LEAN/SIX SIGMA
YELLOW BELT TRAINING

PMI - NORTHERN UTAH CHAPTER
Professional Development Conference
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Dave Dirks, PMP/MBB
Instructor Profile: Dave Dirks

Experience:

AVR Associates, Ltd.,
• Principal

Xerox
• Executive Consultant/Program Manager

Quanterra
• CIO/VP IT

Corning Glass Works
• Manager IT Planning and Technology Assessment
• Manager End User Service
• CIM; Manager Engineering and Manufacturing Info Systems
• Machine Shop: Automation Manager

Education:
• BA Political Science
• BA Manufacturing and Industrial Engineering
• Project Management Professional (PMP) (2000)
• Six Sigma Master Black Belt (2002)

Contact Information:
• davedirks45@gmail.com
• Cell: 303-520-3342
LOGISTICS

- Please turn off or silence cell phones and other communications devices
- We will take frequent breaks, but if you need to leave, feel free
Introductions

- Name?
- What is your current job?
- What are your expectations from this workshop?
WORKSHOP LEARNING OBJECTIVES

- Understand the benefits and implications of the Six Sigma methodology and its significance in the business environment
- Understand Six Sigma language and terms
- Discuss the Six Sigma rating to evaluate the capability of a process or organization
- Understand the use and critical factors within the DMAIC process
- Recognize organizational critical success factors in implementing and maintaining a Six Sigma implementation
- Understand basic Six Sigma tools
- Review basic LEAN concepts and how they apply to Six Sigma
- Discuss how Project Management is a key part of the Six Sigma methodology.
The “Dilbert Perspective”
The “Dilbert Perspective”
The “Dilbert Perspective”

I plan to fuse Six Sigma with Lean methods to eliminate the gap between our strategy and our objectives.
The “Dilbert Perspective”
What is Six Sigma?
Agenda

- What is Sigma?
- What is the Six Sigma Methodology?
- What are Six Sigma Projects and How are They Selected?
- DMAIC Discussion
- DFSS (DMADV) Discussion
- Lean Six Sigma
- Discussion
- Conclusion and Open Items
What is Six Sigma?

- First it is a statistical term.
  - Sigma (σ) is a measure of frequency distribution. (Standard Deviation)
- It is also the name of a problem solving process originally developed by Motorola.
- Further, it is a measure of “quality” within the Six Sigma methodology.
## Normal Distribution

<table>
<thead>
<tr>
<th>Sigma</th>
<th>Percent</th>
<th>Defects: PPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>+/- 1 Sigma</td>
<td>68.27</td>
<td>317,3000</td>
</tr>
<tr>
<td>+/- 2 Sigma</td>
<td>95.45</td>
<td>45,500</td>
</tr>
<tr>
<td>+/- 3 Sigma</td>
<td>99.73</td>
<td>2,700</td>
</tr>
<tr>
<td>+/- 4 Sigma</td>
<td>99.9937</td>
<td>63</td>
</tr>
<tr>
<td>+/- 5 Sigma</td>
<td>99.999943</td>
<td>0.57</td>
</tr>
<tr>
<td>+/- 6 Sigma</td>
<td>99.9999998</td>
<td>.002</td>
</tr>
</tbody>
</table>
What is Six Sigma

• First it is a statistical term
  - Sigma ($\sigma$) is a measure of frequency distribution, standard deviation
    • 3 sigma covers 99.73% of a normal distribution
    • 6 sigma covers 99.999998%
What is Six Sigma?

- Motorola, the original pioneer, used a 1.5 $\sigma$ “shifted yield” to reflect manufacturing reality. (To account for dynamic mean behavior)
Normal Distribution with 1.5 Sigma Shift

<table>
<thead>
<tr>
<th>SIGMA</th>
<th>PERCENT</th>
<th>DEFECTS: PPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>+/- 1 Sigma</td>
<td>30.23</td>
<td>697,700</td>
</tr>
<tr>
<td>+/- 2 Sigma</td>
<td>69.13</td>
<td>308,700</td>
</tr>
<tr>
<td>+/- 3 Sigma</td>
<td>93.32</td>
<td>66,810</td>
</tr>
<tr>
<td>+/- 4 Sigma</td>
<td>99.3790</td>
<td>6,210</td>
</tr>
<tr>
<td>+/- 5 Sigma</td>
<td>99.9767</td>
<td>233</td>
</tr>
<tr>
<td>+/- 6 Sigma</td>
<td>99.99966</td>
<td>3.4</td>
</tr>
</tbody>
</table>
What is Six Sigma?

• First it is a statistical term.
  - Sigma ($\sigma$) is a measure of frequency distribution
    • 3 sigma covers 99.73% of a normal distribution
    • 6 sigma covers 99.999998%

• Motorola, the original pioneer, used a 1.5 $\sigma$ “shifted yield” to reflect manufacturing reality. (To account for dynamic mean behavior)
  - 3 sigma shifted equals 93.32% yield
  - 6 sigma shifted equals 99.99966% yield
What is Six Sigma?

- As a measurement, it is the “Holy Grail” of process performance.
- So what?
Results from a 3 Step Process

<table>
<thead>
<tr>
<th>PROCESS STEP</th>
<th>3 σ Quality Level</th>
<th>6 σ Quality Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>BATCH</td>
<td>93.32%</td>
<td>99.99965%</td>
</tr>
<tr>
<td>FORM</td>
<td>93.32%</td>
<td>99.99965%</td>
</tr>
<tr>
<td>FINISH</td>
<td>93.32%</td>
<td>99.99965%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FINAL RESULTS YIELD</th>
<th>3 σ Quality Level</th>
<th>6 σ Quality Level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>81.27%</td>
<td>99.99898</td>
</tr>
</tbody>
</table>

Process Improvement Does Have Benefits!
SIX SIGMA - DPMO Discussion

• Six Sigma is equal to 3.4 Defects Per Million Opportunities (DPMO)

• DPMO is a rate, not an absolute measurement
  - 10% error rate = .10 = 100,000/1,000,000 opportunities = DPMO of 100,000

• Example:
  - What is an opportunity?
  - Why are they selected?
SIX SIGMA - Targets

