NORTHROP GRUMMAN DEFINING THE FUTURE

Mission Systems

Experiences with Leveraging Six Sigma to Implement CMMI Levels 4 and 5

CMMI Technology Conference and User Group

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Northrop Grumman

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What is the Essence of Level 4?

- **In our last Peer Review, we:**
  - Reviewed 40 SLOC / Review Hour
    - Others have been able to review >100 SLOC/hour
  - Found 15 defects with 1½ hours of prep time and 4 reviewers
  - Reviewed 75 SLOC

As a manager, do I make any changes???

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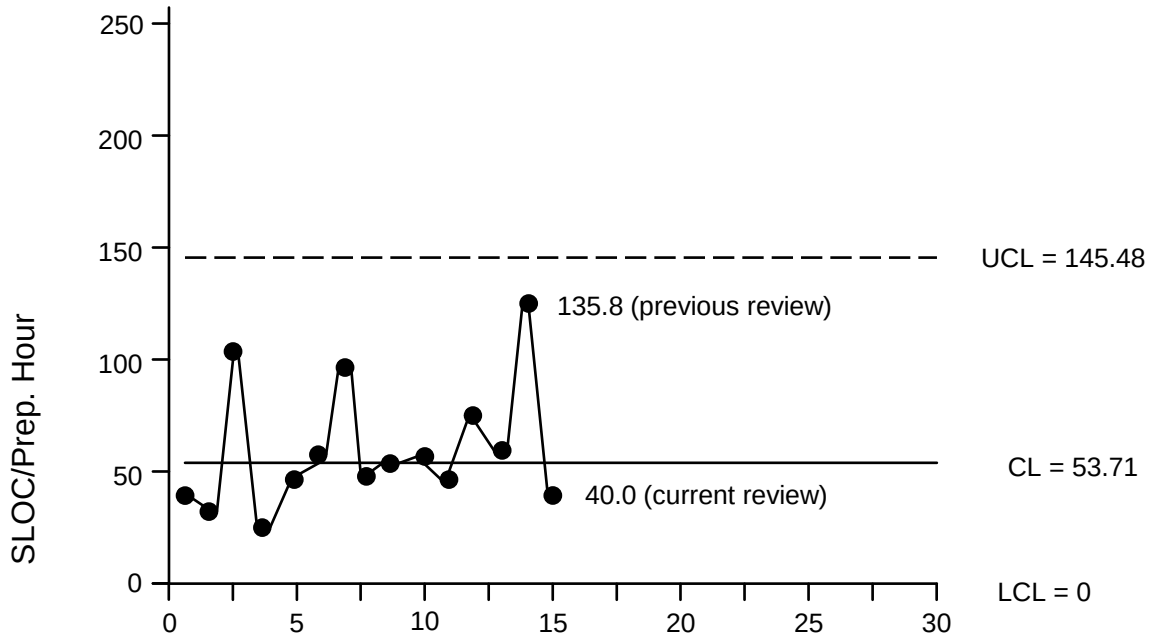
What is the Essence of Level 4?



- 71% reduction in # of SLOC reviewed per prep hour
- Average # of SLOC reviewed / hour is about 54
- Run of data from previous 15 reviews
- Control chart with control limits
  - This is Level 4 knowledge!

As a manager, do I make any changes <u>yet</u>???

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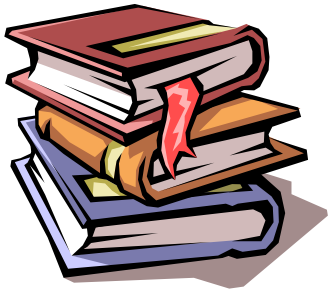
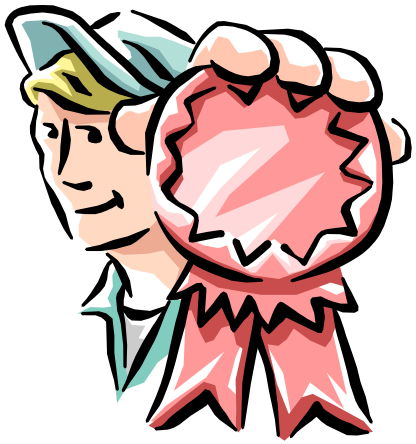
What Kind of Skills are Needed?

