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Shaping your Processes for Competitive Advantage

Integrating Lean, Six Sigma, and CMMI

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Agenda

- Problem Statement
- A Little History
- Popular Approaches
- Comparison of Approaches
- Summary

Problem

- Adoption of Six Sigma and Lean is increasing among organizations that already employ CMMI-based software process improvement.
- These approaches are superficially different:
  - Language and terminology
  - Consultants and training
  - Sponsoring professional societies
- Are these approaches incompatible?

Solution

- Six Sigma, Lean, and CMMI are approaches to Continuous Improvement that can be integrated in ways that yield synergy rather than interference.
- These approaches derive from the same historical roots and address the same objective -
  - Efficient production of products of exceptionally high quality
- Focusing on the principles rather than the techniques and terminology helps to understand the relationships

A Little History

- Concern for Continuous Improvement is not new and won't go away:

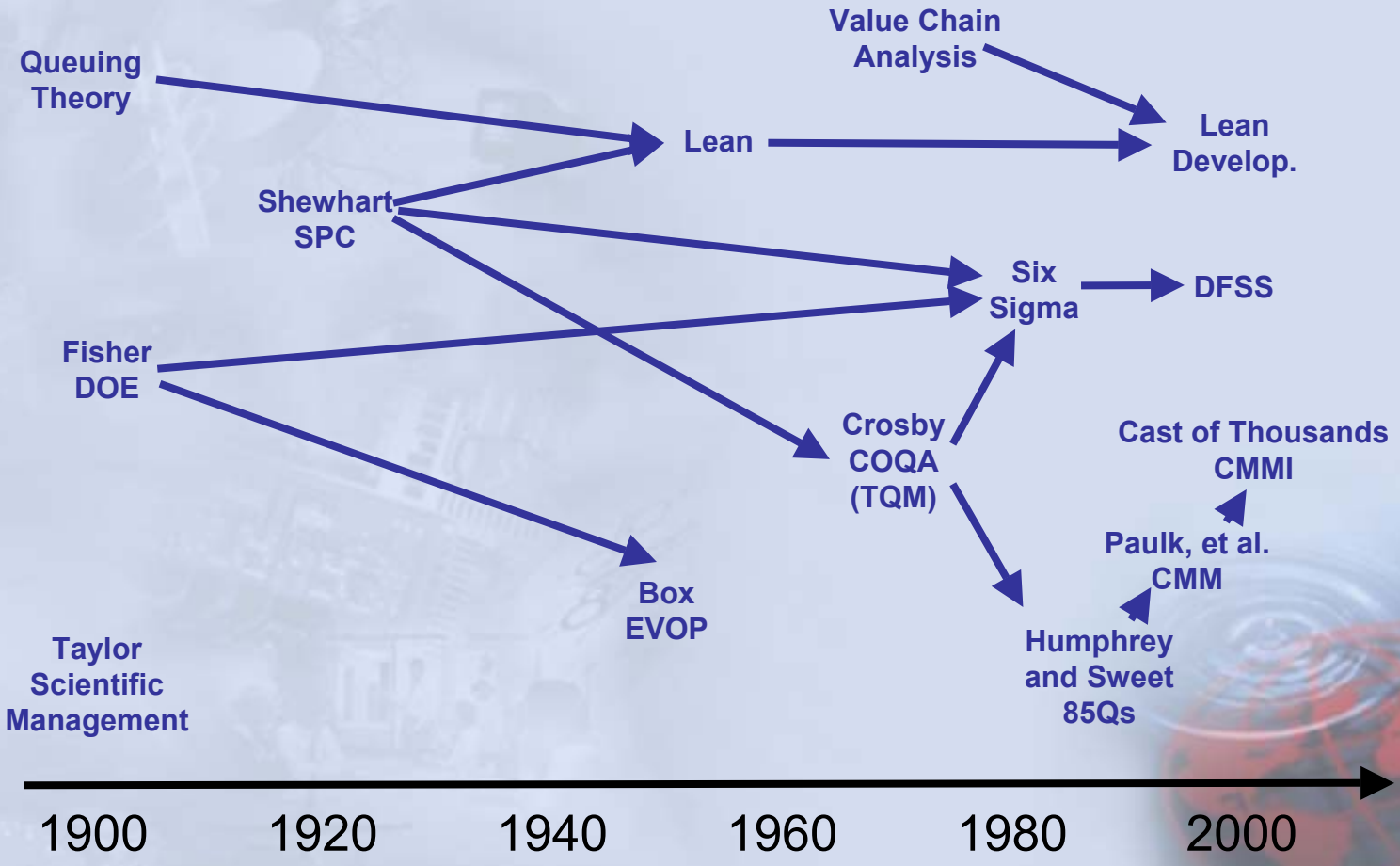
"If someone gave me eight hours to chop down a tree, I would spend six hours sharpening the axe."

Abraham Lincoln

"The difference between previous total quality approaches and the Six Sigma concept was a matter of focus."

Mikel Harry

Some Historical Influences



What are These Approaches?