- Six Sigma is equal to 3.4 defects per million opportunities (DPMO)
- Restaurant bills - 3.82 sigma, 10,000 DPMO
- Domestic airlines fatality rate is 6 sigma
- Airline Baggage - 4.06 sigma, 5,000 DPMO
- The real goal for service is to be “best in class”, what is good based on economics, VOC, and practicality.
SIX SIGMA CALCULATION

SIGMA LEVEL CALCULATOR

Instructions:
1) Select Calculator Based on Available Information
2) Enter Data in Gold Cells
3) Read Sigma Level in Blue Cells

Single Product

Enter Number of Defects: 1
Enter Number of Units: 500
Enter Number of Opportunities Per Unit: 2
Defects Per Million Opportunities: 1,000
Sigma Level: 4.6

Multiple Products From Same Process

| Product          | Product A | Product B | Product C | Total |
|------------------|-----------|-----------|-----------|
| Enter Number of Defects: |           |           |           |       |
| Enter Number of Units:     |           |           |           |       |
| Enter Number of Opportunities Per Unit: |           |           |           |       |
| Defects Per Million Opportunities: | -         | -         | -         | -     |

Sigma Level

| Product          | Product A | Product B | Product C | Total |
|------------------|-----------|-----------|-----------|
| Enter Number of Defects: |           |           |           |       |
| Enter Number of Units:     |           |           |           |       |
| Enter Number of Opportunities Per Unit: |           |           |           |       |
| Total Opportunities:       | -         | -         | -         | -     |

Sigma Level

| Product          | Product A | Product B | Product C | Total |
|------------------|-----------|-----------|-----------|
| Enter Number of Defects: |           |           |           |       |
| Enter Number of Units:     |           |           |           |       |
| Enter Number of Opportunities Per Unit: |           |           |           |       |
| Total Opportunities:       | -         | -         | -         | -     |

Sigma Level
Six Sigma Methodology

• Begun by Motorola in 1987.
• A systematic, data driven discipline to improve business performance (problem solving methodology).
• Motorola floundered, program was picked up by GE and others.
### Six Sigma Motorola History Notes

<table>
<thead>
<tr>
<th>Year</th>
<th>Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981</td>
<td>• Training Center Established&lt;br&gt;• 5 year, 10x Quality Improvement Goal set</td>
</tr>
<tr>
<td>1985</td>
<td>• Bill Smith, Motorola Quality Engineer, coins term Six Sigma</td>
</tr>
<tr>
<td>1987</td>
<td>• Six Sigma adopted&lt;br&gt;• 4 year, 100x Quality Improvement Goal set, 40 hour quality training target&lt;br&gt;• Sales per FTE $69k&lt;br&gt;• Overall Corporation at 4 Sigma</td>
</tr>
<tr>
<td>1988</td>
<td>• Corporate Group wins Baldrige Award</td>
</tr>
<tr>
<td>1993-1995</td>
<td>• 40,000 new people hired, 40 hour quality training standard ends&lt;br&gt;• Revenue Growth @ 27%&lt;br&gt;• Overall Corporation is @ $110k Sales per FTE&lt;br&gt;• Overall Corporation is at 5.2 Sigma</td>
</tr>
<tr>
<td>1994</td>
<td>• Motorola owns 60% of wireless market&lt;br&gt;• Six Sigma Academy formed</td>
</tr>
<tr>
<td>1998</td>
<td>• Motorola owns 34% of wireless market&lt;br&gt;• Revenue Growth @ %5&lt;br&gt;• Shareholder return @ 1% had been 54% previous 3 years</td>
</tr>
<tr>
<td>2003</td>
<td>• Motorola Announces “Digital Six Sigma” (more use of technology)</td>
</tr>
<tr>
<td>2007</td>
<td>• 20th Anniversary of Six Sigma, estimated program savings $17 billion</td>
</tr>
</tbody>
</table>
What Happened to Motorola?

- Autonomous divisions didn’t cooperate
- A VP set cellular directions without talking to customers
- SS culture diluted by hiring and not training
- They got over confident
- Success leads to reluctance to change
- Did not apply SS to whole customer experience

MESSAGE: Six Sigma is not just talk. If the discipline is followed, it works.
SIX SIGMA IN FORTUNE 500

- Virtually 100% in aerospace, defense, computer equipment, medical products and equipment
- 85% of wholesalers, healthcare, banks, insurance
- 26% to 50% food service, hotels and casino’s, resorts, utilities
- 5% to 25% of engineering and construction, diversified outsourcing, mining, homebuilders, medical facilities

(iSixSigma Magazine)

• TOP 100 82.0 %
• TOP 200 70.0 %
• TOP 300 63.7 %
• TOP 400 59.8 %
• ALL 500 53.2 %
• Average savings of 2 % of annual revenue
• Greatest potential for growth: food and drug stores, homebuilders, healthcare, medical facilities, automotive retailing, pipeline facilities
Six Sigma versus ISO
(GENERALIZATION)

- **Six Sigma**
  - A problem solving methodology
  - Not a process certification tool
  - Not a ticket to participate
  - The latest in a long line of “Quality Initiatives”

- **ISO**
  - Primarily documentation and consistency
  - Assumes process has been optimized
  - Ticket to play in some markets
  - Evidence of control
Six Sigma versus TQM

• TQM entails creating a total quality culture bent on continuously improving the performance of every task and value chain activity.
  - Does every step really need to be improved?
  - Will a “continuous improvement” approach necessarily yield significant improvement?
• Quality just for the sake of quality doesn’t necessarily improve business performance
• Baldrige & Shingo (Lean) cautions.
So What is Six Sigma?  
According to $D^2$

- A systematic, rigorous way to improve business performance.
- Driven by “real” improvements and focus on the customer.
- A fact based decision process.
- The latest evolution of the Demming, Juran, Maynard et al Quality Programs.
- Process Focus, Management and Improvement.
- Proactive Management.
- Boundaryless Collaboration.
- A proven way to improve performance. Drive for Perfection.
- Simple in concept, potentially complex in application - the tools can seem scary.
- An enterprise “way of life” program.
Six Sigma as a “Corporate Way of Life”

- Senior Management is committed, not just involved (Bacon and Eggs).
- New Organizations and Roles.
  - Project Selection
  - SS Implementation Team
  - Dedicated, Full Time Change Agents
- The way of doing business changes.
  - Project Selection
  - Performance Management
  - Selection for Leadership Positions
  - Performance Targets
  - Black Belts return to the organization in leadership positions
What Are the Roles

- **YELLOW BELT**: people who have been trained in basic concepts and tools
- **GREEN BELT**: people trained to act as team members, perhaps lead small projects
- **BLACK BELT**: individual project leaders, key to the program
- **MASTER BLACK BELT**: responsible for overall program management, aiding black belts
- **CHAMPION**: executive within business units trained to support. Project selection and support are key roles
- **EXECUTIVE LEADER**: leads the effort at the highest levels.

