Six Sigma

Breakthrough Strategy or Your Worse Nightmare?

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Agenda

- What is Six Sigma?
- What are the challenges?
- What are the rewards?
- Summary and Questions
Six Sigma has many meanings

- A Symbol \( \sigma \)
- A Measure
- A Benchmark or Goal
- A Method
Six Sigma: A Symbol

- $\sigma$ is a Statistical Symbol for Standard Deviation
- Standard Deviation is a Measure of Variability
The “Sigma Level” of a process can be used to express its capability:
- How well it performs with respect to customer requirements.

Defects per million opportunities
Doing the math

6 Sigma = 3.4 defects per million
5 Sigma = 230 defects per million
4 Sigma = 6,210 defects per million
3 Sigma = 66,800 defects per million
2 Sigma = 308,000 defects per million
1 Sigma = 690,000 defects per million
Some Examples to Illustrate Typical Defect Rates

Defects per Million Opportunities

SIGMA

Average Company

Best in Class

IRS - Tax Advice (phone-in)

(66,888 ppm)

(6,210 ppm)

(66,800 ppm)

(230 ppm)

(3.4 ppm)

(0.43 ppm)

Domestic Airline Flight Fatality Rate

(with ±1.5 Sigma Shift)

Purchased Material
Lot Reject Rate
Air Line Baggage Handling

Restaurant Bills
Doctor Prescription Writing
Payroll Processing
Order Write-up
Journal Vouchers
Wire Transfers

Defects per Million Opportunities

100K
10K
1K
100
10
1
2 3 4 5 6 7
SIGMA

SIGMA (with ±1.5 Sigma Shift)
Six Sigma: A Benchmark or Goal

- The specific value of 6 Sigma (as opposed to 4 or 5 Sigma) is a benchmark for process excellence.
- Adopted by leading organizations as a goal for process capability.
- Delivering nearly defect-free products and services
- Focus on variation reduction
Six Sigma: A Method

- A well defined process and toolkit used for:
  - Product/Service Design
  - Product & Process Improvement
DMAIC Approach

Chronic Waste

Sporadic Spike (Special Cause)

Common Cause Variation

Chronic Waste
DMAIC Approach

**Define**
Select customer-focused problem, document business impact, determine project deliverables, complete project charter, form multidisciplinary team

**Measure**
Develop factual understanding of current process, locate current problem sources, establish “as-is” process baseline, measure baseline process capability

**Analyze**
Identify potential defect root causes and sources of variation, investigate using experiments and statistics, verify root causes

**Improve**
Use design of experiments to develop solutions. Eliminate the verified root cause(s), or reduce sources of variation, demonstrate with data

**Control**
Implement methods to hold the gains such as SOP’s and statistical process controls (SPC).
Six Sigma DMAIC Tools

Define
- Project Scope
- Project Charter
- Business Impact
- Voice of the Customer (VOC)
- Affinity Diagram
- Kano Model
- CTQ Tree diagram

Measure
- Process Map
- Data Collection
- Control Charts
- Pareto Charts
- Prioritization Matrix
- Measurement System Analysis
- Process Capability
- Yields (RTY)

Analyze
- Multivari Analysis
- Cause & Effect Matrix
- FMEA
- Hypothesis testing
- ANOVA
- Noise Variables
- Scatter plots
- Design of Experiments

Improve
- Brainstorming & Creativity tools
- Design of Experiments (DOE)
- Full Factorial
- Fractional Factorial
- Response Surface
- Pilot Trials
- Implementation Plan

Control
- Statistical Process Control (SPC)
- Standard Operating procedures (SOP)
- Data Collection & sampling plans
- Control Plans
- Measurement Systems Analysis (recheck)
- Project summary & lessons learned
All Work is a Process

Supplier  →  Process

Requirements → Inputs  →  Value-added tasks  →  Output → Customer

Requirements  →  Feedback

S.  I.  P.  O.  C.
What is a process?

Controllable Inputs ($X$’s) → Process → Key Process Outputs ($Y$’s)

