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DEFINING THE FUTURE

Achieving the Promised Benefits of CMMI

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Background

- **Many organizations have implemented the Capability Maturity Model Integrated (CMMI)**

- **Although they have achieved their desired maturity level and improvement goals, some organizations have seen little or no financial benefits**

What are the underlying principles of CMMI as they relate to productivity, predictability, and speed?

What is the return on investment?

What are the timelines for realizing these benefits?

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Agenda

- **CMMI principles**

- **Industry data on return on investment**

- **A framework for measuring benefits**

- **Project performance benefits**

- **Organizational performance benefits**

- **Northrop Grumman experience**

- **Strategic actions needed to extract value from maturity**

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Projects Have Historically Suffered from Mistakes

People-Related Mistakes
1. Undermined motivation
2. Weak personnel
3. Uncontrolled problem employees
4. Heroics
5. Adding people to a late project
6. Noisy, crowded offices
7. Friction between developers and customers
8. Unrealistic expectations
9. Lack of effective project sponsorship
10. Lack of stakeholder buy-in
11. Lack of user input
12. Politics placed over substance
13. Wishful thinking

Process-Related Mistakes
14. Overly optimistic schedules
15. Insufficient Risk Management
16. Contractor failure Insufficient planning
17. Abandonment of planning under pressure
18. Wasted time during the fuzzy front end
19. Shortchanged upstream activities
20. Inadequate design
21. Shortchanged quality assurance
22. Insufficient management controls
23. Premature or too frequent convergence
25. Omitting necessary tasks from estimates
26. Planning to catch up later
27. Code-like-hell programming

Product-Related Mistakes
28. Requirements gold-plating
29. Feature creep
30. Developer gold-plating
31. Push me, pull me negotiation
32. Research-oriented development

Technology-Related Mistakes
33. Silver-bullet syndrome
34. Overestimated savings from new tools or methods
35. Switching tools in the middle of a project
36. Lack of automated source-code control

Standish Group, 2003 survey of 13,000 projects
- 34% successes
- 15% failures
- 51% overruns

Reference: Steve McConnell, Rapid Development

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Many Approaches to Solving the Problem

- **Which weaknesses are causing my problems?**

- **Which strengths may mitigate my problems?**

- **Which improvement investments offer the best return?**

People

Business Environment

Management Structure

Tools

Product

Methods

One solution!

**Process**

Technology
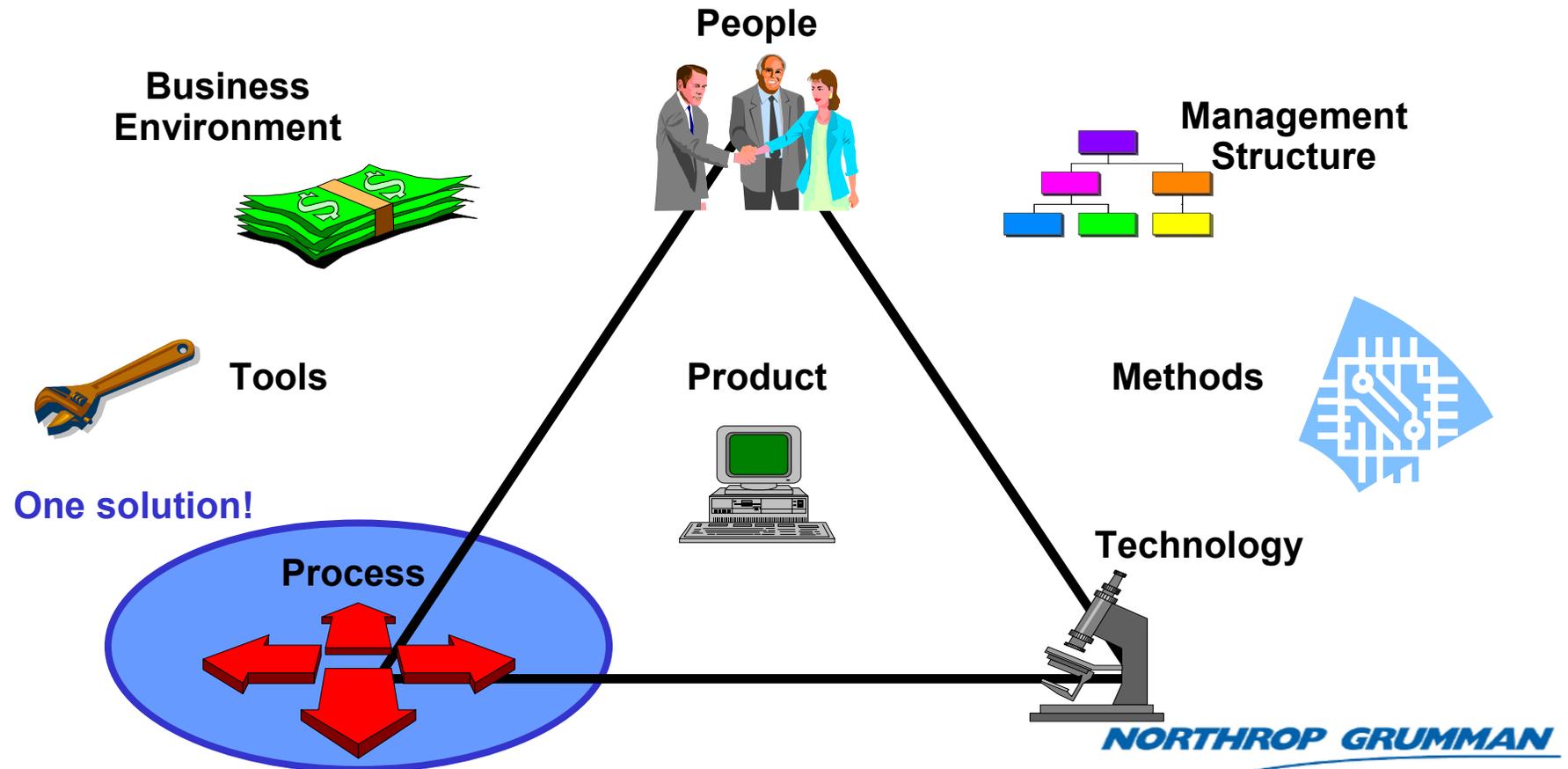
Approaches to Process Improvement