- **To accomplish Levels 4 and 5, you must be capable of:**
  - Statistical thinking
  - Analyzing causes
  - Process thinking
  - Focusing on what is important to the customer
  - Understanding “capability”
  - Affecting improvement





These skills are essential for successfully implementing Levels 4 and 5

Six Sigma provides the foundation for how to solve relevant problems!!

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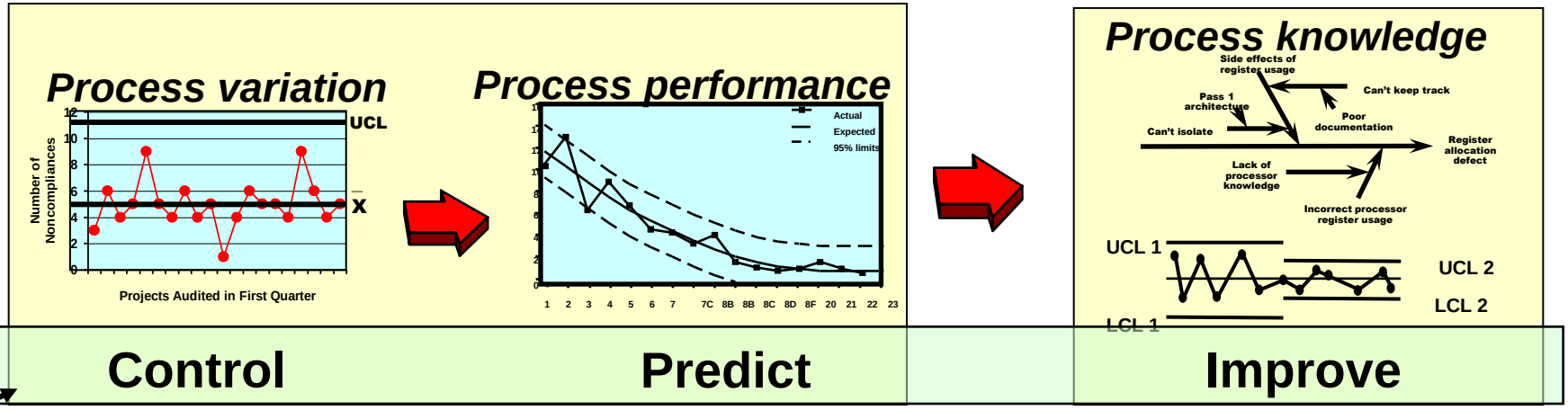
CMMI Levels 4 and 5 (Required Skills)

ESSENCE OF LEVELS 4 AND 5:



Level 4

1) Project's **process capabilities** based on process performance baselines

2) **Control process variation** (removing "assignable causes")

3) **Predict results** using process performance models

4) **Manage** to achieve **goals**

Level 5

1) **Improvement** goals based on future business needs

2) **Eliminate problem and defect causes** ("common causes")

3) Select, predict, and measure improvements to **change the process performance** baselines

