Statistical Engineering: What, Why and How

Panel Discussion

Moderator: Christine Anderson-Cook, LANL

Panelists:
Ronald Snee, Snee Associates
Geoff Vining, Virginia Tech
Mark Zabel, Straight Line Performance Solutions

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Session Format

- What? (Led by Ron Snee)
  - Examples, Definition, as a Discipline
- Why? (Led by Mark Zabel)
  - Benefits to the individual statistician, team member and the organization
- How? (Led by Geoff Vining)
  - Roles and Challenges

Format: 30 min presentation, 15 min additional comments from other panelists, open discussion

- Founder and President of Snee Associates
- 24 years at Dupont
- Author of 3 books on Statistical Thinking and LSS with Roger Hoerl
- Academician in the International Academy for Quality, Fellow ASQ and ASA
- Recipient of ASQ Sherhart and Grant Medals
- Author or more than 225 papers in performance improvement, quality, management and statistics

- Professor and former Department Head in Department of Statistics at Virginia Tech
- Former editor of Journal of Quality Technology, and Quality Engineering
- 2010 ASQ Shewhart Medal recipient
- Winner of ASQ Brumbaugh and Lloyd Nelson award
- Author of 3 textbooks
- Internationally recognized expert in the use of designed experiments for quality and productivity improvement

- President and Co-founder of Straight Line Performance Solutions
- Statistical Engineer and Certified Master Black Belt
- Educated, mentored and coached more than 2250 LSS professionals
- 20+ years of experience in LSS, statistics, analytical methods, software development and process re-engineering
- Led design, redesign and improvement projects resulting in hundreds of millions of dollars of delivered value for a wide range of businesses

What is Statistical Engineering?

Ron Snee

Some Examples

- DMAIC Problem Solving and Improvement Framework
  - Links and sequences a variety of statistical and non-statistical tools
- DuPont Product Quality Management System
  - Integrates a variety of tools into a comprehensive quality system
- Strategy of Experimentation
  - System that links a variety of designs into an overall strategy
- GE Collections System
  - Process monitoring and improvement system that uses a variety of tools including flowcharts, control charts, Pareto charts and DOE
- Pharmaceutical and Biotech Quality by Design
  - Integration of process modeling, process and measurement control and process optimization creating process understanding

Major Impact is Created by Linking and Sequencing Many Different Tools into a System