(Dr. Mikel Harry of Motorola and Clifford Ames of Unisys coined the Black Belt naming convention in 1987 because it was sexier than “process characterization experts”)

ONE THING TO REMEMBER

\[ y = f(x) \]

y is a function of x

y (output) is a function of x (input)

The only way to get “y” where you need it is to understand, manage and control “x”
DATA
vs.
NUH UH
THE ANALYTICAL SPECTRUM

Data & Statistics
THE ANALYTICAL SPECTRUM

Data ‘ish

Data & Statistics
THE ANALYTICAL SPECTRUM

Nuh-uh

Data ‘ish

Data & Statistics

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THE ANALYTICAL SPECTRUM

- The power of unjustified certainty
- The quality of the argument
- Where do you go when you have no data?
- The goal is to become “reality driven”
DATA & STATISTICS

- Pareto
- Regression Analysis
- Statistical Process Control
- Things based on observable, repeatable, demonstrable information
- Provable relationships
- If it is not data: what is it?
- Can there be “false” or “misleading” data
DATA ‘ISH

- Decision matrix
- Nominal group technique
- Fishbone Diagrams
- Failure Mode and Effects Analysis (FMEA)
- Kepner Tregoe
- Weighted voting methods
- The power here is in the building of consensus, not the quality of the analysis
NUH - UH

- Unjustified or unsupported certainty
- Juxtaposition versus relationship (correlation versus causation)
- I just don’t think that’s right
- The “devil’s advocate”
- We’ve looked this before and that’s not how it is
- I don’t believe you
What Are Some Key Components

- **DMAIC**: Define, Measure, Analyze, Improve, Control - the main mantra.
- **DMAIC** is a very detailed, proven WBS.
- **DFSS**: Design For Six Sigma - product or process design to meet SS criteria.
- **VOC**: Voice Of the Customer - tools and mindset to concentrate on meeting the needs of the customer.
- **Measure** of business impact: monetary or otherwise
- **EVA**: Economic Value Added (economic profit) - key way to select strategic projects. Multidimensional measure. 
  
  \[
  \text{EVA} = \text{NOPAT} - \text{Capital Charge} \quad \text{profit required by investors}
  \]

(EVA is a Registered Trademark of Stern Stewart Company)
Fundamental Notions

- Process variation is bad.
- Errors cost money.
- Errors lead to the loss of customers.
- Errors diminish the bottom line.
- Make decisions based on facts.
- Take the time to do it right.
- Focus on the Customer.
- Project Management & SS Disciplines are very much symbiotic.
Six Sigma Environments

• **Manufacturing:** traditional area, generally has more data available to which statistics can be applied.

• **Transactional/Service:** basically everything else, not everything applied, but still very good tools and techniques.
Where Do Projects Come From?

Top Down
- Business Unit Analysis
- Earned Value Analysis
- Legal/Compliance Issues
- Strategic Initiatives
- Voice of the Customer

Bottom Up
- Quality Issues/Metrics
- Productivity
- Operating Personnel
- Lean Initiatives
- Process Maps
Opportunity Selection Process

- Key strategic business drivers.
  - VOC (VOX)
  - Financial
  - Operations
  - Regulatory
  - Strategic
- Identify possible opportunities.
- Sort and prioritize.
  - Risk versus return
  - Benefit effort Matrix
- Draft Scope and Definition Statements.
- Prioritized List of Defined Projects.
Opportunity Selection Process

Portfolio Management Process

• Minimum Criteria to be met:
  - Maximize Value
  - Achieve the Right Value
  - Ensure Strategic Alignment
  - Get to the Right Number
Benefit - Effort Matrix

Project Risk & Return Portfolio

- Winners
- Quick Hits (Worthwhile provided project can be completed quickly)
- Leaps-of-Faith
- Losers

Benefit vs. Effort Matrix
Portfolio Management, Bubble Diagram

Typical Risk Reward Diagram

- **Pearls**
- **Bread and Butter**
- **Oysters**
- **White Elephants**

Circle Size = annual resources required by each project

Legend:

- **High**
- **Low**

Probability of Technical Success (x-axis)

Reward - $M (NPV) (y-axis)
Six Sigma Process Steps

- **DMAIC** - the main problem resolution methodology.
  - Define
  - Measure
  - Analyze
  - Improve
  - Control

- **Key Requirement**: A gate review between each step and a specific approval to move on to the next step.
DMAIC - Define

- Identify the opportunity
  - Size
  - Benefits
  - Critical to success
- Write and gain commitment to the Project Charter
  - Organizational commitment
  - Team commitment
  - Set expectations
- Identify and plan for mitigation of risks
DMAIC - Measure

• Survey the data availability and evaluate its’ suitability
• Test for:
  - Accuracy
  - Repeatability
  - Reproducibility
  - Ability to drill down to assignable cause
• Gather and store in suitable means/methods
  - Based on learning, you may need to recast the information
  - Will it lead to Y = f(x)?
DMAIC - Analyze

- Your holy grail is $Y = f(x)$
- Look for assignable cause
- What has always been done may not be sufficient
- Many times simple, graphical tools can lead the way
- Don’t be afraid to go complex - get help if you need it
- Facts will always beat conjecture and supposition
DMAIC - Analyze

• Fix the Obvious:
  • “Low Hanging Fruit”
  • DON’T stop at the obvious
• Build and Test Models.
• Identify KPIV (input variable) and KPOV (output variable).
• Establish Base Case for All Variables.
• Make sure you understand and can explain. (prove) $y = f(x)$
DMAIC - Improve

