Chapter 1
Six Sigma Overview

COPQ

Costs of Poor Quality (COPQ)

Internal Failure and External Failure costs.
The obvious and "visible" costs are a small portion of the overall COPQ. The bottom of the iceberg represents the majority of the COPQ and are not as easily identified and quantified.

- Inspection
- Warranties
- Rework
- Scrap
- Sorting
- Reprocess
- Set-ups
- Scheduling Conflicts
- Time value of money
- Unpredictable P&L
- Returns and Allowances
- Morale Loss
- Customer Loyalty
- Expediting
- Higher Risk
- Buffer Inventory
- Administration Costs
- Lost Sales
- Customer Scorecard Impact

The Cost of Quality
1) Appraisal
2) Detection
3) Internal Failure
4) External Failure

Cost of Doing Nothing Different (CODND)

http://www.six-sigma-material.com/Cost-of-Poor-Quality.html
1.1 Background of Six Sigma

- Motorola (1980s):
  - Bill Smith, Senior Eng. & Scientist
  - Bob Galvin, CEO
  - Jack Germaine, Sr. VP, Quality Director
  - Motorola University
  - Malcolm Baldrige National Quality Award, 1988

- GE (mid-1990s)
  - Jack Welsh, CEO

- Six Sigma Projects
  - “Push” projects vs “Pull” projects
  - Define “defect” vs Not defining “defect”

1.1 Background of Six Sigma

- Project Execution Roadmap
  - Process Improvement/ Reengineering projects: Sec. A.1
  - Product DFSS: Chapter 49
  - Process DFSS: Chapter 50
1.4 What is Six Sigma and $S^4$/IEE?

Xs or Key Process Input Var. (KPIVs):
- Out of stock items
- Amount of internal rework
- Process temperature

Ys or Key Process Output Var. (KPOVs) /Critical to Quality (CTQ):
- Customer satisfaction
- Production cycle time
- Critical dimension on a part

1.5 The Six Sigma Metrics

- The “Goodness level” of 99% equates to
  - 20,000 lost articles of mail per hour
  - Unsafe drinking water almost 15 minutes per day
  - 5,000 incorrect surgical operations per week
  - Short or long landing at most major airports each day
  - 200,000 wrong drug prescriptions each year
  - No electricity for almost 7 hours per month

- The sigma quality level used as a measurement within a Six Sigma program includes $\pm 1.5\sigma$ value to account for “typical” shifts and drifts of the mean.
1.5 The Six Sigma Metrics (Figure 1.3)

- The sigma level of most services is about 4 sigma, while world class is considered 6.

Sigma Scale

- IRS tax advice (phone in)
- Doctor prescription writing
- Restaurant bills
- Airline baggage handling
- Domestic airline fatality rate (9.43 PPM)
- Average company
- Best-in-class
- Your plant

Sigma (short-term) scale of measure


Area Under The Normal Curve

- μ = 100
- σ = 10

- ±2σ = 95.4500%
- ±3σ = 99.7300%
- ±4σ = 99.9937%
- ±6σ = 99.9999998%

1.5 The Six Sigma Metrics
(Figure 1.6)

1.5 The Six Sigma Metrics
(Figure 1.7)
1.6 Traditional Approach to the Deployment of Statistical Methods

Challenges
• Complex statistical analysis (software)
• Problem definition and dissemination of statistical techniques
• Benefit ➔ $ (Business case)

1.8 S⁴/IEE Business Strategy Implementation

Organizational Strategic Plans, Policies, Goals
• Goals should have measurable results through defined action plans
• Concern: Effective & aligned mgmt system practice
• S⁴/IEE: Satellite-level Metrics
  • Theory of constraints (TOC)
  • Traditional business measures
  • Tracked by XmR chart
1.8 S^4/IEE Business Strategy Implementation
S^4/IEE: Satellite-level Metrics

- Stockholders (Value-adds Interest)
  - Dividend Payment
  - Stock Price Increase
  - Return on Equity (ROE)
- Stock Analysts, Board Members, & CEO
  - Sales Growth
  - Operating Income (OI) Growth
  - Earning per Share
  - Debt Service Charge
  - Price/Earning (P/E) Ratio
  - Return on Invested Capital (ROIC) / Return on Equity (ROE)
  - Economic Profit
  - People Development