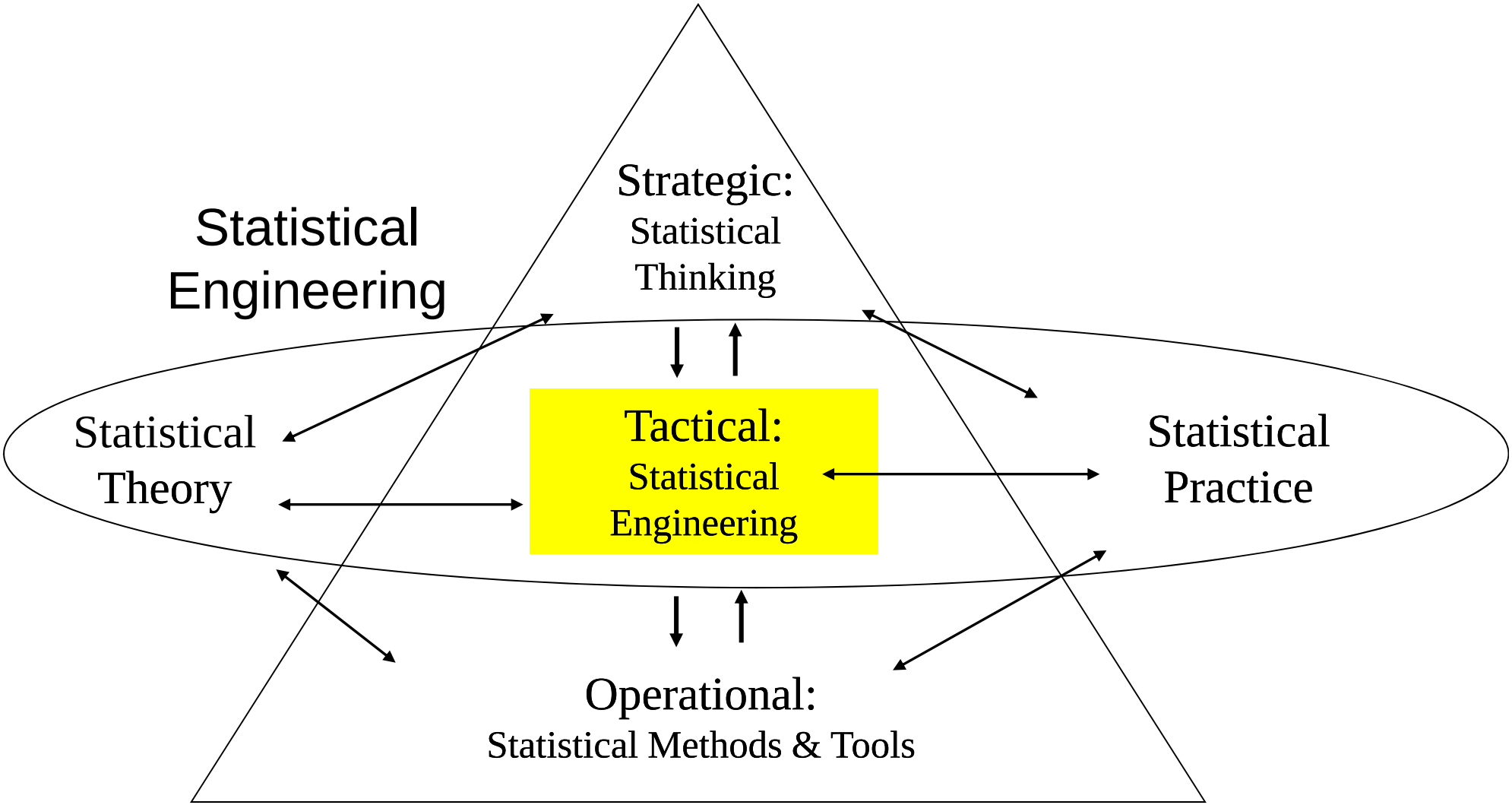
Statistical Engineering Definition

- Statistical engineering:
  - 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 (Hoerl and Snee 2010)
  - Trying to build something with the statistical science parts list

Notes

- For this to be a true engineering discipline as opposed to just a sexier term for applied statistics, there must be a dynamic theoretical foundation based on rigorous research, just as there is for electrical engineering, mechanical engineering, and so on
- This definition does not refer to application of statistics to engineering
  - Statistical engineering can be applied to improving anything
- This is a different definition than that used by Eisenhart, who we believe was the first to use this term in 1950

Statistical Engineering as a Discipline



Statistical Engineering - Discipline that Studies How to Drive Greater Impact from Existing Science and Theory of Statistics.

How Is It Different?

Problem Dimension	Traditional Applied Statistics	Statistical Engineering
Criticality to the Organization	Low - Medium	High
Impact – Financial, Process Performance, Customer, Social, and Environmental	Low - Medium	High
Number of Departments, Groups, or Functions Involved	Few	Several
Complexity – Technical, Political	Low	High
Sources of Information and Data	Few	Many
Number of Tools Involved	Few	Many
Use of Information Technology	Some	Essential
Need for Sustainability	May be needed	Essential

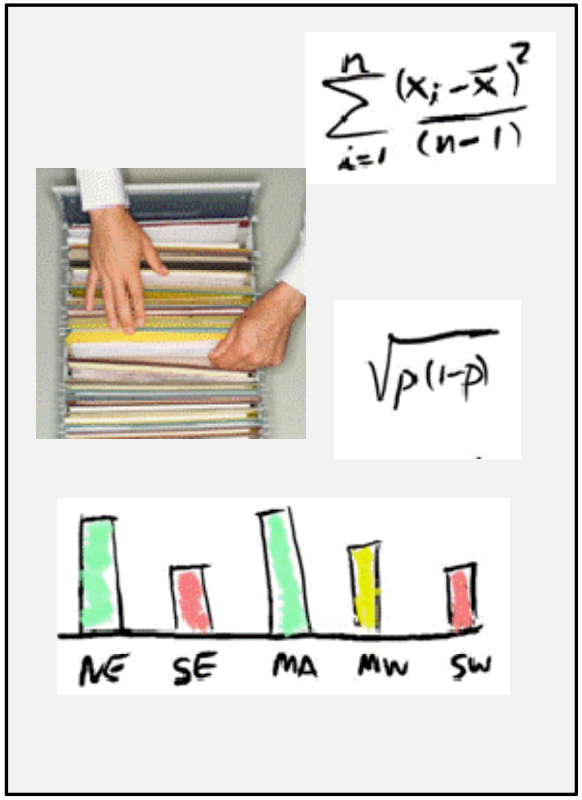
Why Statistical Engineering?