- Optimize the process to meet the customer’s requirements
- Be able to factually show the $Y = f(x)$ relationship
- Many times change will be incremental
- Don’t be afraid to investigate bold changes
- Simulations can be invaluable in testing proposed changes
- Use the team, use the team.............
DMAIC - Improve

- Optimize KPOV’s:
  - Use sequential experimentation to exercise range of KPIV, see changes in KPOV
  - Validate proposed solution against customer requirements
  - Process oriented, use experimentation
- Transaction, use simulation to do experimentation.
DMAIC - Control

- Control the process:
  - Control plan
  - Corrective action plans
  - Feedback systems
- Maintain and leverage gains:
  - Management of Change (MOC)
DMAIC - Summary

• Tools and techniques are not new.
• DMAIC has been proven to improve the likelihood of success on complex projects.
• Power is in the organization of tools rather than new adaptation of the tools. (The application of good Project Management)
• Applicable for both PROCESS (industrial) and TRANSACTIONAL (service) projects. The two require some different tools.
• Does not need to be applied in detail in every project. Champion and MBB will determine what is required.
Key Tools

• Statistics:
  - Critical part of the program in all phases
  - Key goal is to achieve clear and demonstrable understanding of the current process, and knowledge that the changes induced in fact produced the desired results
  - The most challenging part of the program
  - Many software packages to reduce technical tasks (Minitab, SAS, Microsoft Excel based programs)

• Process Mapping
• Cycle Time Reduction
• Simulations
• Business Process Engineering
SIX SIGMA - Service Reactions

• It’s too complex - not necessarily!
• It’s too time consuming - how long does it take to fix the problem 2-3 times?
• We already know the problem - Really - then why haven’t you fixed it?
• Solutions are simple and obvious - Really - then why aren’t they implemented?
• IT Solutions are Silver Bullets - Riigght!
• Product Development Methods aren’t useful - versus what’s been done in the past?
SIX SIGMA - Service Summary

- Right tool - right job, use simple if it works.
- DMAIC and ICOV (identify, characterize, optimize, validate) are proven, but heavy statistics may not be necessary/appropriate.
- Resistance comes from asking non-analytical people to apply analytical methods.
- Project Management is key.
- Statistical tools can still be applied with help of MBB.
- BB’s may need more support than in other areas.
DESIGN FOR SIX SIGMA (DFSS)

- When developing a totally new process
- The goal is to meet customer requirements at Six Sigma quality levels.
- The Process Steps are DMADV:\n  - DEFINE: goals of the design activity
  - MEASURE: customer input regarding CTQ. What are the delighters?
  - ANALYZE: how can you best meet customer needs for products and services
  - DESIGN: new processes, products and services
  - VERIFY: does the new system actually meet the needs? Is the system in control?

1 “The Six Sigma Handbook” Thomas Pyzdek

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DMADV - DEFINE/MEASURE

- Identify CTQ’s (Critical to Quality) & CTC’s (Critical to Customer)
- Create a dashboard to “operationalize” CTQ’s & CTC’s
- Establish and validate measurement systems
- Sponsor define/measure gate review
DMADV - ANALYZE

- Link CTQ’s & CTC’s to design features
- Determine importance of design features
- Benchmark similar companies or processes
- Define performance standards
- Develop design concepts
- Select best design
- Sponsor Analyze gate Review
DMADV - DESIGN

- Develop detailed design
- Estimate CTQ’s, CTC’s
- Tweak until CTQ’s & CTC’s goals are met
- Conduct Pilot
- Revise as necessary
- Develop implementation plan
- Conduct FMEA, analyze for hidden issues
- Sponsor Design gate review
DMADV - VALIDATE

- Control Plan
  - FMEA recommendations
  - Standardization
  - Control metrics
  - Metrics collection, display and analysis
- Transition Plan
  - Train and hand off
  - Monitor and tweak process
- Project Review
  - Lessons learned
  - Transfer learning to other areas
DMADV - KEY ISSUES

- Focus on CTQ and CTC issues
- Work to get through noise to “real” needs
- Heavy use of simulations
  - Don’t build castles on sand
  - Use the “does this make sense?” check (GIGO)
- Don’t just settle for incremental change - look to change the game
SIX SIGMA - Lean Manufacturing

• Repetitive Producers who are world class.
• Mission is to achieve perfection at the lowest cost.
• People are responsible for the whole job - Cellular Manufacturing.
• Continuous learning and teamwork.
• Meet the customers requirements.
• Kaizen (10% exercise), Poka-Yoke, 5s’.
• Lots of industrial engineering tools, versus statistical tools, DMAIC is still appropriate.
History Timeline of Lean Thinking

- 1850: Eli Whitney, interchangeable parts
- 1900: Frederick Taylor, standardized work, time study, work standards, worker/management dichotomy
- 1900: Frank Gilbreth, process charts, motion study
- 1910s: Henry Ford, assembly lines, flow lines, manufacturing strategy
- 1950s: W. Edwards Deming, Juran, SPC, TQM
- 1950s: Eiji Toyoda, Taiichi Ono, Toyota Production System, Just-In-Time, stockless production, world-class manufacturing
- 2000: Lean manufacturing
SIX SIGMA - Lean Manufacturing

Some Buzz Words

- Takt Time: time per piece to meet customer requirements.
- Jidoka (Autonomation): giving equipment or process “intelligence” so people don’t have to monitor automatic operation.
- Poka-yoke: mistake proofing.
- 5s:
  - Sort
  - Set in Order
  - Shine
  - Standardize
  - Sustain
- Visual Management: design to be able to easily see the status of an operation so immediate corrective action can be taken.
- “Lean Production Simplified”, Pascal Dennis, Productivity Press, 2002
SIX SIGMA - Some Terms

- FMEA: Failure Mode Effects analysis - problem definition, identification technique
- GAGE R&R: repeatability and reproducibility
- ANOVA: analysis of variance
- CPk, Ppk: measure process capability
- DPU: defects per unit
-CTX: Critical To ‘X’ (X being some factor of the process or interaction)
- DPMO: defects per million opportunities
- DOE: Design of Experiments
- QFD: Quality Function Deployment (house of quality)
- DFSS: Design for Six Sigma
- ICOV: Identify, Characterize, Optimize, Validate
- KPIV/OV: Process variables
Six Sigma Issues