- CMMI – a framework for managing processes and integrating activities across an organization
- Lean – a set of principles for efficient and effective processes
- Six Sigma – a problem-solving approach that addresses specific improvement needs through improvement projects

Common Themes

- Focus on eliminating defects and rework
- Reliance on measurement and statistical methods
- Emphasis on understanding and reducing variability
- Adaptation necessary to transition approaches beyond manufacturing
- Trend towards over-simplification and “window dressing” with popularization

What's the CMMI?

- An adaptation and extension of Crosby's QMMG to systems and software development
- A synthetic benchmark of generic practices
- A framework for evaluation and comparison of engineering processes

Quality Management Maturity Grid

Typical Manufacturer

QUALITY MANAGEMENT MATURITY GRID

Rater _____ Unit _____

Measurement Categories	Stage I: Uncertainty	Stage II: Awakening	Stage III: Enlightenment	Stage IV: Wisdom	Stage V: Certainty
Management understanding and attitude	No comprehension of quality as a management tool. Tend to blame quality department for "quality problems."	Recognizing that quality management may be of value but not willing to provide money or time to make it all happen.	While going through quality improvement program learn more about quality management; becoming supportive and helpful.	Participating. Understand absolutes of quality management. Recognize their personal role in continuing emphasis.	Consider quality management an essential part of company system.
Quality organization status	Quality is hidden in manufacturing or engineering departments. Inspection probably not part of organization. Emphasis on appraisal and sorting.	A stronger quality leader is appointed but main emphasis is still on appraisal and moving the product. Still part of manufacturing or other.	Quality department reports to top management, all appraisal is incorporated and manager has role in management of company.	Quality manager is an officer of company; effective status reporting and preventive action. Involved with consumer affairs and special assignments.	Quality manager on board of directors. Prevention is main concern. Quality is a thought leader.
Problem handling	Problems are fought as they occur; no resolution; inadequate definition; lots of yelling and accusations.	Teams are set up to attack major problems. Long-range solutions are not solicited.	Corrective action communication established. Problems are faced openly and resolved in an orderly way.	Problems are identified early in their development. All functions are open to suggestion and improvement.	Except in the most unusual cases, problems are prevented.
Cost of quality as % of sales	Reported: unknown Actual: 20%	Reported: 3% Actual: 18%	Reported: 8% Actual: 12%	Reported: 6.5% Actual: 8%	Reported: 2.5% Actual: 2.5%
Quality improvement actions	No organized activities. No understanding of such activities.	Trying obvious "motivational" short-range efforts.	Implementation of the 14-step program with thorough understanding and establishment of each step.	Continuing the 14-step program and starting Make Certain.	Quality improvement is a normal and continued activity.
Summation of company quality posture	"We don't know why we have problems with quality."	"Is it absolutely necessary to always have problems with quality?"	"Through management commitment and quality improvement we are identifying and resolving our problems."	"Defect prevention is a routine part of our operation."	"We know why we do not have problems with quality."

Source: P. Crosby, *Quality is Free*, 1979

Focus of CMMI Levels

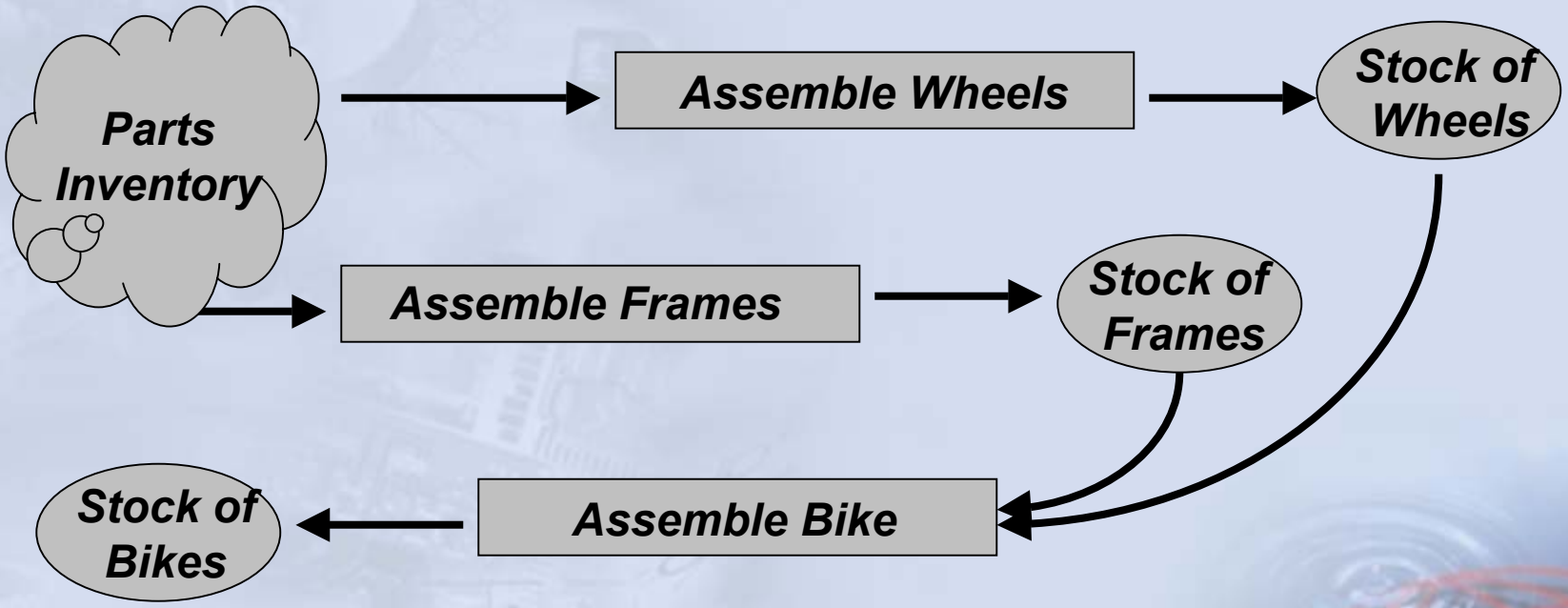
- Levels 2 and 3 address the definition of engineering and management processes
  - Organizational Process Definition
  - Organizational Process Focus
  - Others defining specific disciplines
- Levels 4 and 5 address the control and improvement of those processes
  - Organizational Process Performance (OPP)
  - Quantitative Project Management (QPM)
  - Causal Analysis and Resolution (CAR)
  - Organizational Innovation and Deployment (OID)

