfaction
 - Addresses all aspects of process management
 - Process design/redesign, improvement and control
 - Can address all types of improvement
 - Includes management systems of improvement
 - Plans, goals, budgets and reviews
 - Focus on developing an improvement culture
 - Uses improvement as a leadership development tool

The Expanding Role of Statisticians and Quality Professionals

- As never before, statisticians and quality professionals have opportunities to influence how organizations run their business
- As the world of statisticians and quality professionals expands from problem solving, to process improvement, to organizational, the ultimate culture change!



Wrap Up

- After this discussion, we can realize the following:
 - Statistics are used more in the present than ever before and this trend will continue in the near future.
 - The service sector in addition to manufacturing can benefit from the use of statistics
 - Statisticians need to get more involved with practical problems and maybe expand their science into an engineering field.
 - Also need to collaborate more with engineers, computer scientists and experts in operation research in order to develop new techniques that can help us face the challenges that are arising.
 - Six Sigma is a proven methodology for process improvement but it has to evolve in order to be useful to face problems in the future
 - Why newer statistical techniques have not been integrated into the methodology?
 - Data gathering techniques are not included in these programs



Wrap Up (Cont' d)

- Statisticians can contribute to develop better statistical software that can help practitioners to avoid common errors.
- There are a considerable set of technological developments that will force the development of new statistical and data mining techniques due the large amount of data that is processed.
- A fusion of improvements methodologies such as Lean Six Sigma with Quality Management Systems such as ISO 9000 could be the next generation of improvement methodologies that will lead to a cultural change from top to bottom of the organizations
- Top management commitment and involvement is critical for the success of any improvement strategy
- Statisticians and Quality Improvement experts will always be needed to help the business to reach their short and long term goals.



References

- This presentation is mainly based in two articles from different ASQ Journals
 - The Future of Industrial Statistics: A Panel Discussion
 - Technometrics May 2008, Volume 50, Number 2
 - Statistical Thinking and Methods in Quality Improvement: A look to the Future
 - Quality Engineering, Jul-Sept 2010, Vol. 22, Number 3
- In addition to these articles, a Special Publication of the ASQ Statistics Division was used
 - Methods for Business Improvement-What's on the Horizon By Ronald D. Snee
 - Special Publication, Spring 2007