   - Shift the mean; tighten the variance

4) **Manage change**

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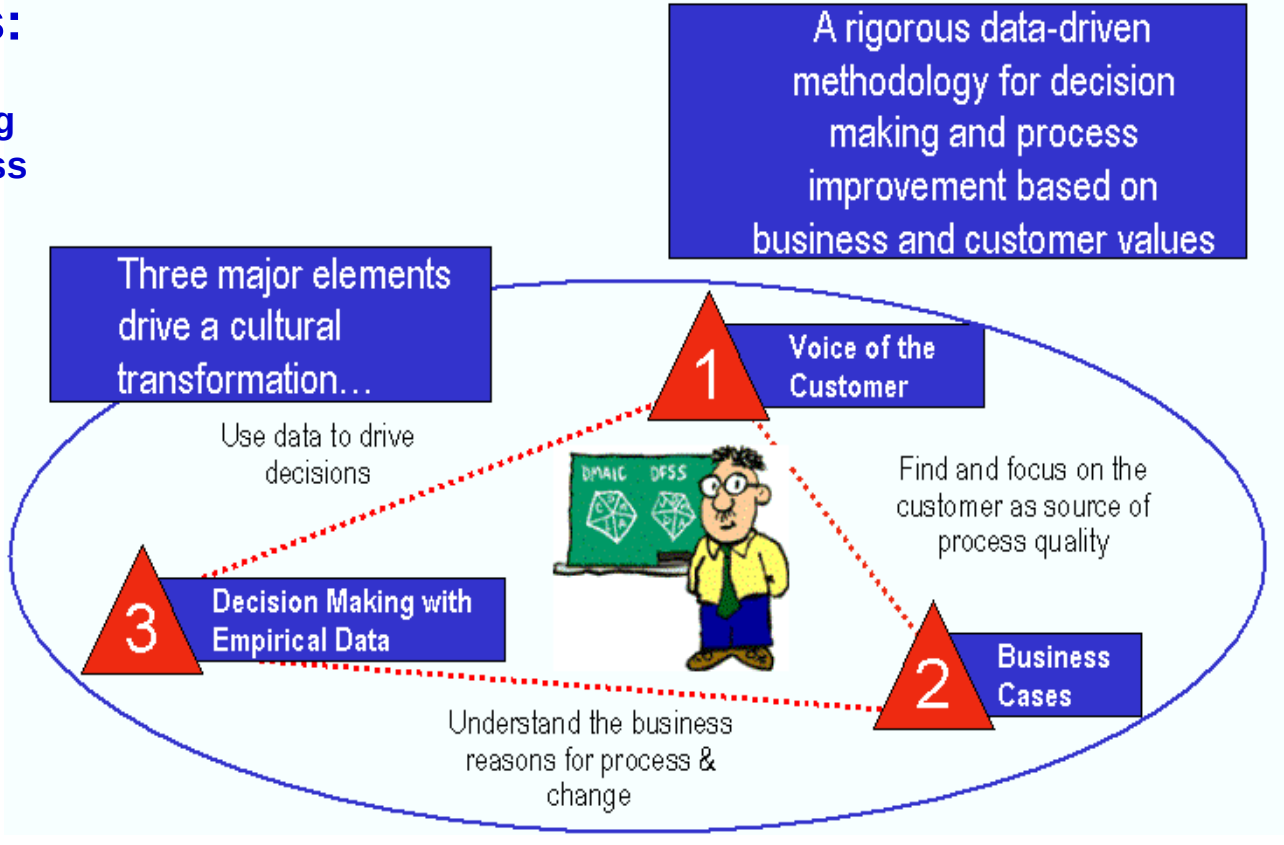
What is Six Sigma??

Six Sigma: A best-in-class change strategy for accelerating improvements in processes, products, and services

What Six Sigma is:

- → Method/tools
- → Mindset/way of thinking
- → A way of doing business



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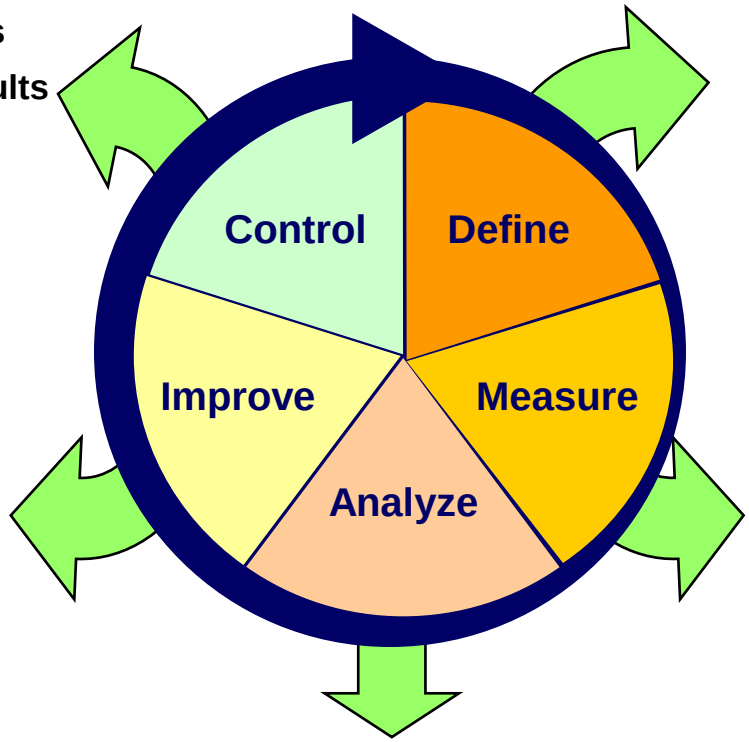
6σ DMAIC Process

- ☐ Institutionalize Improvement
- ☐ Control Deployment
- ☐ Quantify Financial Results
- ☐ Present Final Project Results and Lessons Learned
- ☐ Close Project