QM

What is Lean?

- It is not about “light weight” processes
- “Lean” refers to reducing inventory and “work in progress”
- Lean is accomplished through robust processes
  - Simple
  - Reliable
  - Standardized
  - Enforced
- Based on principles from queuing theory

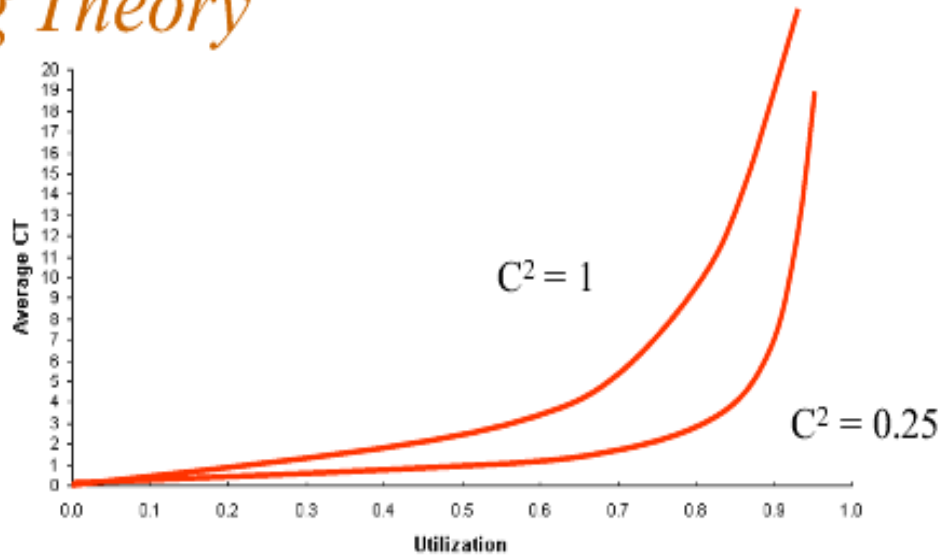
Example Manufacturing Process



Inventory and Work in Progress Enable Inefficient and Unreliable Processes!

Limits to Performance

Queuing Theory



Capacity Utilization and Variability

Variability

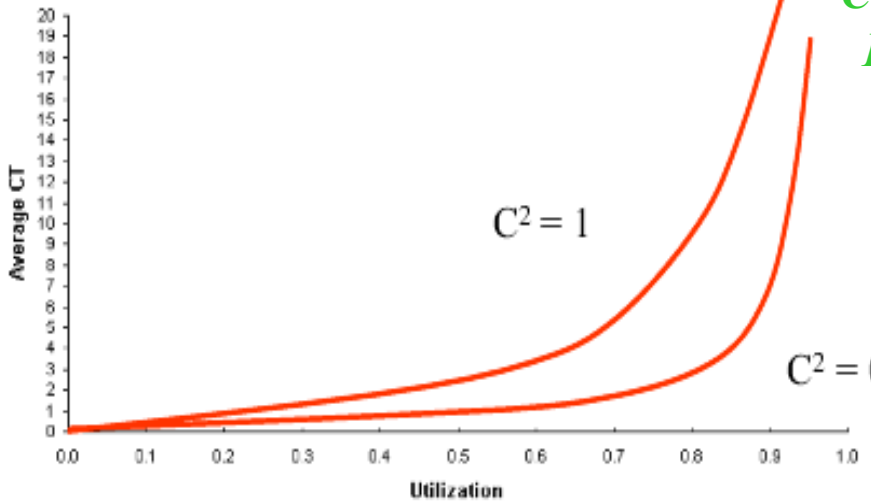
Capacity Utilization

$$CT_q = \left(\frac{Ca^2 + Ce^2}{2}\right)\left(\frac{u}{1-u}\right)te$$

High levels of variability further exacerbates the effects of capacity utilization