1.8 S^4/IEE Business Strategy Implementation
S^4/IEE: 30,000-Foot-level Metrics

- Corporate Executive
  - Profit & Loss Optimization Metrics
  - Asset Management Metrics
  - People Development
  - Factory Metrics (Percent Yield, Run Time, Productivity, etc.)
  - Safety
  - Supply Chain Metrics
  - Salesperson Productivity
  - Patents
  - New Product Introduction
  - Supplier Metrics (Cost, Quality, Service)
Enterprise Business Planning Methodology (EBPM):

- Create satellite-level metrics for the past two to five years.
- Select goals that are in alignment with improvement desires for the satellite-level metrics.
- Select strategies that are in alignment with goals.
- Examine supply chain process map.
- Choose high-potential areas for focusing improvement efforts using goals and supply chain process map to help guide the selection process.
- Select and create 30,000-foot-level operational metrics that are in alignment with the high potential areas for improvements.
- Select S^4/IEE project areas that are in alignment with operational metrics.
Enterprise Business Planning Methodology (EBPM):-cont.

- Drill down project areas to well-scoped projects (project scope) that are not too large or too small.
- Create 30,000-foot-level project metrics for base-lining projects and tracking impact from S^4/IEE project work.

Enterprise Cascading Measurement Methodology (ECMM):

- Meaningful measurements are statistically tracked over time at various functional levels of the business.
  - Satellite-level business metrics
  - High-level KPOV operational metrics at 30,000-foot level, 20,000-foot level, or 10,000-foot level (infrequent sampling)
  - KPIV at 50-foot level (frequent sampling)
1.9 Six Sigma as an S^4/IEE Business Strategy: DMAIC Project Execution Roadmap

Steering Team → Champion and Black Belt with Team → Steering Team

- Foundation → Define Project
- Measure → Passive Analysis
- Proactive Testing → Control
- Integration

Plan Project & Metrics → Baseline Project → Consider Lean Tools → MSA → Wisdom of the Organization

1.10 Creating An S^4/IEE Business Strategy with Roles and Responsibilities

Organizational Leader

- SBU#1 Champion
  - Sponsor/Process Owner
    - Black Belt
- SBU#2 Champion
  - Sponsor/Process Owner
    - Black Belt
- SBU#3 Champion

Figure 1.16
Possible S^4/IEE Organizational Interrelationship
1.10 Creating An S⁴/IEE Business Strategy with Roles and Responsibilities

Executive:
- Motivate others toward a common vision.
- Set the standard, demonstrate the behaviors.
- Use satellite-level and 30,000-foot-level metrics.
- Ask the right questions.
- Use S⁴/IEE tools in day-to-day operations.
- Be visible.
- Give a short presentation for each S⁴/IEE training wave.
- Attend project-completion presentations conducted by S⁴/IEE team.
- Stay involved.

Figure 1.17 Possible S⁴/IEE Technical Relationships
1.10 Creating An S⁴/IEE Business Strategy with Roles and Responsibilities

Steering Team:
- Same as executive roles and responsibilities, plus
- Develop project selection criteria.
- Set policies for accountability for project results.
- Develop policies for financial evaluation of project benefits.
- Establish internal and external communication plan.
- Identify effective training and qualified trainers.
- Develop human resource policies for S⁴/IEE roles.
- Determine computer hardware and software standards.
- Set policies for team reward and recognition.
- Identify high potential candidates for S⁴/IEE roles.

Champion:
- Remove barriers to success.
- Develop incentive programs with executive team.
- Communicate and execute the S⁴/IEE vision.
- Determine project-selection criteria with executive team.
- Identify and prioritize projects.
- Question methodology and project-improvement recommendations.
- Verify completion of phase deliverables.
- Drive and communicate results.
- Approve completed projects.
- Leverage project results.
- Reward and recognize team members.
Master Black Belt:
- Function as change agents.
- Conduct and oversee S^4/IEE training.
- Coach black belts / Green belts.
- Leverage projects and resources.
- Formulate project-selection strategies with steering team.
- Communicate the S^4/IEE vision.
- Motivate others toward a common vision.
- Approve completed projects.