Mark Zabel

Statistical Engineering

Proliferation and Accessibility of Data

Yesterday



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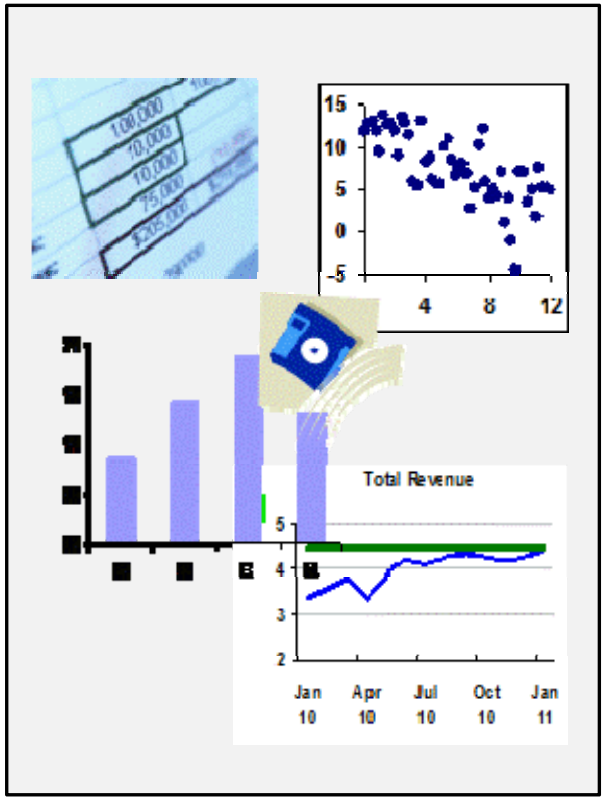