Limits to Performance

Queuing Theory



Continuous Improvement Increases Capacity and Reduces Variability

Capacity Utilization and Variability

Variability

Capacity Utilization

$$CT_q = \left(\frac{C_a^2 + C_e^2}{2}\right)\left(\frac{u}{1-u}\right)t_e$$

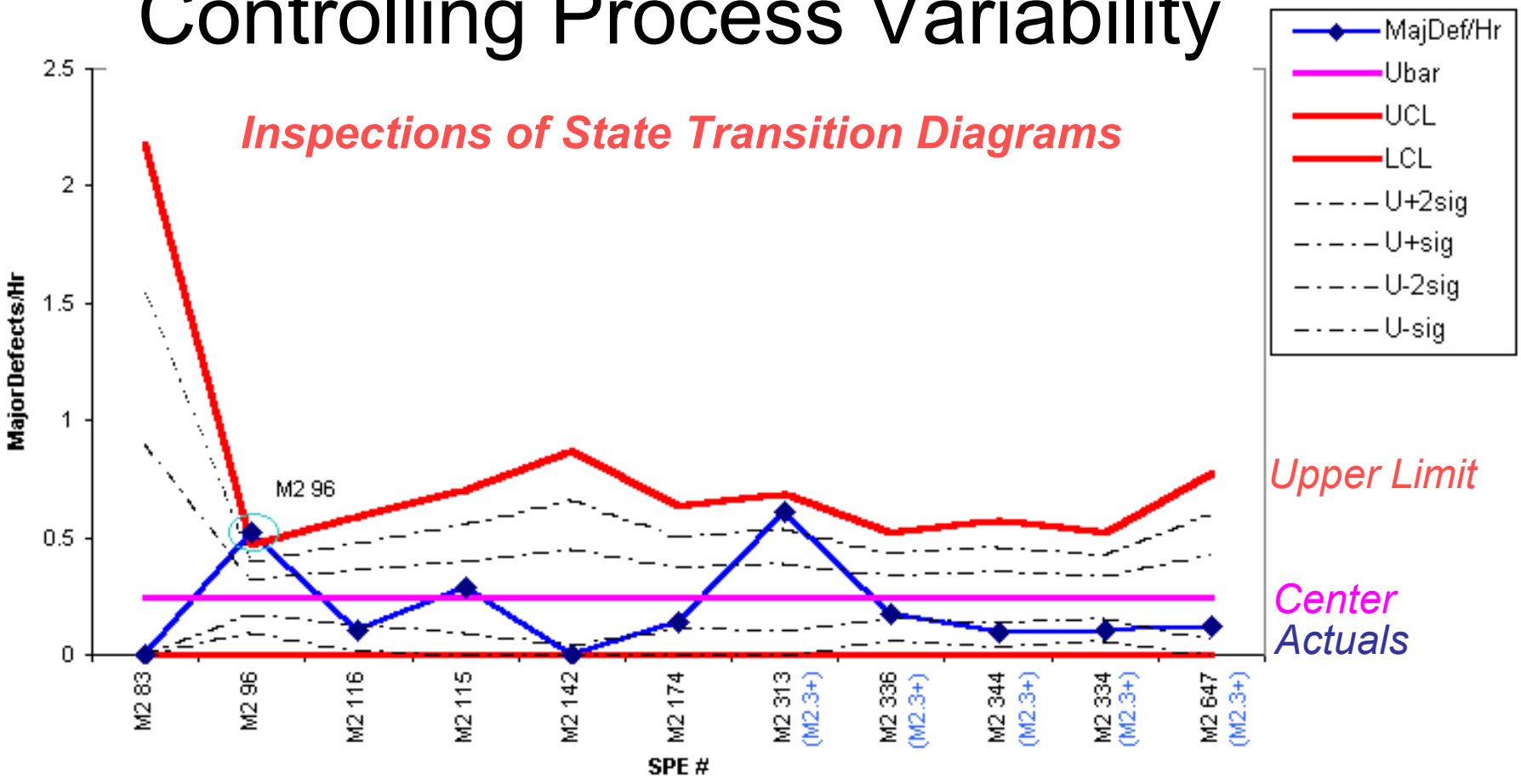
High levels of variability further exacerbates the effects of capacity utilization

From P. Middleton, Lean Product Development, 2005

Reducing Work in Progress

- Small work packages
- Robust processes
- Capacity management
- Variability reduction
  - Tasks
  - Processes
- Minimal
  - Stockpiling/Waiting
  - Handoffs
  - *External* QA
- No redundant tasks

Controlling Process Variability



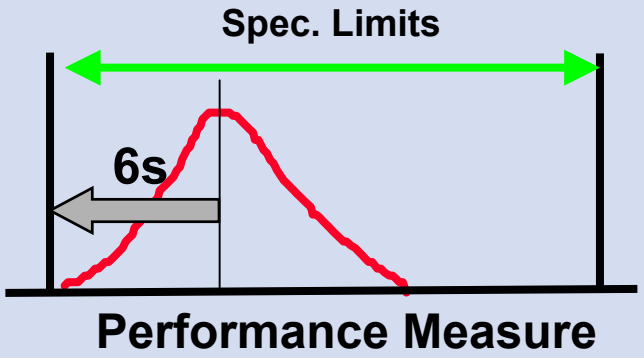
From D.Card, Controlling the Object-Oriented Design Process, *CNRC Conference on Quality Assurance of Object-Oriented Software*, February 2000

The Capacity Myth

- Most engineering organizations behave as if their system/software development capacity is elastic
  - Capacity expands to accommodate the need
  - Projects are planned in isolation
- Systems have limits to performance
  - Must understand the limits in order to optimize performance
  - Organizational performance must be managed

What is Six Sigma?

