A Statistical Engineering Approach to Problem Solving

Fall Technical Conference

Philadelphia, PA

October 5th, 2017

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I would like to acknowledge Ron Snee for his significant input into the ideas in this presentation.

Outline

- Problems with the current state of problem solving
  - Pervasive faulty assumptions
- Can statistical engineering help?
  - Definition of statistical engineering
  - Key attributes
- Applying statistical engineering principles to problem solving
- The broader framework – holistic improvement
- Summary

Problems With Problem Solving

- Unending search for the "best" methodology
  - Six Sigma, Lean, Work-Out, TRIZ, etc.
  - Leads to jumping on a "merry-go-round" of improvement bandwagons
  - Merry-go-rounds lead to cynicism
- Innovation is seen as different from problem solving – a "competitor"
- Now, Big Data analytics is seen as different from problem solving – also a "competitor"
  - Have we just created a bigger merry-go-round?
- The research literature on problem solving *per se* is thin – across disciplines (DiBenedetto 2014)
  - The literature on *individual methods* is extensive

A Fresh Approach is Needed

An Old Model From Organizational Effectiveness

Thinking → Behavior → Results

- If we don't like our results, let's go back to our thinking that led to this behavior and these results
- "Our current problems cannot be solved at the same level of thinking we were at when we created them." - Einstein

Evaluation of Methods is Easier than Evaluation of Our Thinking

Faulty Assumptions About Problem Solving

- These issues appear to stem from some faulty, but rarely challenged assumptions:
  - There is one best method for solving problems
  - ISO9000 eliminates the need for problem solving
  - Big Data analytics is an end unto itself
    - A what, not a how
  - True innovation is done in a vacuum
    - Solving problems does not lead to creativity or innovation
  - Problem solving is a necessary evil; required, but not strategic and certainly not a differentiator
    - Not worthy of significant management attention
    - Not worthy of serious research

These Assumptions are Easy to Detect in the Business & Quality Literature

The Result of These Assumptions

- No one has “mastered” problem solving, or improvement in general
- Very few organizations can claim to have a culture of continuous improvement
- Improvement efforts rarely led from the top
- Improvement efforts that should be well-integrated are more often managed in “silos”
  - Results in “islands of improvement”
  - Leads to dysfunctional internal competition

A Strategic Approach, as We Might See in Finance, is Sorely Lacking

Is This the Best We Can Do?

- The statistics community has been involved in, and researched, continuous improvement for decades.
- Can't we do better than this dysfunctional situation?
- What alternatives are out there?
- I propose a statistical engineering mindset as one alternative.
  - A different way of thinking that will hopefully drive different behavior, and produce different results.

I Propose That Only a Change in Thinking Will Produce Lasting Results

Can Statistical Engineering Help?

- Definition of 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)
- In other words, trying to build something meaningful from the statistical science "parts list" of tools
  - Focus is on solving problems versus tools, per se
  - Real problems, particularly big problems, require integration of multiple methods
- See special edition of Quality Engineering (2012) on statistical engineering for more background

Statistical Engineering is Not a "Method", Per Se

Key Aspects of Definition

- "the study of"
  - Research oriented
  - Statistical engineering has a theory
- "generate improved results"
  - Results are the "what", methods and tools are "hows"
  - Statistical engineering is therefore tool-agnostic
- "integrate…with"
  - Integration of multiple tools, methods, and even disciplines
- "information technology"
  - IT usually has a major role to play

As a Discipline, SE Can Help Make the Necessary Shifts in Thinking

Can Statistical Engineering Help Address the Faulty Assumptions?

- Assumptions confusing “whats” versus “hows”
  - Results are the only valid “what”. Methods and tools, including Big Data analytics, and innovation, must be viewed as hows.
- There is one universally best method for solving problems
  - Research clearly demonstrates that this is false
  - Our loyalty must be to solving the problem, not to individual methods or tools*
  - To maximize results, we must be tool-agnostic (in applications)
  - Research can help us learn to map individual methods to specific problems – more to come on this
- Problem solving is not strategic
  - Research can compare results from problem solving to results from other activities
  - Existing research demonstrates that improvement is lucrative!!