Black Belt:
- Lead change.
- Communicate the S^4/IEE vision.
- Lead the team in the effective utilization of S^4/IEE methodology.
- Select, teach, and use the most effective tools.
- Develop a detailed project plan.
- Schedule and lead team meetings.
- Oversee data collection and analysis.
- Sustain team motivation and stability.
- Deliver project results.
- Track and report milestones and tasks.
- Calculate project savings.
- Interface between finance and information management (IM)
1.10 Creating An S^4/IEE Business Strategy with Roles and Responsibilities

Black Belt: (cont.)
• Monitor critical success factors and prepare risk-abatement plans.
• Prepare and present executive-level presentations.
• Complete 4 to 6 projects per year.
• Communicate the benefit of the project to all associated with the process.

Green Belt:
• Similar to black belt except they typically:
• Address projects that are confined to their functional area.
• Have less training than black belts.
• Are involved with S^4/IEE improvement in a part-time role.
1.10 Creating An S$^4$/IEE Business Strategy with Roles and Responsibilities

Sponsor:
- Function as change agents.
- Remove barriers to success.
- Ensure process improvements are implemented and sustained.
- Obtain necessary approval for any process changes.
- Communicate the S$^4$/IEE vision.
- Aid in selecting team members.
- Maintain team motivation and accountability.

Important Skills when Selecting a Black Belt:
- **Fire in the belly**: unquenchable desire to improve the way an organization does its business.
- **Soft skills**: ability to work effectively with people in teams and other organizations.
- **Project management**: ability to get things done well and on time.
- **Multitasking**: ability to manage multiple tasks at one time and maintain focus.
- **Big picture**: seeing big picture, not insignificant details.
- **Analytical skills**: 1~2% of total number of employees.
1.11 Integration of Six Sigma with Lean

S\textsuperscript{4}/IEE approach integrate six sigma with lean practice.

- S\textsuperscript{4}/IEE approach does not require the definition of a defect for a project.

1.12 Day-to-Day Business Management Using S\textsuperscript{4}/IEE

S\textsuperscript{4}/IEE Enterprise Cascading Measurement Methodology (ECMM):

- Satellite-level business metrics
- High-level KPOV operational metrics at 30,000-foot level, 20,000-foot level, or 10,000-foot level (infrequent sampling)
- KPIV at 50-foot level (frequent sampling)
- Meaningful metrics at operational level.
1.13 S^4/IEE Project Initiation and Execution Roadmap

- Project identification sub-process (Figure 1.19)
  - Product DFSS
  - Process DFSS
- Stakeholders agree to project problem statement.
- Determine project scope (Project charter)
  - Pareto charts
  - Theory of constraints (TOC)
- Make sure project scope is aligned with improvement needs of the high-level supply chain map.
  - Supply chain process decision program chart (PDPC)
  - Suppliers, inputs, process, outputs, and customers (SIPOC)
1.13 S⁴/IEE Project Initiation and Execution
Roadmap: Sample S⁴/IEE Project Charter

- Project Description
- Start and Completion Date
- Baseline Metrics: Primary and Secondary Metrics
- Goal
- Benefits: Customer/ Financial/ Internal Productivity
- Phase Milestones
  - DM(Metrics/Baseline/Lean Tools/MSA/Wisdom)AIC
  - Team Support: Sponsor/ champion/MBB/Process Owner/ Financial Analyst
- Team Members: Black belt, team members and roles

1.14 Project Benefit Analysis

Traditional COPQ Calculations

Prevention:
- Training
- Capability Studies
- Vendor Surveys
- Quality Design

Appraisal:
- Inspection and Test
- Test Equipment and Maintenance
- Inspection and Test Reporting
- Other Expense Reviews

Internal Failure:
- Scrap and Rework
- Design Changes
- Retyping Letters
- Late Time Cards
- Excess Inventory Cost

External Failure:
- Warranty Costs
- Customer Complaint Visits
- Field Service Training Costs
- Returns and Recalls
- Liability Suits
1.14 Project Benefit Analysis

Cost of Doing Nothing Different (CODND): by Iomega

Bottom-line hard Dollar:
• Decreases existing business costs
• Takes cost off the books or adds revenue to the books

Cost Avoidance:
• Avoids incremental costs

Lost Profit Avoidance:
• Avoids lost sales

Productivity:
• Increases in productivity

Profit Enhancement:
• Potential sales increase

Intangible:
• Improvements to operations of business

1.17 Computer Software

• Excel
• MINITAB