- An attractive slogan
- A business-focused philosophy employing statistical thinking to obtain competitive advantage



- A goal for process capability (C_{pk} = 2.0)
- An integrated set of established techniques including statistical process control, design of experiments, quality function deployment, failure modes effects analysis, etc.

Components of Six Sigma

- Business case for improvement
- Measurement
- Breakthrough strategy
- Benchmarking
- Statistical methods
- Formal training
- Universal metric (DPMO)
- Design for Six Sigma (DFSS)

Many variations – no governing authority.

Business Case for Improvement

Reductions in the cost of quality exceed the cost of judicious investments in defect prevention

THE COST OF QUALITY		
SIGMA LEVEL	DEFECTS PER MILLION OPPORTUNITIES	COST OF QUALITY
2	308,537 *(Noncompetitive companies)*	Not applicable
3	66,807 Software L 1	25 – 40% of sales
4	6,210 *(Industry average)* Manufacturing	15 – 25% of sales
5	233	5 – 15% of sales
6	3.4 *(World class)*	< 1% of sales
Each sigma shift provides a 10 percent net income improvement.		

Source: M. Harry and W. Schroeder, *Six Sigma*, 2002

Breakthrough Strategy

A strategy for applying statistical and other techniques

THE SIX SIGMA ROAD MAP

BREAKTHROUGH STRATEGY	STAGE	BREAKTHROUGH STRATEGY PHASE	OBJECTIVE	BLACK BELT PROJECTS
	Identification	Recognize Define	Identify key business issues	
	Characterization	Measure Analyze	Understand current performance levels	
	Optimization	Improve Control	Achieve breakthrough improvement	
	Institutionalization	Standardize Integrate	Transform how day-to-day business is conducted	

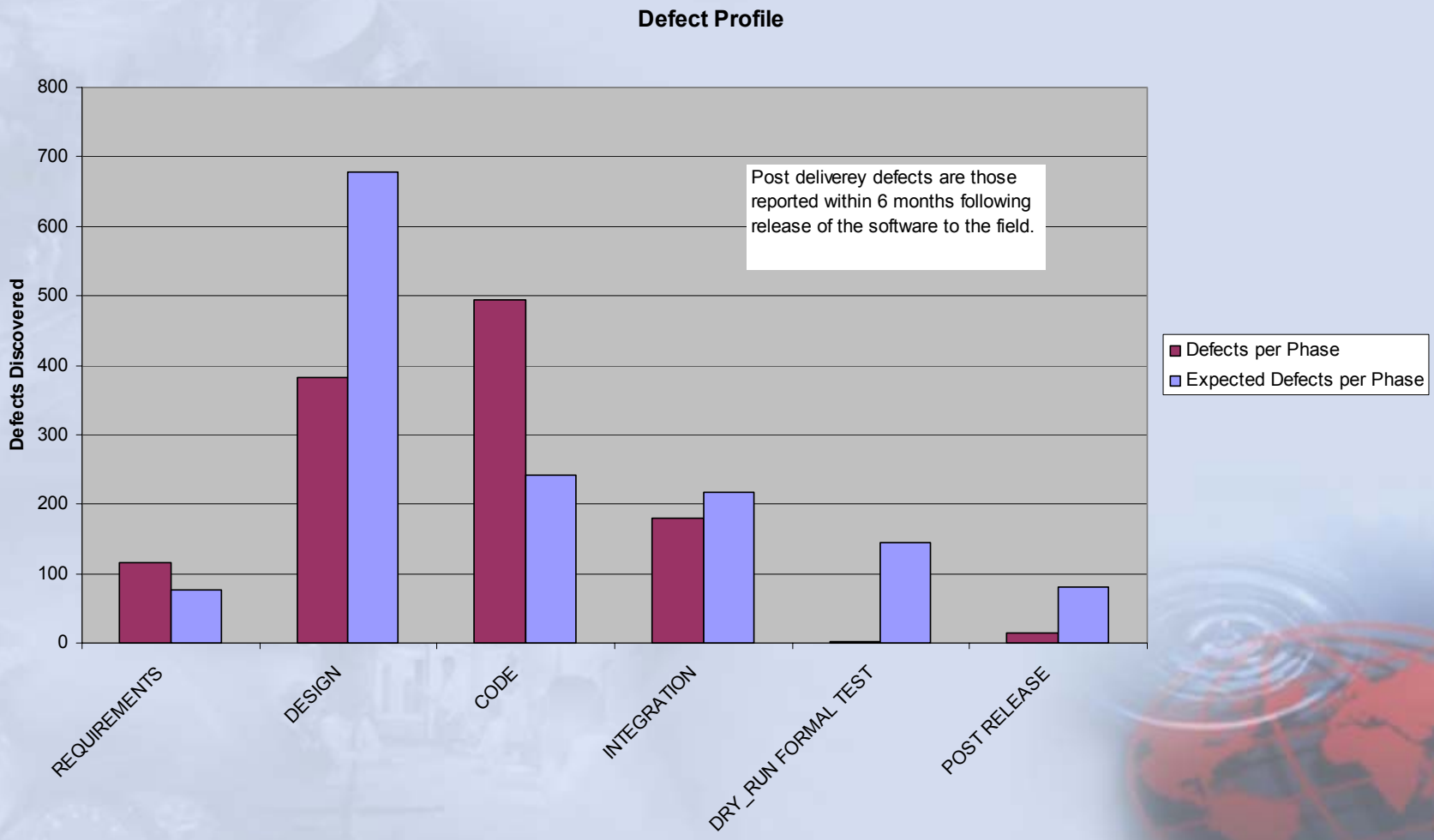
Improvement Projects (DMAIC)