- ☐ Develop Charter and Business Case
- Map Existing Process
- ☐ Collect Voice of the Customer
- ☐ Specify CTQs / Requirements



- ☐ Select Solution (Including Trade Studies, Cost/Benefit Analysis)
- ☐ Design Solution
- ☐ Pilot Solution
- ☐ Implement Solution

- ☐ Measure CTQs / Requirements
- ☐ Determine Process Stability
- ☐ Determine Process Capability
- ☐ Calculate Baseline Sigma
- ☐ Refine Problem Statement

- ☐ Identify Root Causes
- ☐ Quantify Root Causes
- ☐ Verify Root Causes

DMAIC = Define, Measure, Analyze, Improve and Control

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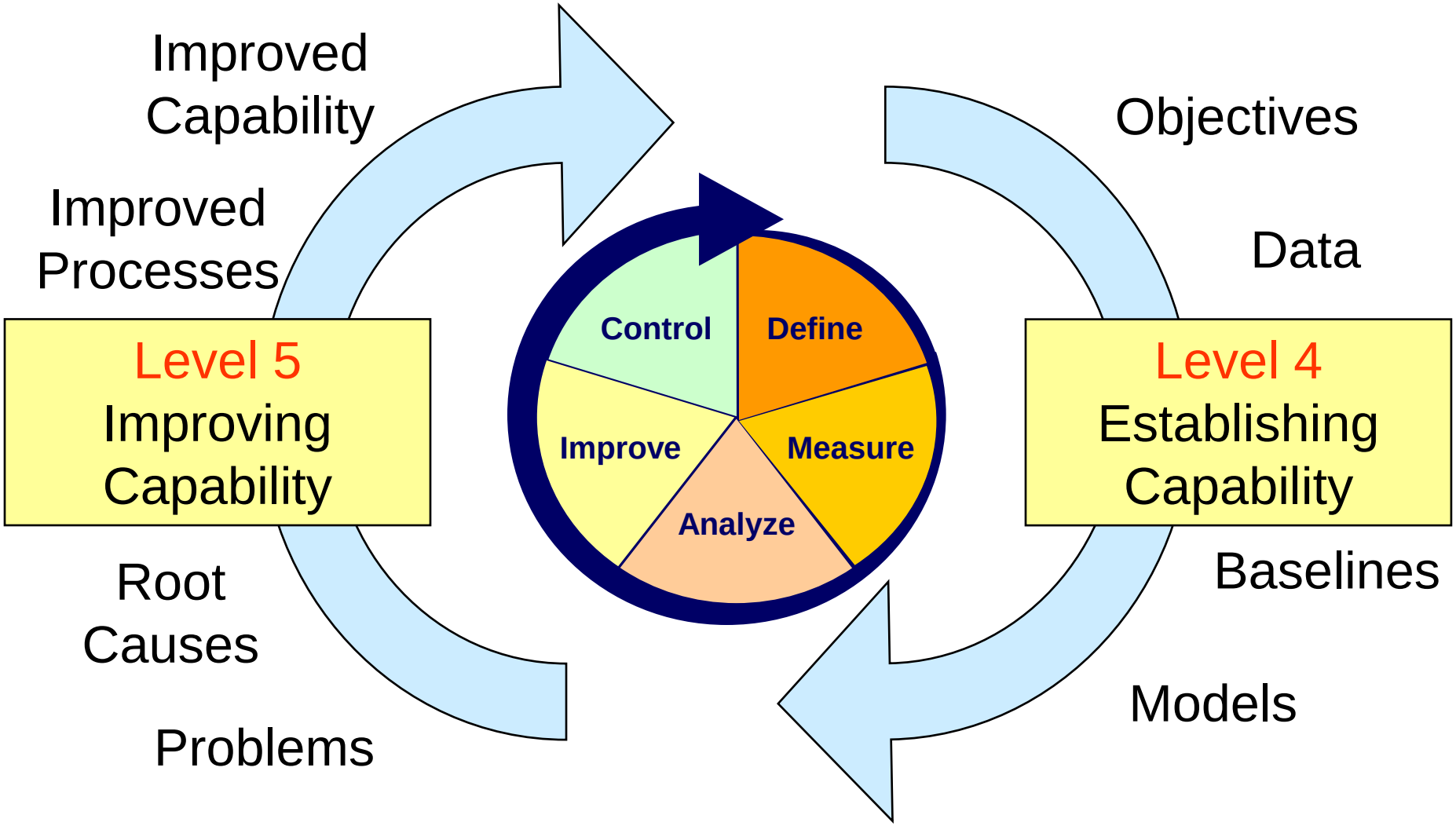
Aligning the 6σ DMAIC Process with the CMMI



