Software Engineering Economics (CS656)

Software Six sigma

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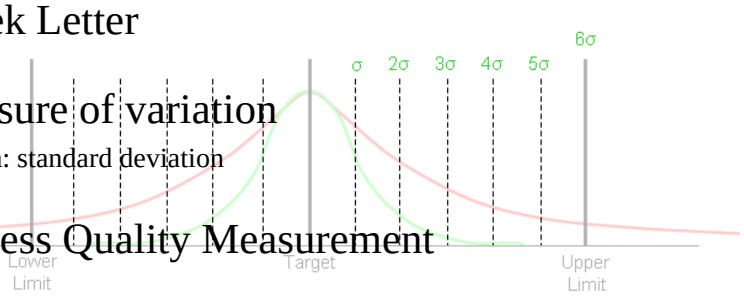
What is Six Sigma?

6σ ???

- Greek Letter
- Measure of variation
  - aka: standard deviation
- Process Quality Measurement



What is Six Sigma?

- Invented by Motorola, Inc. in 1986 as a metric for measuring defects and improving quality.
- A disciplined quantitative approach for improvement of defined metrics
- Has evolved to a robust business improvement methodology that focuses an organization on customer requirements, process alignment, analytical rigor and timely execution.
- Can be applied to all business processes, manufacturing, finance and services

Focus of Six Sigma*

- Accelerating fast breakthrough performance
- Significant financial results in 4-8 months
- Ensuring Six Sigma is an extension of the Corporate culture, not the program of the month
- Results first, then culture change!

Source: Zinkgraf (1999), Sigma Breakthrough Technologies Inc.,

History of Six Sigma

1986 *MOTOROLA INVENTS SIX SIGMA*
Committed to the continuous advancement of Six Sigma, Motorola's Six Sigma experts are invited to contribute their experience and insights.

1987 *MOTOROLA SETS FIRST AMBITIOUS SIX SIGMA GOALS*
Motorola sets the goal of reaching the level of Six Sigma, or no more than 3.4 defects per million opportunities.

1988 *MOTOROLA RECEIVES THE MALCOLM BALDRIGE NATIONAL QUALITY AWARD*
Motorola's efforts are recognized by the Malcolm Baldrige National Quality Award, highlighting the organization's commitment to its customers and quality.

1991 *MOTOROLA CERTIFIES FIRST SIX SIGMA BLACK BELTS*
Motorola introduces the first Black Belts internally as highly trained Six Sigma specialists.

1992 *OTHER LEADING ORGANIZATIONS BEGIN TO ADOPT SIX SIGMA*
Six Sigma is adopted beyond manufacturing by many prominent companies in industries from financial services to transportation to hi-tech.

2002 *THE NEW SIX SIGMA*
Six Sigma evolves from a metric, to a methodology, to a management system for driving business results. Motorola wins the nationally recognized Malcolm Baldrige National Quality Award for the second time.

2003 *MOTOROLA CONTINUES TO INNOVATE USING SIX SIGMA*
Motorola renews its Six Sigma efforts with new advancements and restructured deployment.

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Reasons Why Leaders Love Six Sigma

- Impacts Bottom Line
- Drives Strategy Execution
- Generates Robust, Flexible Business Processes
- Improves Human Performances Across Enterprise
- Is Highly Scalable
- Is a Low Risk Investment

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Industries Using Six Sigma

- Automotive, Chemical, Healthcare, Hi-Tech, Financial, Retail Industries, etc.

Success Stories of 6σ

- Motorola – 10 years; $11 Billion Savings
- Allied Signal - $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 Precepts

- Customer and process focused
  - Focus is on the things that matter
- Data driven decisions
  - Act on fact
- Reduced variation in process performance
  - Variation is the enemy
- Reduction in cycle time
  - Faster is usually better
- Prevention of defects
  - Proactive not reactive
- A new perspective of performance
  - 99% is not good enough

Source: CitiStreet – Design for Success

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Core Principles of Six Sigma

- Customer satisfaction
- Profit improvement
- Project-by-Project improvements
- Prioritization of improvements
- Process-driven approach to managing the business
- DMADV / DMAIC
- Near Perfection as a goal of performance
- Teamwork draws on experience, knowledge and dedication
- Recognition - expression of respect for employee contribution