Source: M. Harry and W. Schroeder, Six Sigma, 2002

Design for Six Sigma

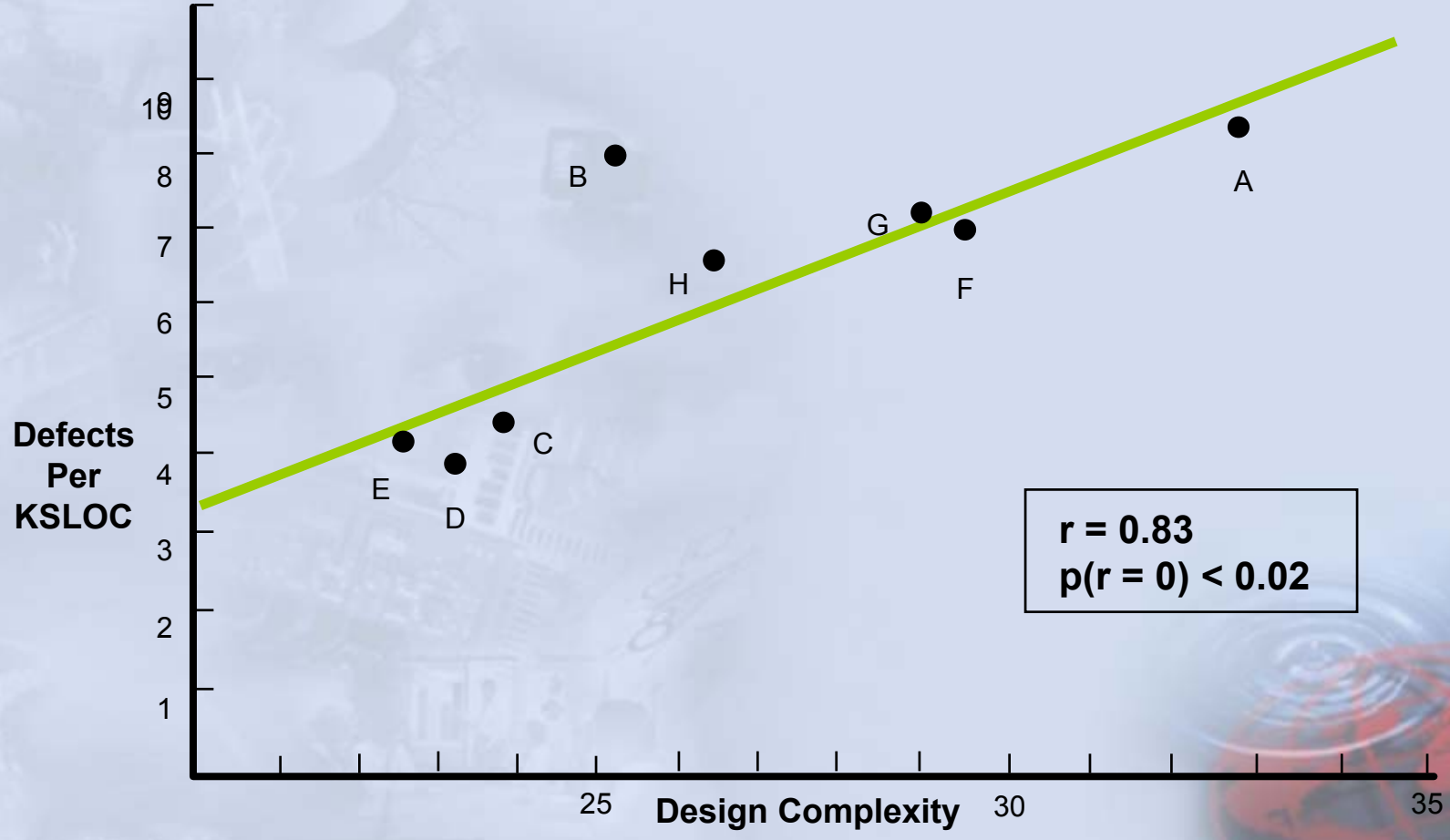
- DFSS includes both a process and product design component, *but is not a design method*
- Two basic strategies are employed:
  - Use standardized and proven parts in product (i.e., reuse and COTS) and processes
  - Minimize complexity in process (e.g., fewer steps) and product (i.e., increase producibility)
- Implies concurrent design of product and process (e.g., tailoring of organizational process)
- Focuses on ensuring “critical to quality” (CTQ) characteristics