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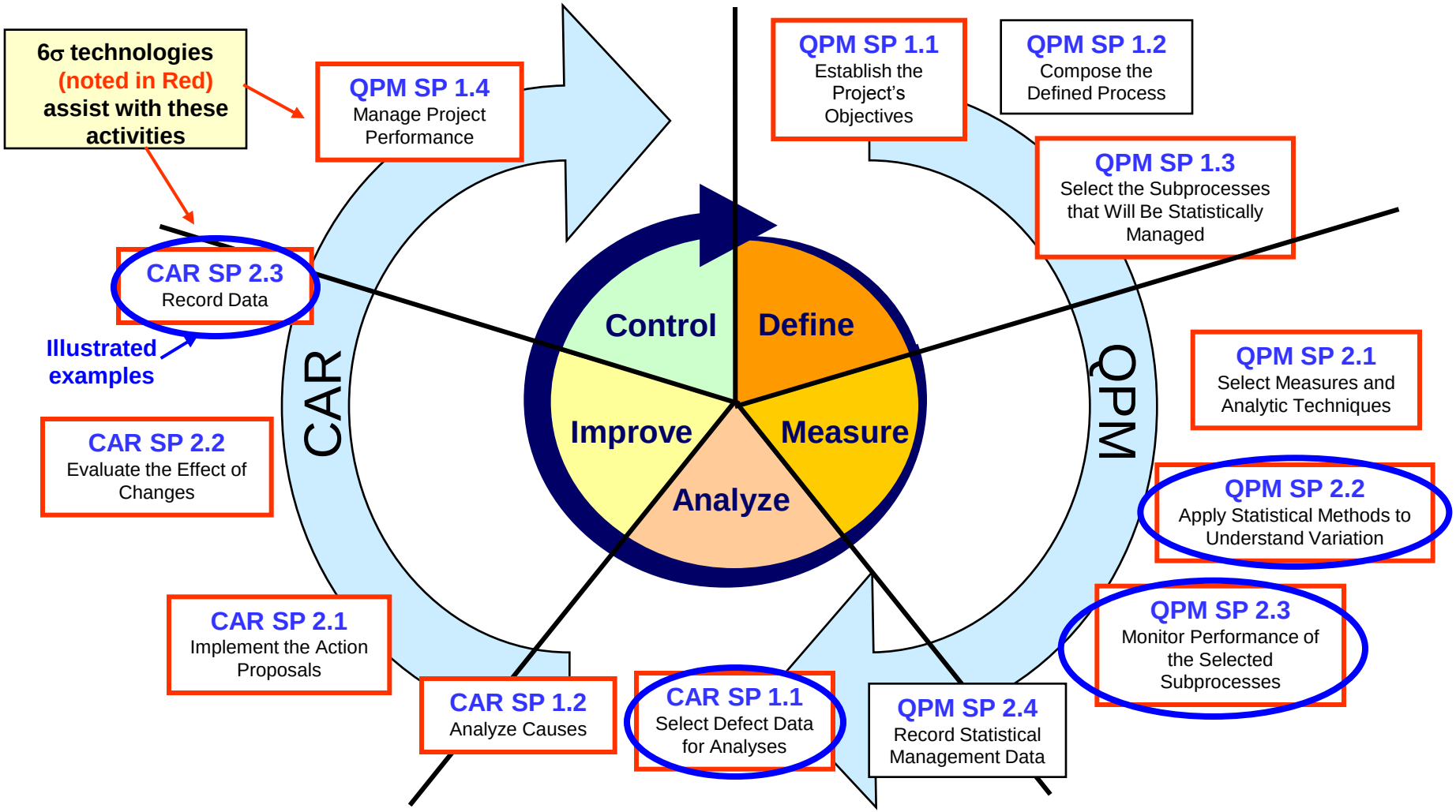
Aligning the 6σ DMAIC Process with CMMI Practices for the Project