Source: CitiStreet – Design for Success

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Barriers to Six Sigma

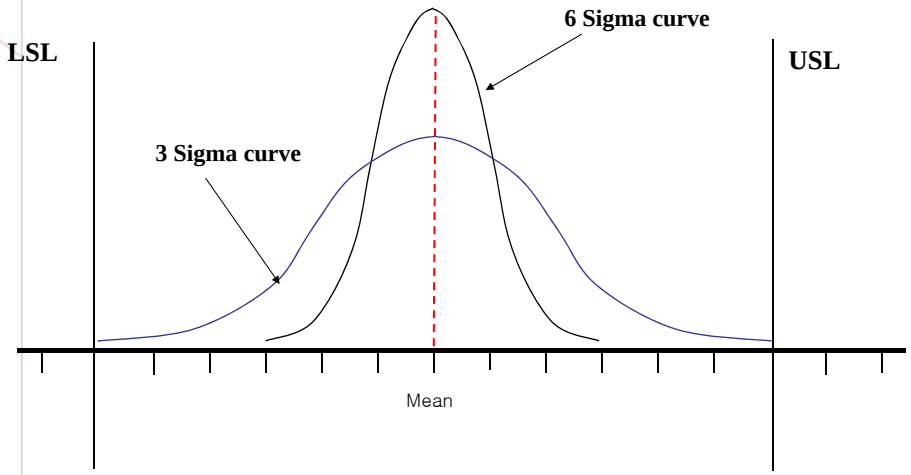
- Engineers and managers are not interested in mathematical statistics
- Statisticians have problems communicating with managers and engineers
- Non-statisticians experience “statistical anxiety” which has to be minimized before learning can take place
- Statistical methods need to be matched to management style and organizational culture

Source: CitiStreet – Design for Success

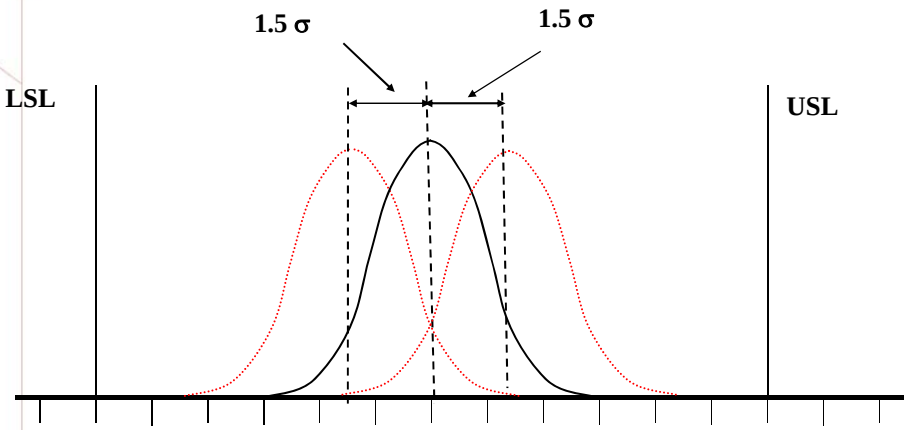
Key Players of Six Sigma

- Executive Leadership
- Champions (or ‘Enablers’)
- Master Black Belts
- Black Belts
- Green Belts
- Sponsors, etc.

3 Sigma vs. 6 Sigma



Amount of Process Shift Allowed



Six Sigma Process Capability

Sigma	Defect rate(PPM)	Cost of quality	Competitive level
6	3.4	<10%	World Class
5	233	10-15%	
4	6210	15-20%	Industry Average
3	66807	20-30%	
2	308537	30-40%	Non Competitive
1	690000	>40%	

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Putting Six Sigma in Perspective!

Four Sigma quality (6210 DPMO) means… 99.370% right…but…..

- 20,000 lost articles of mail *every hour*.
- Power outages seven hours *each month*. .
- 5,000 incorrect surgical procedures *each week* for a major healthcare provider.
- Unsafe drinking water nine minutes *every day*.
- Two long / short airport landings *every day*.

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Six Sigma Methodologies

- Refers to a data-driven quality strategy for improving processes of for designing processes or products
- an integral part of the company's Six Sigma Quality Initiative

• used when an organization wants to improve existing business processes

• used when organizations want to introduce new products or processes

Define Phase

Objective
To identify and/or validate the business improvement opportunity, define critical customer requirements, document (map) processes and build effective teams.

Inputs
- Strategic Priorities
- Scorecard Development
- Core Process Selections
- Improvement Expectations
- Improvement project Team Sponsor, Champion, Team Leader and Members

Define Opportunities
- Identify, Prioritize and Select the Improvement Opportunity
- Develop Project Team Charter
- Build Effective Team
- Identify Customers and Customer Requirements
- Define and Map Process to be Improved

Key Deliverables
- Team Charter
- Action Plan
- Prepared Team
- Critical Customer Requirements
- Process Maps
- Quick Win Opportunities

Measure Phase

Objective
To determine what to measure, manage measurement data collection, develop and validate measurement systems and determine process performance.

Inputs
- Team Charter
- Action Plan
- Prepared Team
- Critical Customer Requirements
- Process Maps
- Quick Win Opportunities

Measure Performance
- Determine What to Measure
- Manage Measurement
- Understand Variation
- Evaluate Measurement System
- Determine Process Performance

Key Deliverables
- Input, process and output indicators
- Operational definitions
- Data collection formats and sampling plans
- Measurement system capability
- Baseline performance metrics
- Productive team atmosphere

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Analyze Phase

Objective
To understand the reasons for variation and identify potential root causes, stratify and analyze the opportunities for improvement, determine sources of variation, identify a specific problem and define an easily understood problem statement.