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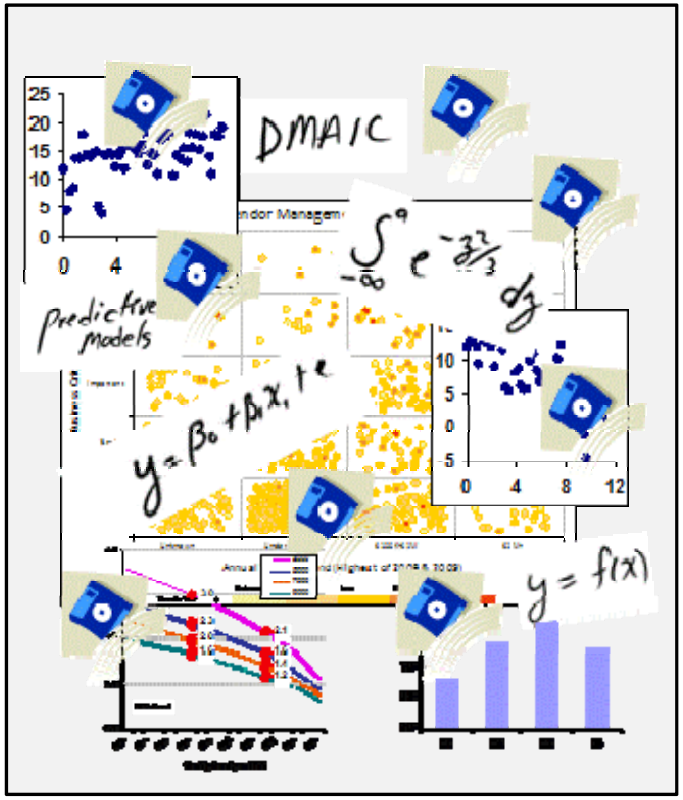
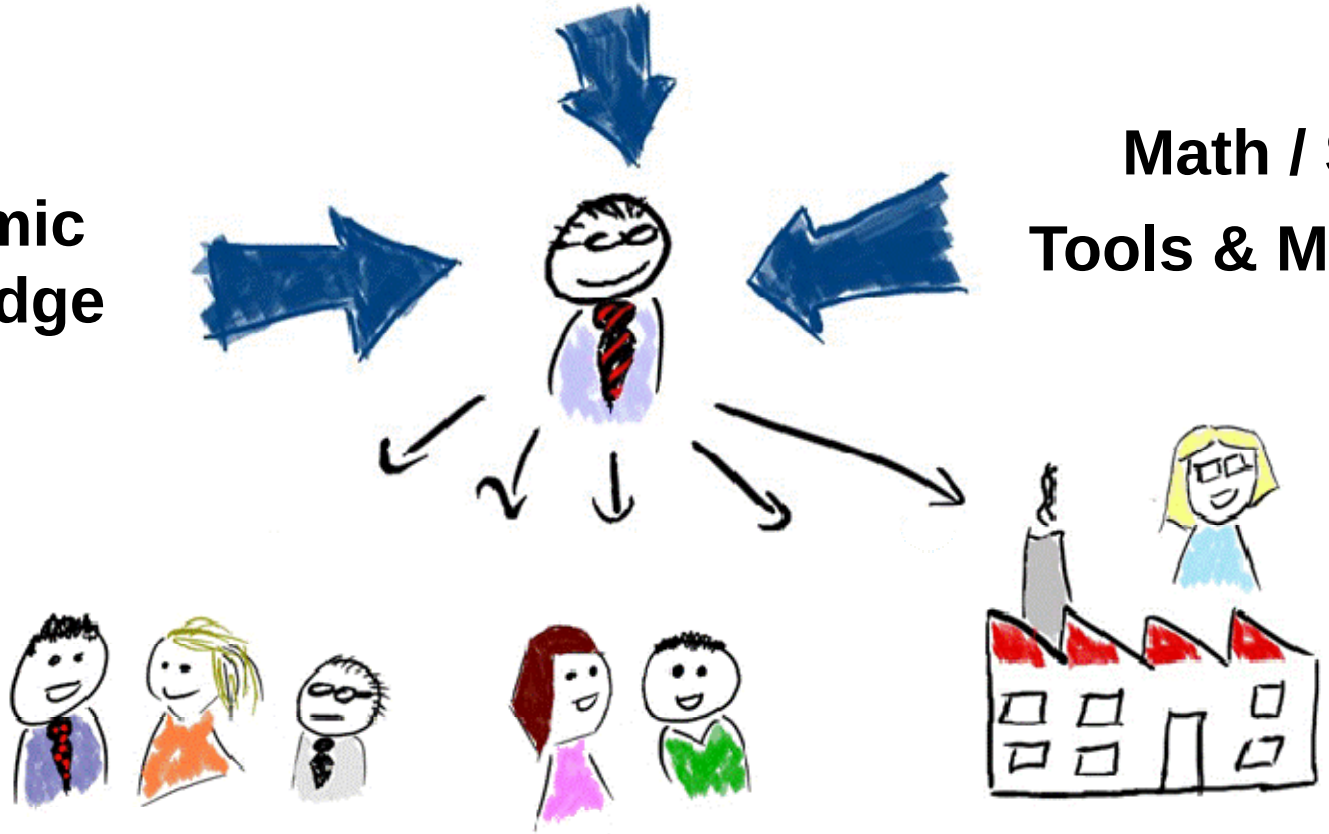