Defects as a CTQ in Software



David N. Card, Managing Software Quality with Defects, *COMPSAC Proceedings*, August 2002

Producibility in Software



From D.N. Card, *Measuring Software Design Quality*, Prentice Hall, 1990

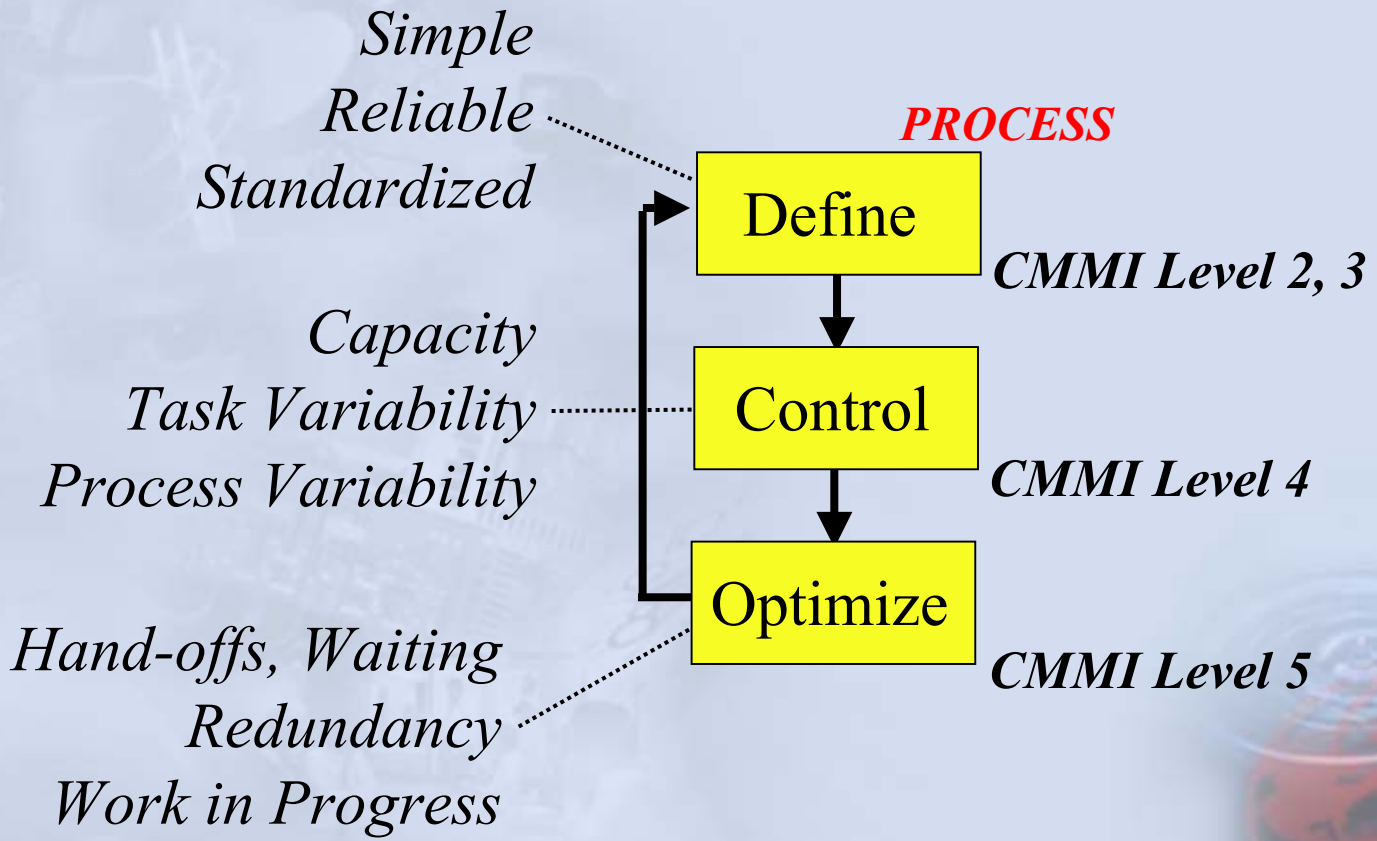
Comparison of Approaches

- High-level assessment of techniques:
  - Significant differences
  - Many similarities
  - Differences can be complementary
- Comparisons are approximate since only the CMMI has a “controlling authority”
- Principles are as important as techniques