- Can’t really be a grass roots effort as a complete program. (?)
- Slavish devotion to the method. (The Book versus Experience)
- The certification dilemma and hitting targets.
- I’ve got a hammer, everything looks like a nail.
- Analytical personalities versus project management personalities.
- Are all Six Sigma efforts Projects?
- Is Six Sigma applicable to all Projects?
Project Management and Six Sigma

PMBOK® Guide
PM Knowledge Areas
PM Processes

Six Sigma
DMAIC

General Methodology
Applicable to Many Types of Work

Both Are Required For Optimal Results

Specialized Methodology
Caveat: It Is Still a Project
Project Life Cycle

• Every project has a natural life cycle
• Generically they can be as varied as the project
• In Six Sigma - the life cycle is defined
  - DMAIC
  - Tasks within each phase are defined like a predefined WBS
  - All of the PMBOK can apply in Six Sigma
  - Same picture, different facet of the prism
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DMAIC & PMBOK (IPECC)

- Items with a blue heading represent DEFINE ACTIONS

- Items with the red - green heading represent MEASURE, ANALYZE and IMPROVE ACTIONS

- Items with a yellow heading represent CONTROL ACTIONS
So, What Does This All Mean For Project Managers?

• It establishes a corporate discipline. Our dreams for a PMO are embodied in the overall Six Sigma implementation structure.
  - Top down planning, prioritization
  - Strict tracking of project performance and results
  - Training
  - Allocation of Resources
• If it is not Six Sigma, it’s not happening.
• Project Management is a recognized need, but not enough.
Where is Six Sigma Potentially Applicable?

- Virtually Anywhere !!!
- BUT - only use if it is appropriate.
  - DMAIC is a problem solving regime.
Six Sigma is becoming the language of commerce. You need to have a basic understanding.

More and more companies are adopting it. Virtually all Fortune 500 companies are already engaged or are looking at it.

It is applicable in service as well as manufacturing.

Most of the tools aren’t new. The discipline to use them across the enterprise is new.

Knowledge of Six Sigma will soon be a basic requirement for leadership positions in virtually all companies.

The very best Six Sigma performers are those that have great Project Management skills.
Some Thoughts

• Get Involved!
• Politic to get involved - they need your skill
• Our skills are VERY complimentary to Six Sigma. It won’t succeed without excellent PM.
• The rate of successful Six Sigma implementation is often driven by how well projects are being managed.
• If you are doing process improvement type projects, the techniques are useful, even if you are not in a Six Sigma environment.
Discussion Issues

• If you do consulting, you need SS as an additional qualification.
• Training can be reasonable to very expensive.
• Certification
  - Project Management has PMI and the PMP
  - There is no equivalent for SS
    • Done within companies
    • ASQ has some exams (Green & Black Belt)
    • No standard
Discussion Issues

• Assume the following conditions are equal at the start of a Six Sigma project:
  - Charter
  - Commitment of resources
  - Problem to be resolved
  - Overall “political atmosphere”

• Why would one effort succeed and another fail?
Key Areas for PM’s to Shine

• Establishing a Charter
• Enabling & Managing Effective Communication (discuss goals and methods of communication)
• Meeting Management
• Actually getting the work done on time and meeting the agreements of the Charter
WEB RESOURCE

- [www.isixsigma.com](http://www.isixsigma.com) is one of the best
DISCUSSION AND EXERCISES
KEY TO SUCCESS

SIGNIFICANT Individual Programs

Sufficient Integrated Approach

- Project Management
- Manage by Fact (Six Sigma)
- Portfolio Management
- Management of Change
How DPMO Relates to Sigma Level

Examples of Sigma Levels

Sigma Level

DPMO

10000000
1000000
100000
10000
1000
100
10
1

1 2 3 4 5 6 7

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SIGMA VERSUS COST OF QUALITY
Kano Model
LEARNING OBJECTIVES

• Detailed review of the DMAIC process
• Review and use of common tools
• Discuss questions and use of the methodology in your “real world” situations.
Six Sigma Process Steps

• DMAIC - the main problem resolution methodology.
  - Define
  - Measure
  - Analyze
  - Improve
  - Control

• Key Requirement: A gate review between each step and a specific approval to move on to the next step.
DMAIC - Define

- Identify the opportunity.
  - Track expenses
  - Performance metrics
  - Customer data/feedback
  - Market research
  - QFD (Quality Function Deployment)
  - EVA (Economic Value Added)
  - Benchmarking

- Define the project.
  - Goal
  - Process
  - Organization
  - People
  - Rewards
  - Link to strategic plan
  - Financial assessment
  - Scope, charter, timeline
  - Risk Analysis
  - MBB, BB, Team
  - Internal support
What is a Project Charter

• A description of boundaries.
• A contract between a sponsor/champion and a project team.
• An agreement as to what specifically is to be done (and not done).
• A short justification for the expenditure of resources. (What does ‘resources’ include?)
• An outline of team resources.
• A signed document which reflects the commitment of the organization.
Generic Project Charter Elements

- Project Scope
- Opportunity or Problem Statement
- Goal Statement
- Business Impact
- Project Plan
- Team Selection
Who Develops the Project Charter in the Six Sigma World

- In theory, the Project Sponsor or Champion.
  - Involved in the high level, EVA process selection process
  - Rarely have the time, skills or predisposition to write a clean Charter
- The Project Manager (GB or BB) with help from the MBB will ultimately own the document and the process.
Who Else is Involved?

- Deployment Manager.
- Finance Representative.
- Division or group management.
- The Belts as much as necessary.
- Team members on occasion, SME’s.
When do you have a Six Sigma Project?

• A challenging goal or issue.
  - Create value for the business
    • What are the types of value?
  - Business unit strategy driven
  - Solution is not readily known
  - Intractable problem

• Willing (necessary) to commit resources.

• Need a “real” fix.