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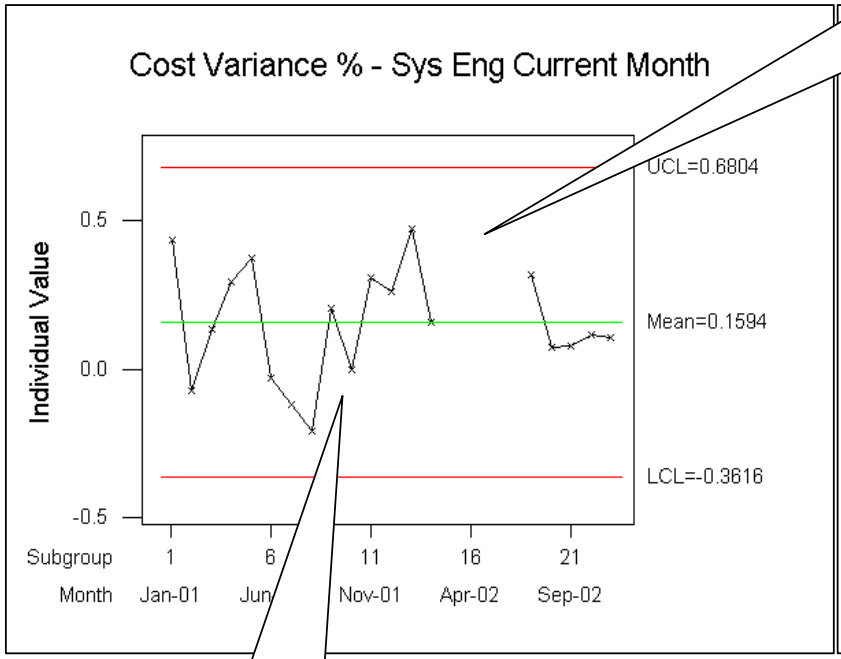
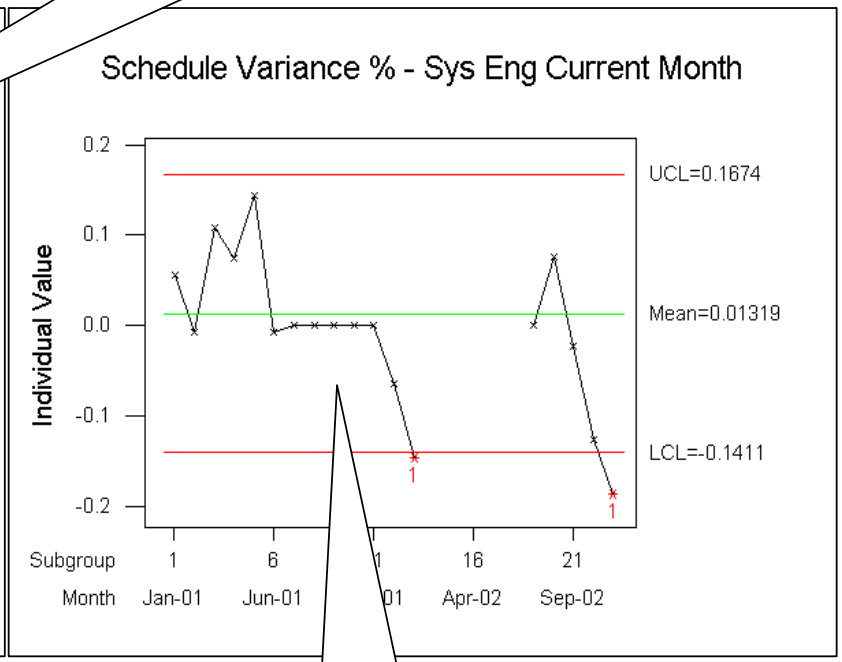
Special Cause Analysis
(QPM SP 2.2)

Project proposal periods in both charts had no assigned budgets. These gaps show where this 'special cause' data was removed as it did not represent the Sys Eng process.





Example Data

System Engineering Cost data seems to vary normally in the period under study

System Engineering Schedule data appears abnormal, and needs more 'special cause' study.