Business Acumen

Academic Knowledge

Math / Stat Tools & Methods



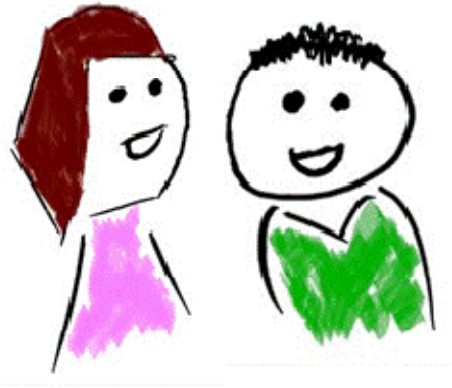
Customers **Team** **Business / Organization**

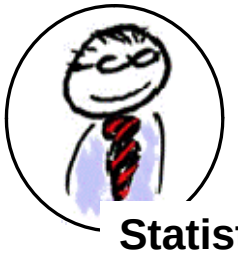
Benefits to the Individual Statistician

Individual Statistician

- **Greater collaboration and more acceptance of methods**
- **Deliver better results**
- **Experience drives new applications for academic work**
- **More opportunities for leadership positions**
- **Higher value to business & organization**

Team





Statistician

Statistical methods strengthen team delivery

- **Better business cases**
- **Better data and metrics**
- **More robust models**
- **Better known uncertainty and risk**
- **Efficient design and analysis**
- **Better reporting and other quantitative deliverables**