• Gain commitment.
When do you NOT have a Six Sigma Project

- Goals and requirements are ambiguous.
- The course of action is already determined.
- There is no process to improve.
- The required resources cannot be made available.
- Can’t agree on a Scope and Charter.
- If it isn’t a Six Sigma Project, as defined, then what?
Major Issues in Charter Development

• Getting the scope right - usually it is too large.
• Big Thinker’ism - scope shaped by a dream rather than reality.
• Management enthusiasm - for how much you’ll get done, and how quickly.
• Management Apathy - don’t want to be involved, just achieve the results.
• Baseline data is non-existent.
• It is not really a Six Sigma effort, Lean tools may be more appropriate.
• Hostile environment.
Opportunity or Problem Statement

- Description of the issue so it is clear what is to be worked on
- Answers the question, “What, specifically, is going to be worked on?”
  - What
  - Where
  - When
  - How Big
Goal Statement

- What is to be achieved?
- If I do this, will be clear that this project is done?
  - NOT “boil the ocean”
  - NOT “fix world hunger”
  - IS specific
- $y = f(x)$
  - Define $y$
  - Baseline data
  - Entitlement
  - Improvement goal
  - units

<table>
<thead>
<tr>
<th></th>
<th>B/L</th>
<th>ENT</th>
<th>I/G</th>
<th>U</th>
</tr>
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<td>Days Sales Outstanding</td>
<td>40</td>
<td>28</td>
<td>20</td>
<td>DSO</td>
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</table>
Business Impact

• If the Goal is achieved, how will the business be impacted?
• Can be (Will Be) Measured
• Can be (Will Be) Verified
• Impacts vs. Impacts
  - Hard dollar savings or increase
  - Soft savings
  - Strategic impact
  - Good of the business (e.g. Sarbanes-Oxley)
Project Plan

- What are the necessary tasks to complete
- Account for all Toll Gate Reviews
- Be realistic - it will always take longer than you think
- RE: The Plan, don’t create a bigger beast than you are willing to feed.
- Logic Check, be critical, can the work get done as scoped, you’ll be held accountable.
Team Selection

- Fight to get the first string
  - They are the busiest, so it will be difficult
  - Test of organizational commitment
- Get the right SME’s
  - Team dynamics do matter
  - Monitor and address issues early
  - Political or purpose members
  - Challenge of the skeptic
- Make sure individual and manager understand rules of participation
- Set a schedule and work to keep to it.
- Set Rules of Participation
  - No redo’s for people not attending
  - Remember what you learned in Kindergarten
Swim Lane Example

ACCOUNTS RECEIVABLE: INTERNET SALES

**SALES**
- User Initiates Purchase
- User Completes System Configuration
- User Finalize Purchase
- Purchase Using Credit Card?
  - Yes 20%
  - No 80%
  - Complete Sales Transaction

**INTERNET PROCESSING**
- Sample System Configurator

**CREDIT MGMT**
- Evaluate Credit Status
- Sale Approval
- Generate and Send Invoice

**FIELD LICENSE PROCESSING**
- Customer Filled Configuration Evaluated
- Feedback to Customer on Final Configuration and Cost
- Send License to Customer

**INVOICING**
- Follow-up

User Initiates Purchase Using Credit Card?

- Evaluate Credit Status
- Generate and Send Invoice
- Follow-up

Sample System Configurator

Evaluate Credit Status

Complete Sales Transaction

Follow-up

Sales

User Completes System Configuration

Send License to Customer
QUALITY FUNCTION DEPLOYMENT

- Another way to look at the process
- First pass, coarse sort on what the priorities might be.
- Based on CTX (customer) but relatively subjective.
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<thead>
<tr>
<th>Importance Rank</th>
<th>Relationship Rank</th>
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<tbody>
<tr>
<td>Highest</td>
<td>Strong</td>
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<tr>
<td>Hi - Mid</td>
<td>Mild</td>
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<tr>
<td>Middle</td>
<td>Weak</td>
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<tr>
<td>Lo - Mid</td>
<td>None</td>
</tr>
<tr>
<td>Lowest</td>
<td>None</td>
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<th>B</th>
<th>C</th>
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<th>I</th>
<th>J</th>
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<th>M</th>
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<td>CONFIGURATOR AVAILABLE AND ACCURATE</td>
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<td>1</td>
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<td>7.1%</td>
<td>7.1%</td>
<td>8.3%</td>
<td>11.1%</td>
<td>24.8%</td>
<td>18.5%</td>
<td>85%</td>
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</table>

**Customer / Business Importance**

**Absolute Importance**

**Relative Importance**
QFD

OTHER AVAILABLE SECTIONS:

- Planning Matrix
- Competition Analysis
- Engineering competitive analysis
- Performance criteria

USEFUL FOR:

- Relating customer requirements into internal processes
- Define, Analyze, Improve
Define - Critical Tasks

- Refine the Project Charter.
- Develop the list of Customers.
- Gather VOC/VOX
- Complete a basic process flow diagram.
- Validate and prioritize requirements.
- Field test your ability to generate accurate data.
- Refine and revise Project Charter to reflect reality.
- Be critical:
  - Is there a project?
  - Do I have the right resources?
  - Can it be done in the allotted time?
  - Are the goals attainable?
  - Outline risks and how to mitigate them.
- Don’t be a wuss, - don’t be afraid to push back.
- Ask for and document what you need to be successful.
The GOAL of the MEASURE phase is to generate meaningful data which will help you discover  
\[ y = f(x) \]
DMAIC - Measure

* Collect data for KPIV and KPOV.
* Define a data collection methodology, Capability.

- Process
  - Data types
  - Measurement resolution
  - Calibration
  - Linearity
  - Bias
  - Measurement stability

- Transactional
  - Data types
  - Collection methods
  - Simulation engine
  - Process flow diagram
  - Survey or sampling methodology
Measure - Critical Tasks

- Develop a Value Stream Map. Group Task
- Develop your Data Collection Plan. Group Task
- Validate your measurement systems. Discuss
- Collect the data. Discuss
- Complete Process Capability Analysis. Discuss
- Be Critical:
  - Can I really prove \( y = f(x) \)
  - Do I really have the data?
  - Is the data in a form/format that will enable me to search for assignable cause? \( \{y = f(x)\} \) (e.g. segmenting, granularity)
  - Does what I’ve collected enable me to support what I said in my Project Charter.
  - Be the auditor before you get audited.
MEASURE - Value Stream Map

• Identify what information is/can be generated from this process
  - Hold times
  - Delays
  - Unnecessary work or inspections
• Identify which steps the customer is willing to pay for and which are wasted time
• Start thinking about how you might modify the process
ANALYZE