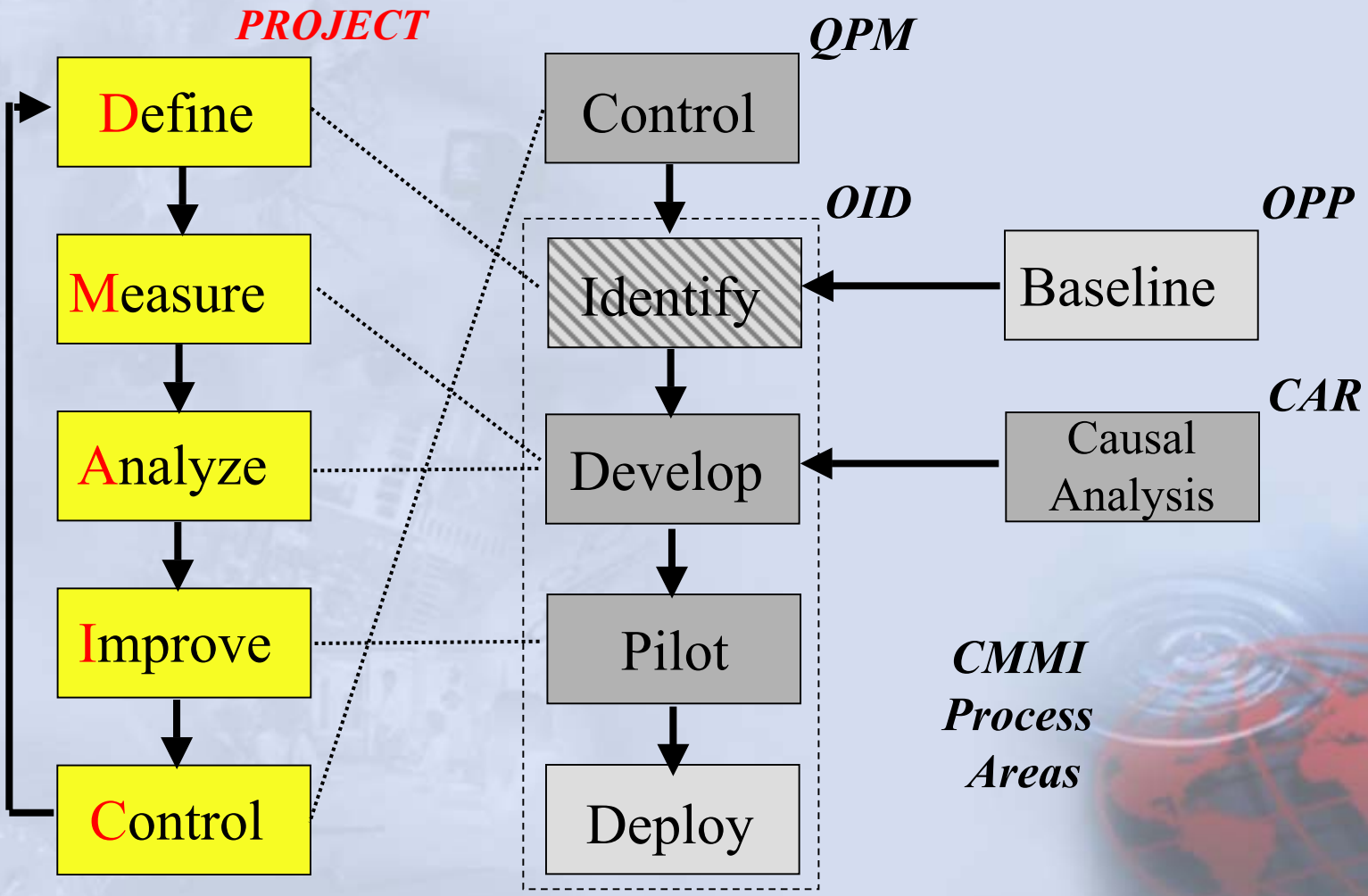
CMMI-Based Improvement

- Maturity Model provides a framework for continual benchmarking
- Assessment-driven improvement strategy based on artifacts
- Performance not directly considered; Lean and Six Sigma focus on performance

Lean Principles and CMMI



DMAIC Cycle and CMMI



Significant Differences

Six Sigma/Lean	*CMM/CMMI*
Assumes processes have been identified and defined	Focus on defining management and technical processes early
Doesn't distinguish organizational standard and project processes	Organizational process definition used to capture best practices
Emphasis on training to motivate and communicate skills	Emphasis on infrastructure to ensure key processes addressed
Reliance on statistical methods to manage performance	Statistical approach intended often not implemented
Focus on learning from internal experience and data	Additional mechanisms to leverage external technology
Prioritization of efforts based on business payoff	Link to strategic planning weak and often ignored
6s (only) certification of individual practitioners, not organizations	Certification of assessors and organizations, not practitioners

Based on: Sorting Out Six Sigma and the CMM, *IEEE Software*, May 2000

Common Problems

- Difficulty adopting statistical methods
- Excessive focus on the “score”
  - CMMI Level
  - “Sigma” rating
- Tendency to do the “minimum” – avoid the hard stuff
- Reluctance to recognize (and measure) the magnitude of software (and engineering) rework (*Typically 30-50%)

***For Example: Ray Dion, SEPG Conference, 1998**

Dimensions for Integration

- Organization
- Planning
- Training
- Tools and Techniques
- Organizational processes

Summary

- CMMI translates many Six Sigma concepts into software and systems terminology
- Six Sigma is difficult for Level 1 organizations to implement, however Lean principles do apply
- Lean, Six Sigma, and CMMI-based process improvement are complementary
- Incorporating Lean principles and Six Sigma techniques helps organizations working towards Level 4 and 5 to deliver the best business results

If you are not going ahead, then you are falling back!

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