*Narrow focus in research is OK, narrow focus in applications is not

Applying Statistical Engineering to Problem Solving

- What would a statistical engineering approach to problem solving look like?
  - First, we must reverse the order of methods and problems
    - Start with the problem, and only then consider methods
    - Recognize that there are many different types of problems
    - Recognize that in many cases we must integrate tools
  - Next, we need to develop theory on how to map methods to types of problems
  - The above needs to be done strategically, not as a series of "one-offs"

Significant Research is Needed on How to Do This

Mapping Methods to Problems: Some Theory

From Hoerl and Snee (2013)

Key questions to be answered noted in each quadrant

	Solution Known	**Solution Unknown**	Clue
Low Complexity	1 Work-Out Nike Projects **Who** will address it? By **when**?	2 Team Problem Solving* Kepner-Tregoe **Why** did it happen?	(Problem Solving – Special Cause)
High Complexity	3 Lean (Kaizen) Event Reengineering **How** should we Implement solution?	4 Six Sigma TRIZ **What** is the solution?	(Breakthrough Improvement – Common Cause)

*Structured team problem solving, using the "Magnificent 7" Tools, for example

Use of Improvement Matrix

- A guide; not a prescriptive, rule-based system
- Not exhaustive; many other methods could be mapped into matrix
- Knowledge of likely solution and complexity level are the jugular issues to select most appropriate method
  - Special/common cause distinction provides a clue
- Use of a matrix is an example of statistical engineering applied to problem solving
  - How can we improve improvement?

Simply a Tool To Help Determine Best Improvement Approach

The Broader Framework: Holistic Improvement

- Taking this statistical engineering approach to its logical conclusion, what we need long term is an overall improvement system
- Strategic in nature; led by senior executive
- Improvement efforts housed under "one roof"
  - No competitive "islands of improvement"
- Addressing the diversity of improvement needs
- What might such as system look like?

The Future of Quality Improvement?