The GOAL of ANALYZE is to pick from the amazing inventory of tools available to generate $y = f(x)$ for the process you are working on

• Use what you have, be practical
• Don’t settle, if you need the data fight to get it
• Don’t be shy, ask for help with complex analysis
• Follow the data
DMAIC - Analyze

- ANALYZE ROOT CAUSES:
  - Brainstorming
Brainstorming
DMAIC - Analyze

**ANALYZE ROOT CAUSES:**
- Brainstorming
- Histograms, correlation’s
Histogram

Histogram of Length, with Normal Curve

Frequency

Length

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In general, we expect a variable such as Length to follow the normal distribution. In this case, the histogram would be approximately bell-shaped. The histogram you just created is certainly not bell-shaped. In fact, it would appear from the spikes at 598, 599, and 601 that we may be dealing with more than one separate and distinct distributions.
Histogram Tool
DMAIC - Analyze

• ANALYZE ROOT CAUSES:
  • Brainstorming
  • Histograms, correlation’s
  • Fishbone diagrams
Fishbone

Wonder Bit Fishbone Example

Software Listing Wrong

Sales used wrong Price sheet
Sales is lazy!

Invoice Wrong

Sales used Wrong price sheet

Configurator Errors

Pricing Incorrect

No identified Responsible person
Fishbone
DMAIC - Analyze

- ANALYZE ROOT CAUSES:
  - Brainstorming
  - Histograms, correlation’s
  - Fishbone diagrams
  - Pareto analysis
Pareto

- Used to discriminate between the vital few and the trivial many
- Useful in the define and analyze stages
- Data must be counts (attribute data), costs and additive
- Data such as yields or percentages aren’t useful
- Goal is 80:20 sort
Pareto Chart of the Standardized Effects
(response is Yield, Alpha = .10)

- A: Temp
- B: Pressure
- C: Catalyst

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Pareto Tool
DMAIC - Analyze

- ANALYZE ROOT CAUSES:
  - Brainstorming
  - Histograms, correlation’s
  - Fishbone diagrams
  - Pareto analysis
  - 5 Why’s
5 WHY’s

• State result or problem, i.e. the invoices are wrong.
• Ask “why” 5 times
• Simple but effective @ getting to root cause
DMAIC - Analyze

- ANALYZE ROOT CAUSES:
  - Brainstorming
  - Histograms, correlation’s
  - Fishbone diagrams
  - Pareto analysis
  - 5 Why’s
  - Update design FMEA and/or C&E matrix
# FMEA

## Failure Mode Effects Analysis

Instructions:
1) Complete header with process information, date, and revision level.
2) List potential failure modes.
3) Enter values for Severity (A), Occurrence (B), and Detection (C).
4) Prioritize Improvement actions based on RPN.
5) Revise values for Severity (A), Occurrence (B), and Detection (C) based on improvement actions.
6) Evaluate new RPN for acceptability.

Note: Seat belt process information shown for example purposes only.

### FMEA

<table>
<thead>
<tr>
<th>Process Name: Use Configurator</th>
<th>Process Number: Sales 101</th>
<th>Date: 6/10/2006</th>
<th>Revision Level: 1.3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Failure Mode</strong></td>
<td><strong>A) SEVERITY</strong></td>
<td><strong>B) OCCURRENCE</strong></td>
<td><strong>C) DETECTION</strong></td>
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<tr>
<td></td>
<td>Rate 1-10</td>
<td>Probability</td>
<td>Difficulty</td>
</tr>
<tr>
<td></td>
<td>10=Most</td>
<td>Rate 1-10</td>
<td>Rate 1-10</td>
</tr>
<tr>
<td></td>
<td>Severe</td>
<td>10=Highest</td>
<td>10=Most</td>
</tr>
<tr>
<td>1) Pick Wrong Base config</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>2) Use wrong conversion factor</td>
<td>9</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>3) Failure to update new</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>products</td>
<td></td>
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</tbody>
</table>
DMAIC - Analyze

- ANALYZE ROOT CAUSES:
  - Brainstorming
  - Histograms, correlation’s
  - Fishbone diagrams
  - Pareto analysis
  - 5 Why’s
  - Update design FMEA and/or C&E matrix
  - Control Charts
Basic Trend Chart

• Simple plotting of data values
• Time series rather than random data points
## Trend Chart

Instructions:
1. Fill in all gold areas with Title, Data, Date
2. Revise chart by double-clicking on any elements.
3. Move chart by clicking on black “resizing” boxes.

This chart will handle any number up to 25 items.
Insert Rows in the middle of the Array to add Observations.

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<thead>
<tr>
<th>Period/ Date</th>
<th>Defects</th>
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</thead>
<tbody>
<tr>
<td>1-Jan</td>
<td>2.00</td>
</tr>
<tr>
<td>2-Jan</td>
<td>3.00</td>
</tr>
<tr>
<td>3-Jan</td>
<td>7.00</td>
</tr>
<tr>
<td>4-Jan</td>
<td>12.00</td>
</tr>
<tr>
<td>5-Jan</td>
<td>2.00</td>
</tr>
<tr>
<td>6-Jan</td>
<td>6.00</td>
</tr>
<tr>
<td>7-Jan</td>
<td>11.00</td>
</tr>
<tr>
<td>8-Jan</td>
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</tr>
<tr>
<td>9-Jan</td>
<td>5.00</td>
</tr>
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<td>10-Jan</td>
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<td>13-Jan</td>
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<td>4.00</td>
</tr>
<tr>
<td>25-Jan</td>
<td>3.00</td>
</tr>
</tbody>
</table>
Control Chart

PREMISE:

• All processes have variation
  - Common cause: normal, expected variation
  - Special cause: some outside influence changing the normal performance
• Common cause should be minimized
• Special cause should be identified and eliminated.
• Says something’s wrong - not what is wrong.
X and Moving Range Charts

Instructions:
1) Enter data in the gold-highlighted column.
2) Data and control limits will be plotted automatically.
3) Table & graph handles up to 100 periods of data.
4) Click on Chart Title or Chart Axis Title to change.