Inputs
- Input, Process, and Output Indicators
- Operational Definitions
- Data Collection Formats and Plans
- Baseline Performance Metrics
  - Process Capability
  - Sigma
  - Cost of Poor Quality (COPQ)
  - Time
  - Other
- Productive Team Atmosphere

Analyze Performance
- Identify Potential Root Causes
- Apply Failure Modes and Effects (FMEA)
- Implement Comparative Methods
- Conduct Sources of Variation (SOV) Studies
- Conduct Correlation and Regression Analyses

Key Deliverables
- Data Analysis
- Validated Root Causes
- Problem Statements
- Sources of Variation
- Process FMEA
- Potential Solutions

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Improve Phase

Objective

To identify, evaluate, and select the right improvement solutions. To develop a change management approach to assist the organization in adapting to the changes introduced through solution implementation.

Inputs
- Data Analysis
- Validated Root Causes
- Problem Statements
- Sources of Variation
- Process FMEA
- Potential Solutions

Improve Performance
- Generate Solutions
- Rank and Select Solutions
- Develop and Execute a Pilot Plan
- Manage Change

Key Deliverables
- Solutions
- Process Maps and Documentation
- Cost/Benefit Analyses
- Improvement Impacts and Benefits
- Pilot and Solution Results
- Storyboard
- Change Maps

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Control Phase

Objective

To implement the final solution, guarantee process improvements are maintained, ensure that new process problems are identified and quickly corrected, disseminate lessons learned, and identify replication and standardization opportunities.

Inputs
- Solutions
- Process Maps and Documentation
- Cost/Benefit Analyses
- Improvement Impacts and Benefits
- Pilot Results
- Storyboard
- Change Plan

Control Performance
- Plan and Implement Solution
- Implement Statistical Process Control (SPC)
- Process Integration
- Closure and Recognition

Key Deliverables
- Process Control Plans and SPC Systems
- Standards and Procedures
- Training Plans
- Team Evaluation
- Potential Problem Analysis
- Solution Results
- Success Stories
- Trained Associates
- Replication Opportunities
- Standardization Opportunities

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Benefits of Six Sigma

- For the organization
  - Bottom line cost savings (5%-20% of turnover per annum)
  - Improved quality of product or service as perceived by the customer (internal and external customers)
  - Reduction in process cycle times
  - Development of staff skills
  - Common language throughout the organization
  - World class standard
- For the individual
  - Improved knowledge and skills
  - Ability to use a wide range of tools and techniques
  - A status that is recognized world wide

Six Sigma vs. CMM

• Manufacturing Background (Process Visible)	• Software Eng Background (Process Not Visible)
• Customer's view of Quality (fitness for use)	• Producer's view of Quality (meets specifications)
• Customer Focus Explicit	• Customer Focus Implicit
• Wide scope (Improvement)	• Narrow scope (Development)
• Statistics emphasized	• Statistics not emphasized
• Good (Business) Results	• Good (Internal) Processes
• Proj Mgt, Org not addressed	• Proj Mgt, Org are addressed
• Assumes Stability	• Does not assume Stability

Source: Greg Jones – Bank of America

Integration of 6σ & CMM

- Statistical techniques do work for Software Engineering
- CMM Levels 4 & 5 work well with Six Sigma
  - Emphasis on Data Collection and Analysis
  - KPAs: “Quantitative Process Management”, “Defect Prevention”
  - Level 4 & 5 could identify problems for Six Sigma to fix
  - Many Six Sigma tools can become toolset for Level 4 & 5 practices
- Six Sigma could be pursued after Level 3, rather than Levels 4 and 5
- Six Sigma supports continuous improvement after Level 5
- Use Six Sigma to improve Software Processes
  - SW-CMM identifies requirements for quantitative process improvement
  - Six Sigma provides detailed methods/techniques to meet those requirements
- CMM fits within “Improve” phase of Six Sigma

Source: Greg Jones – Bank of America

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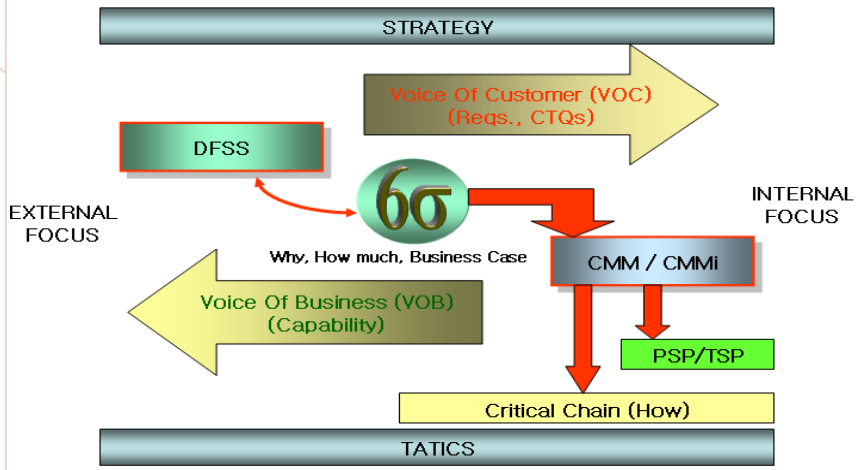
Integration of 6σ & CMM



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Q & A