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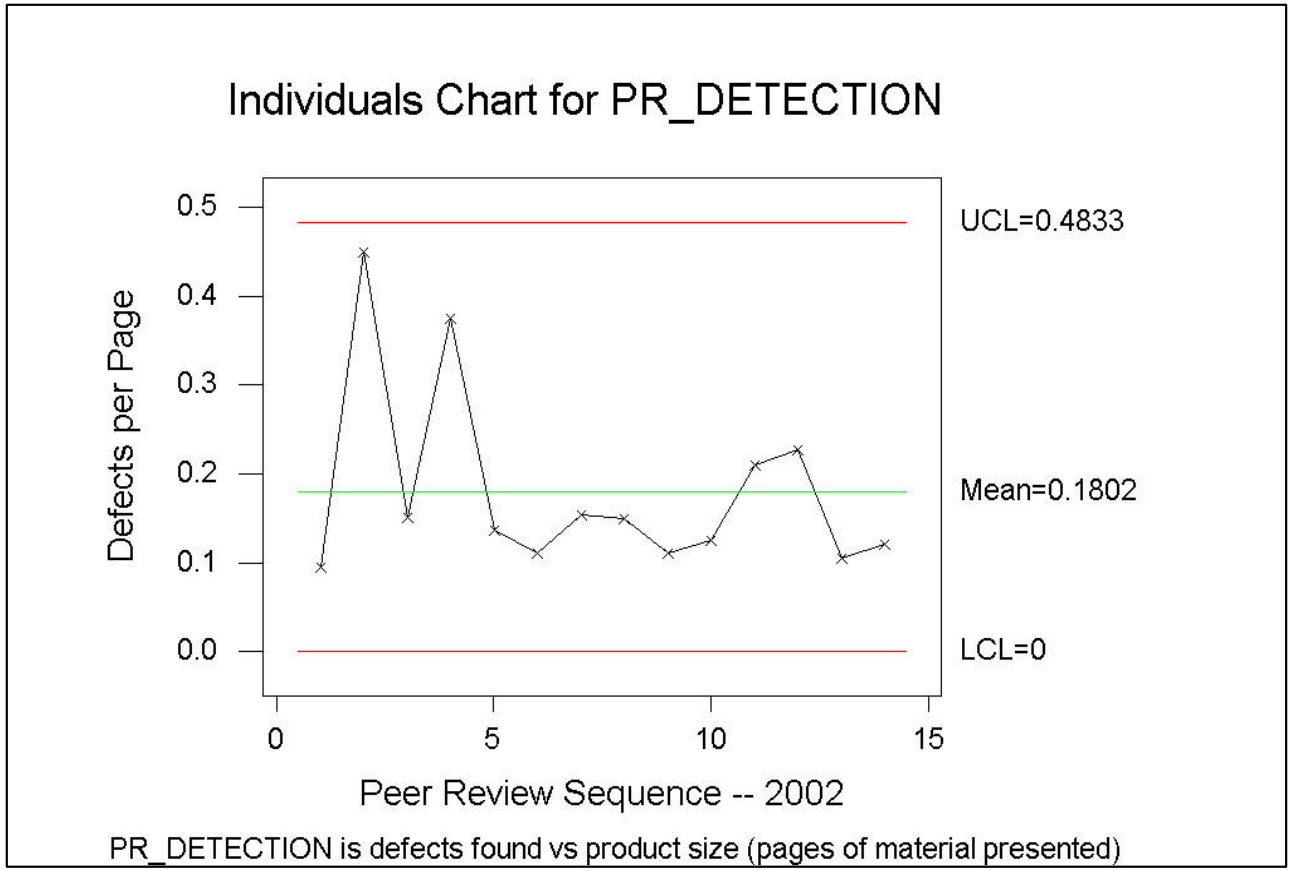
Control Charts (QPM SP 2.3)



Example Data

Tool: Minitab used across 6σ and CMMI projects

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CAR Watchlist (CAR SP 1.1)

Causal Analysis & Resolution (CAR) Watch List				SP 1.1a	SP 1.1b	SP 1.2a	SP 1.2b	SP 2.1	SP 2.2	SP 2.3	
#	Orig. Date	Title	Disposition	Defect Data Gathered	Defect Types Selected	Causes Analyzed	Actions Proposed	Actions Implemented	Effects Evaluated	Final Results Submitted	Comments
1	1/10/03	Reliability	Closed	✓	✓	✓	✓	✓	✓	✓	6 σ project done.
2	3/14/03	Test Planning	Closed	✓	✓	✓	✓	✓	✓	✓	6 σ project done.
3	2/18/03	Late CDRL Delivery	Open	✓	✓	✓	✓	✓			Collecting data from improved delivery process.
4	8/24/03	SRS Requirements in Test Procedures	Open	✓							Just starting

Example Data

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CAR Worksheet (CAR SP 2.3)