Note: You may unprotect this worksheet should you wish to modify it: select Tools, then Protection, then Unguard Sheet

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<th>Range</th>
<th>R-median</th>
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X and Moving Range
XmR

Upper Range Limit - Formula: 3.87 x medianR
LCL(X) - Formula: X - (3.14 x medianR)
UCL(X) - Formula: X + (3.14 x medianR)

Range Chart

X-Chart
X and MOVING RANGE INTERPRETATION

Divide Chart Into Three Zones:

- Zone A: between 2σ and 3σ
- Zone B: between 1σ and 2σ
- Zone C: between centerline and 1σ
X and MOVING RANGE INTERPRETATION

Process Out of Control:

- Rule 1: Single data point outside of 3σ
- Rule 2: 2 of 3 data points on the same side of the centerline and > 2σ
- Rule 3: 4 of 5 data points on the same side of the centerline and > 1σ
- Rule 4: 8 data points on the same side of the centerline
- mR chart: only Rule 1 applies
X-bar R CHART

Same Basic Concept as XmR

- X-bar represents the average of a series of data, rather than a single data point
- R represents the range within the observations, rather than between the previous observation.
- Rules of interpretation the same, plus a few more.
DMAIC - Analyze

- **MULTIPLE STATISTICAL TOOLS:**
  - Logistic regression
  - Contingency table
  - Regression
  - ANOVA
  - Sequential linear regression
  - Multiple linear regression
  - Multivariate linear regression
SAMPLE TOOLS

- FMEA Template
- Flow Chart Shapes
- Sigma Level Calculator
- Trend Chart Template
- Basic xmr charts template
- SIPOC

- Cost Analysis Pareto
- Problem Analysis Pareto
- Basic Pareto
- Scatter Plot
- Histogram Template
- MBF Chart
Analyze - Critical Tasks

- List probable critical x’s.
- Prioritize critical x’s.
- Conduct Analysis.
- \( y = f(x) \).
- Be Critical:
  - Am I just rehashing old data and assumptions or am breaking new ground?
  - Do my assumptions on assignable cause make sense?
  - Does my presentation pass the “Executive Test”?
  - Do I need statistics help to do the analysis required?
ANALYZE

BOTTOM LINE:

There are MANY analysis tools. We’ve covered a few of the very simple ones. The text “Six Sigma DeMystified” is a very good reference if you want to know more. If you go further with Six Sigma, you learn much more. The key is to get to an understanding of $y = f(x)$. 
IMPROVE

The GOAL of IMPROVE is to develop, test and implement process changes which move the process output to the desired goal.
Key Thoughts:

- Plan changes carefully
  - Can you document cause and effect?
  - Can you effectively collect data?
- Consider process simulations before making actual changes
  - No -> low impact
  - Explore many alternatives
IMPROVE

• Do the “does this make sense?” test
• Document, document, document
• Be there physically. Watch, monitor, ask questions. Don’t depend on the data
• Use the complete team, i.e. project team members, stake holders, Sigma support staff
• Six Sigma can focus on small increments. Also consider the major change
• Discuss what we would do with the Wonder Bit process.

• Make whatever assumptions necessary to support your suggestion.

• We don’t have much data, but what does our data suggest.
Improve - Critical Tasks

• Yes - do quick hits if they are obvious and easy - document them.
• Be creative, push your assumption.
• Focus on VOB and VOC.
• LISTEN TO and USE the team.
• Think FMEA:
  - What am I fixing?
  - What new problems am I introducing?
• Prove your plan: simulate, optimize, test, validate.
• Be Critical:
  - Have I been true to the Project Charter
  - Do the work, but don’t be pedantic
  - Is this really the best result
  - At the end of the day, does it all make sense
CONTROL

Make sure what you have done will stay done

• Measurement and performance tracking
• If you really understand the process, you should have some predictive measures \( y = f(x) \) and assignable cause
• Good simple dashboards
• Go back and audit after 4-6 months
Control - Critical Tasks

- Develop the Control Plan. Use the team, they must own it.
- Clearly document what was done.
- Clearly outline the new process and what must be done to maintain.
- Be aware of Change Management Issues, who wins, who loses. Don’t leave any “infections” you will live to regret.
- Be Critical:
  - Have I left metrics that make it clear what the process is doing
  - Has the process been “Lean” processed
  - Do I have ALL the data.
  - Look for opportunities to reward and celebrate
SUMMARY

• Six Sigma is a structured, disciplined approach to problem solving.
• It has proven to be very successful, when applied correctly.
• The tools are not new. Time will tell if this approach has staying power. It is 20 years old now.
• While the overall program is a “corporate way of life”, the approach and technique is useful at an individual level \( y = f(x) \)
WHERE DO YOU GO FROM HERE?

• A “Yellow Belt” equips you to participate in Six Sigma projects and understand the first principles.

• If you have greater interest, look into a Green Belt, which provide a much more in-depth understanding of the tools. On-line or classroom alternatives exist.

• A Black Belt is only appropriate if you are going to be able to use it somewhere. Costs can be very high, and the use can be very company specific.

• No matter what, the concept of managing by fact and insisting on understanding $y = f(x)$ is not a bad thing.
YELLOW BELT LEARNING OBJECTIVES

• Understand the benefits and implications of the Six Sigma methodology and its significance in the business environment
• Be able to communicate and understand Six Sigma language and terms
• Use the Six Sigma rating to evaluate the capability of a process or organization
• Understand the use and critical factors within the DMAIC process
• Recognize organizational critical success factors in implementing and maintaining a Six Sigma implementation
• Understand and apply basic Six Sigma tools such as process flow charting, value stream mapping, SIPOC, Pareto Chart, Histogram, Trend Chart, Fishbone Diagram, 5 Whys, FMEA, and others.
• Learning Objectives comparable to ASQ specifications.
• This class is designed to understand the process, not to make you proficient in the use of the myriad tools available.
AVR Six Sigma Training Offerings

- Six Sigma Yellow Belt
- Lean Six Sigma Green Belt
- On Line Green Belt Class
- Failure Proofing Projects

CHECK OUR WEBSITE, www.avrassociates.com, for more information

- Custom training or consulting can be negotiated.
Dave Dirks, PMP - MBB
Principal, AVR Associates, Ltd.
davedirks45@gmail.com
303-520-3342

Hal Lunka, PMP, MSME, SSGB
Principal, AVR Associates, Ltd.
lunka214@msn.com
303-748-3788

www.avrassociates.com