Noise Inputs

$Y = f(X)$
Visualizing Process Capability

C_p = 1
Visualizing Process Capability

C_p = 2
Visualizing Process Capability

Change the process to fit in the original specification window
Process Drift

$C_p = 1.33$

$C_{pk} = 1.33$

Process is Centered Between the Specification Limits
Process Drift

$C_p = 1.33$

$C_{pk} = 0.83$

Process has Drifted Between the Specification Limits
Process Capability Summary

Capable Process

This process is not capable
Unstable Process

- Mean shifts present
- Excess variation (σ changes)
- Special causes of variation are present,
- Process output is not stable over time and is not predictable
Stable process:
• Variation reduced (lower $\sigma$)
• Process is centered in spec window
• Mean shifts reduced
• Only common cause variation is present
• Process output is stable/predictable
• The process is termed “in statistical control.”
History of Six Sigma

- Originated at Motorola in the early 80’s
- Doesn’t use “Quality” in the name
- Uses a modification of the Deming Plan-Do-Check-Act (PDCA) cycle
- Adopted widely in the 90’s by major corporations including AlliedSignal (now Honeywell), GE, Kodak, and a growing list of small, medium, and large companies.
Training for Six Sigma

- **Executives**
  - 8 hour Six Sigma overview and implementation roadmap development.

- **Champion**
  - 30 hour course, overview of DMAIC, Tools overview
  - Focus on developing project selection skills

- **Black Belt**
  - 160 hours of classroom, total of four months to train
  - Required to have a project

- **Green Belt**
  - 30-80 hours depending on training philosophy
  - May or may not have to complete a project
Identifying Six Sigma Projects

Basic Project Criteria
• Problem in key business activity
• Large financial impact
• Can measure and quantify performance

Easy to Fix?  

Quick Hit

Solution Available?  

Other Initiative

Six Sigma Project

• Process focus
• Analyze Y = f(x)
• Reduce variation & defects
• Complex relationships
Project Focus

- Projects are chartered by Champions and business leaders
- Led by Black Belts
- Assisted by Green Belts
- Each experienced Black Belt can typically handle between 4-6 projects per year
- Typical financial impact is approximately $175,000 per project
- Experienced Black Belt can generate about $1M in savings per year
Why adopt Six Sigma?

- Concept has been around for 16 years, proven track record at big companies.
- Has shown the most endurance and return on investment of any improvement initiative.
- Starting to be implemented in small and medium-sized corporations.
- Provides a comprehensive set of philosophies, tools, methods, and fundamental concepts leading to quantifiable business results.
- Involves the entire organization; from CEO, CFO, Champions, Black Belts, Green Belts, and workers.
What are the Challenges?

- Takes careful preparation and a commitment to fundamental change efforts required.
- Training – key for all levels in the organization
- It is not a quick fix nor a “one-size-fits-all” approach.
- Statistical analysis is not generally part of the engineering discipline in most companies.
- Tendency to work on too many projects at once. Resource limitations are real!
- Need to manage expectations on payback time, typically takes 9-12 months from roll-out to start seeing quantifiable financial gains.
What are the Rewards

- Increased value to the customers and shareholders.
- Improved reliability and predictability of products and services.
- Significant reduction in defects.
- Institutionalization of a “process” mindset.
- Increased competitive advantage.
Some Results...

- Motorola – 10 years; $11 Billion Savings
- AlliedSignal - $1.5 Billion estimated savings
- General Electric – started efforts in 1995
  - 1998: $1.2 Billion less $450 Million in costs… net benefits = $750 Million
  - 1999 Annual Report: more than $2 Billion net benefits
  - 2001: 6,000 projects completed; $3 Billion in savings
Six Sigma Summary

- Disciplined & Systematic Approach
  - Process orientation, drive for variation reduction
  - Focus on quantitative methods and tools
  - Focus on control to hold the gains
  - Uses a new metric for defects (sigma, DPMO, ppm)

- Results oriented management leadership, using data-driven decision making

- Significant training & organizational learning
Six Sigma Summary

- Success happens “one project at a time”
- Good project selection leads to large financial impact
- Implementation is hard work, not magic. Expect bumps in the road, stay the course, results will happen
- Six Sigma is “A journey not a destination”
Questions?
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