Causal Analysis & Resolution (CAR) Worksheet	
CAR IDENTIFICATION	
CAR Problem Short Title	SPR Defects
CAR Problem Description	Quantity of SPRs prevents working off enough SPRs before scheduled CM turnover
Point of Contact/Project	Project Manager
WORK STEPS	**EVIDENCE**
SP 1.1a: Gather relevant problem data	SPR Defect_Type field data
SP 1.1b: Determine which defects and other problems will be analyzed (pareto chart)	Pareto chart showing distribution of SPR defect types counted so far, and showing "programming language misuse" caused the majority of SPRs
SP 1.2a: Analyze causes (Fishbone…)	Fishbone Diagram for "programming language misuse", showing Training caused most of the costly SPRs
SP 1.2b: Propose actions addressing root causes	• Procure advanced PL training • Increase mentoring by SPMs • Institute code inspections
SP 2.1: Implement action proposal(s)	Training bought from Abs SW Corp. 3/12/03
SP 2.2: Evaluate effect of changes	Proportion of SPRs which are "programming language misuse" decreases 39% to 19% (4/12/03)
SP 2.3: Submit final results	Data sent to organization
CAR STATISTICS	
Actual Hours Spent	1300 hours

Example Data

- **CAR briefing template accompanies this CAR worksheet**
- **Can be used in lieu of a Six Sigma tollgate briefing for CAR status**
- **Organized by CAR specific practices**

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Six Sigma Training

- **Excerpts from standard Green Belt Six Sigma training:**
  - Business Case development
  - Voice of the Customer (Critical to Quality items)
  - Basic Statistics and Sampling
    - Data distributions
    - Representative samples
  - Patterns in Data – Variation
    - Special vs common causes
    - Stratification of data
    - Run charts, control charts
  - Organizing Causes
  - Hypothesis Testing / Regression Analysis

Use of statistical analysis tools are included throughout this training!

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Using the Six Sigma Fundamentals

- **The fundamentals of Six Sigma can be used without running a "formal" Six Sigma project**
  - Statistical analysis and control of Level 3 data
    - Capability
    - Statistical control
    - Regression
  - Improvement in "capability" can be identified
  - Root cause analysis techniques can be applied
    - Regression
    - Fishbone diagrams
    - Pareto analysis
    - Affinity diagrams

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The Bottom Line

- **Northrop Grumman was able to accelerate achievement of Levels 4 and 5 using Six Sigma**
- **Six Sigma training was essential to changing the culture of process improvement**
  - Six Sigma methodology was institutionalized
- **5 months after achieving their Level 3 rating, Northrop Grumman achieved their Level 4 rating**
- **4 months after achieving their Level 4 rating, Northrop Grumman achieved their Level 5 rating**

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Six Sigma for the Organizational Process Areas

- **Organizational Process Areas**
  - Level 4: Organizational Process Performance (OPP)
  - Level 5: Organizational Innovation and Deployment (OID)
- **The same Six Sigma methodology was used by Northrop Grumman for the OPP and OID process areas**

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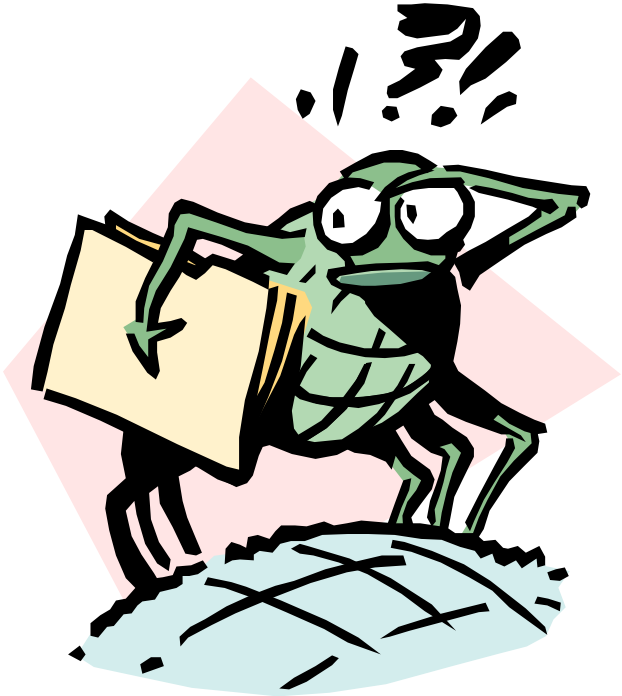
Questions?