A Statistical Engineering Approach to Problem Solving

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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

<table>
<thead>
<tr>
<th>Low Complexity</th>
<th>High Complexity</th>
<th>Solution Known</th>
<th>Solution Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Work-Out Nike Projects</td>
<td>Team Problem Solving* Kepner-Tregoe</td>
</tr>
<tr>
<td>Who will address it?</td>
<td>Why did it happen?</td>
<td>By when?</td>
<td>Kepner-Tregoe</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>Lean (Kaizen) Event Reengineering</td>
<td>Six Sigma TRIZ</td>
</tr>
<tr>
<td>How should we implement solution?</td>
<td>What is the solution?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

Clue

(Problem Solving – Special Cause)

(Breakthrough Improvement – Common Cause)
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?
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

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