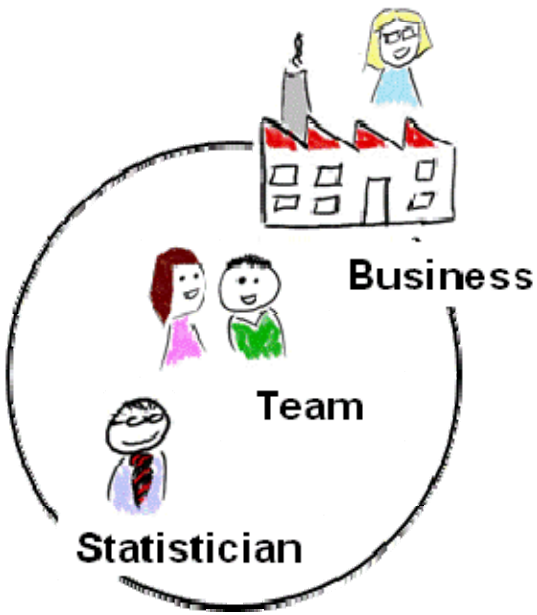
Benefits to the Business / Organization

Business

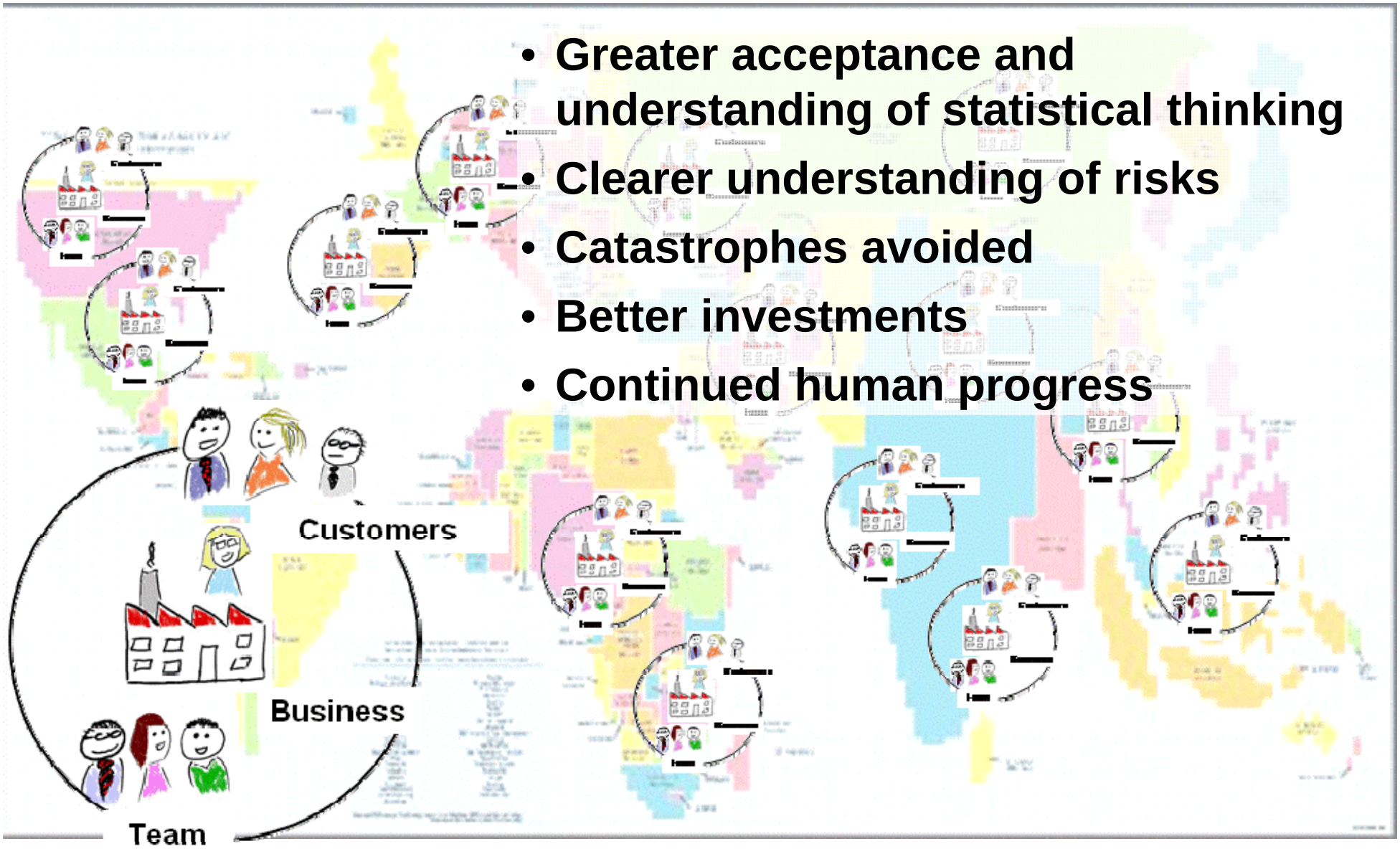
- **Better delivery = greater ROI**
- **Better and more informed decisions**
- **Lower uncertainty & risk**
- **Reduced costs**
- **Higher degree of fact-based engagement**
- **Better analytics**
- **Added insight into business and customer needs and wants**

Benefits to Customers

Customers



- **More robust, higher quality products & services**
- **Business partners who make better decisions**
- **Wants and needs are better known and better addressed**
- **Clearer insight**
- **Better decisions**



- Greater acceptance and understanding of statistical thinking
- Clearer understanding of risks
- Catastrophes avoided
- Better investments
- Continued human progress

The How of Statistical Engineering?

Geoff Vining

Cultural Challenges

- Agency
  - Past: Mechanical – Aerospace Driven
    - "Deterministic" Universe
    - Statistics not Always Appreciated
  - Current: Need to Quantify Uncertainty
    - Major Driver: Risk Management
    - Agency Requirements:
      - Rigorous
      - Scientifically defendable
    - Provides an Excellent Opening for Statistical Engineering

- Engineering
  - Example: To Estimate a Straight Line, Why Do We Use Ten or More Un-Replicated Levels?
    - "Replicates introduce error" (actually, they provide estimate of true error)
    - Only two levels needed to estimate the line; three levels allow estimate of lack-of-fit
  - Need for Statistical Thinking
    - All work occurs in systems of interconnected processes
    - Variation exists in all processes
    - Keys to success: understanding and reducing variation

Agency Challenges

- Statisticians
  - Passive/Active
  - Periphery/Central
  - Purely Data Analysis/Problem Solver
    - Problem Definition/Clarity
    - Systems Thinking
    - Tactical Deployment of “Statistical Tools”
  - Non-Essential Team Member/Full Colleague
  - Perception: Part of the Problem/Part of the Solution

Summary of Challenges

- Complex Problems Require Appropriate Solutions
  - Team Approach to Solutions
  - Clear and Precise Problem Definitions
  - Systems Thinking
  - Understanding Sources of Variation
  - Appropriate Data
  - Tactical Deployment of Analytics
- Statistical Engineering Is an Appropriate Approach!