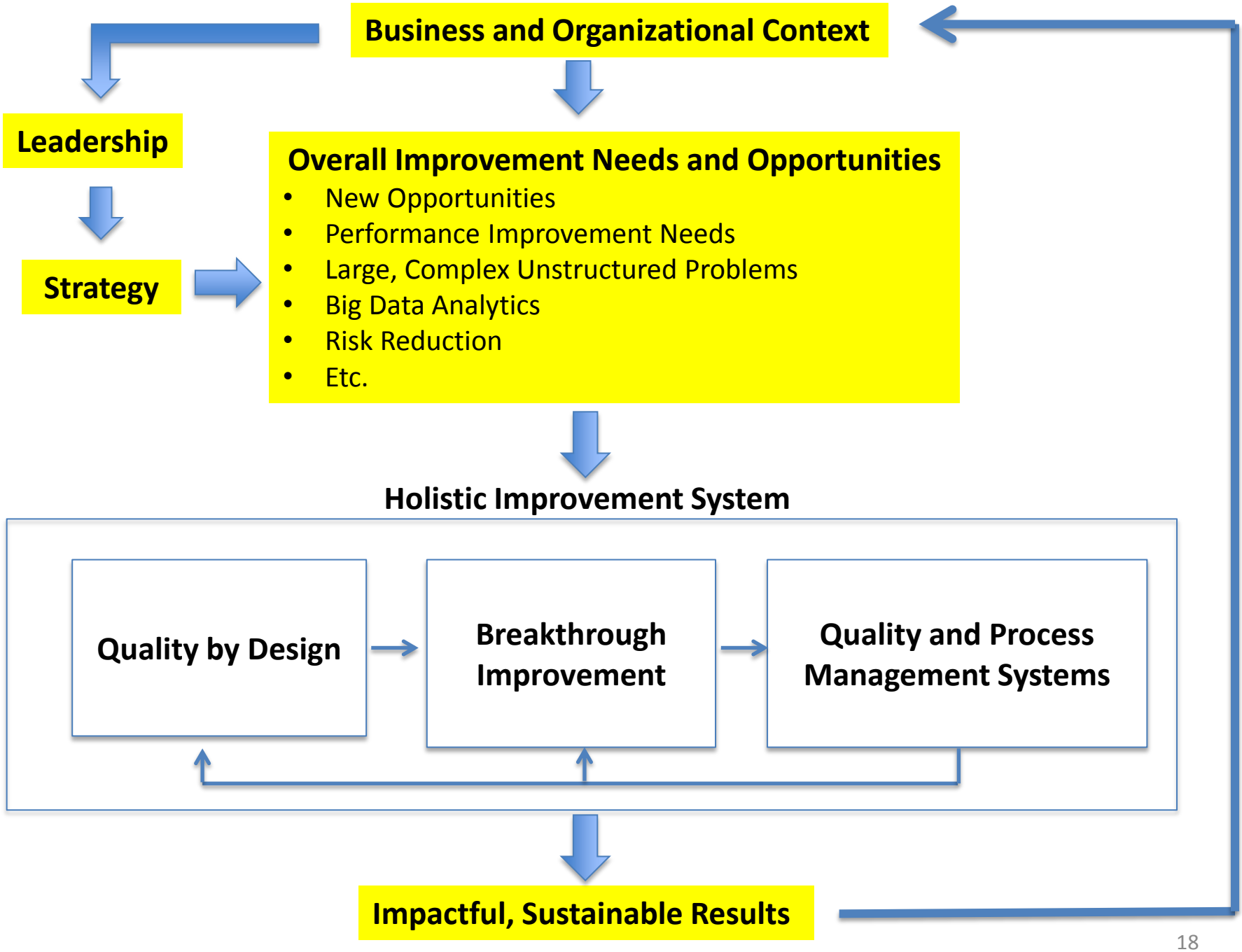
Importance of Terminology

- I have been using terms loosely up until this point, i.e., improvement, problem solving, etc.
- To go forward, I need to be more precise in my language

Imprecise Terminology, “Data Science”, for Example, is Often a Source of Significant Confusion

Terminology

- Breakthrough Improvement: taking a process to a higher (new) level of performance
- Problem solving: returning a process to normal after it has deteriorated
  - Fixing something that is broken
- Design: developing something new – “idea to implementation”
- Methodology: an overall approach that may involve multiple tools
  - Six Sigma would be one example
- Tool: a specific technique used in a methodology
  - Regression, control charting, and so on


Business and Organizational Context
Leadership
Strategy
Overall Improvement Needs and Opportunities
• New Opportunities
• Performance Improvement Needs
• Large, Complex Unstructured Problems
• Big Data Analytics
• Risk Reduction
• Etc.
Holistic Improvement System
Quality by Design
Breakthrough Improvement
Quality and Process Management Systems
Impactful, Sustainable Results

Holistic Improvement System Needs and Sample Approaches

Quality by Design

Needs

- Business innovation
- Process design/redesign
- Product design/redesign
- Organizational design/redesign

Approaches

- Innovation/Creativity
- DFSS
- TRIZ

Breakthrough Improvement

Needs

- Meet annual and strategic plans
- Better product/process performance
- Better organizational performance
- Mission critical problems

Approaches

- Six Sigma
- Lean
- Big Data Analytics
- Work-Out

Quality and Process Management Systems

Needs

- Quality & process management system
- Risk management system
- IT system
- Measurement system
- Training system

Approaches

- ISO/Baldrige
- Total Productive Maintenance
- Kepner-Tregoe
- “Internet of Things”

Summary

- The state of problem solving/process improvement is, with a few exceptions, rather poor globally
  - Lots of money being left on the table
- The search for a "silver bullet" continues unabated
  - The one "best" improvement method that will solve all our problems
- Emergence of Big Data analytics only magnifies the problem
  - Another competitor on an already crowded merry-go-round
- Fortunately, the principles of statistical engineering can help clarify our thinking about improvement
- A holistic approach is needed
  - Integration of methods
  - Tool agnostic

Recognition of the Need for Multiple Methods is One Major Step Forward

Appendix

Foundations of a Holistic Improvement System

Strategic Level

- Senior management involvement; led by Chief Improvement Officer (CIO)
- Creation of improvement culture – Part of each job description
- Improvement Council (IC) is permanent part of the business planning cycle

Managerial Level

- Rigorous, defined system for planning and implementing improvements
- There is a defined organizational structure to support the improvement system

Without Leadership No Improvement Methodology Will Succeed

Foundations of a Holistic Improvement System

Operational Level

- Dynamic "core set" of proven improvement methodologies – LSS, TRIZ, Work-Out…
  - Dedicated experts in core methodologies
  - Training is based on organizational need; not all employees are trained in each method
  - Additional "non-core" methodologies may be utilized as needed
- Employees are expected to implement improvements outside of formal projects – as a normal part of their jobs

Flows From Strategic Level to Managerial and Operational Levels

How Do We Get Started?

Start Small – Think Big ….. Evolution vs. Revolution

- Migrate a LSS initiative towards Holistic Improvement
- Where a LSS Leader and Quality Council exist, work to broaden their scope
- Integrate potentially competing improvement groups, such as ISO Certification, Lean, Six Sigma, and Business Process Improvement
- Migrate all improvement projects to a common project portfolio.
  - All projects compete for the same pool of resources.
  - Project selection decisions made from a common prioritized list are most effective

Start With Where You Are – Add With a Goal in Mind