Data-Driven (e.g., Six Sigma, Lean)
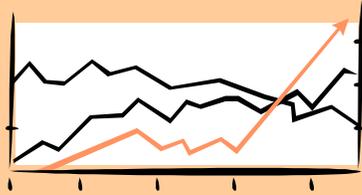
- **Clarify what your customer wants (Voice of Customer)**
  - Critical to Quality (CTQs)

- **Determine what your processes can do (Voice of Process)**
  - Statistical Process Control

- **Identify and prioritize improvement opportunities**
  - Causal analysis of data

- **Determine where your customers/competitors are going (Voice of Business)**
  - Design for Six Sigma

Model-Driven (e.g., CMM, CMMI)
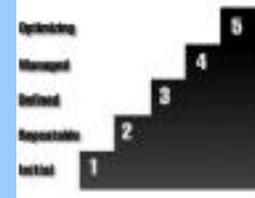
- **Determine the industry best practice**
  - Benchmarking, models

- **Compare your current practices to the model**
  - Appraisal, education

- **Identify and prioritize improvement opportunities**
  - Implementation
  - Institutionalization

- **Look for ways to optimize the processes**

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What is the CMM?

- **Capability Maturity Models are a structured set of industry best practices**
  - Based on industry research and expert consensus

- **People adopt CMMs to emulate the behavior (and hopefully, performance) of successful organizations**

- **The value of a CMM is dependent upon**
  - Understanding the new practices you are adopting
  - Adapting them to your environment
  - Staying with them long enough to see the benefits

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How Do Mature Processes Help?

- **Process maturity gets at one source of the problem, e.g.,**
  - Are we using proven industry practices?
  - Does the staff have the resources needed to execute the process?
  - Is the organization providing effective project support?

- **The main benefits typically seen are:**
  - Improved predictability of project budgets and schedules
  - Improved management awareness of problems
  - Reduced re-work, <u>which improves predictability, cost, and schedule</u>

J. Herbsleb and D. Zubrow, "Software Process Improvement: An Analysis of Assessment Data and Outcomes"
- 13 organizations
- ROI of 4:1 to 9:1
- Improved quality, error rates, time to market, productivity

R. Dion, "Process Improvement and the Corporate Balance Sheet"
- ROI of 7.7:1: Reduced re-work, improved quality
- Two-fold increase in productivity

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The Knox Cost of Quality Model

- **Extension of the Cost of Quality model used in manufacturing**

Cost	Category	Definition	Typical Costs for Software
Conformance	Appraisal	Discovering the condition of the product	Testing and associated activities, product quality audits
	Prevention	Efforts to ensure product quality	SQA administration, inspections, process improvements, metrics collection and analysis
Non-conformance	Internal failures	Quality failures detected prior to product shipment	Defect management, rework, retesting
	External failures	Quality failures detected after product shipment	Technical support, complaint investigation, defect notification

Knox's Theoretical Model for Cost of Software Quality (Digital Technical Journal, vol.5, No. 4., Fall 1993, Stephen T. Knox.)

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Knox Model – Theoretical Benefits
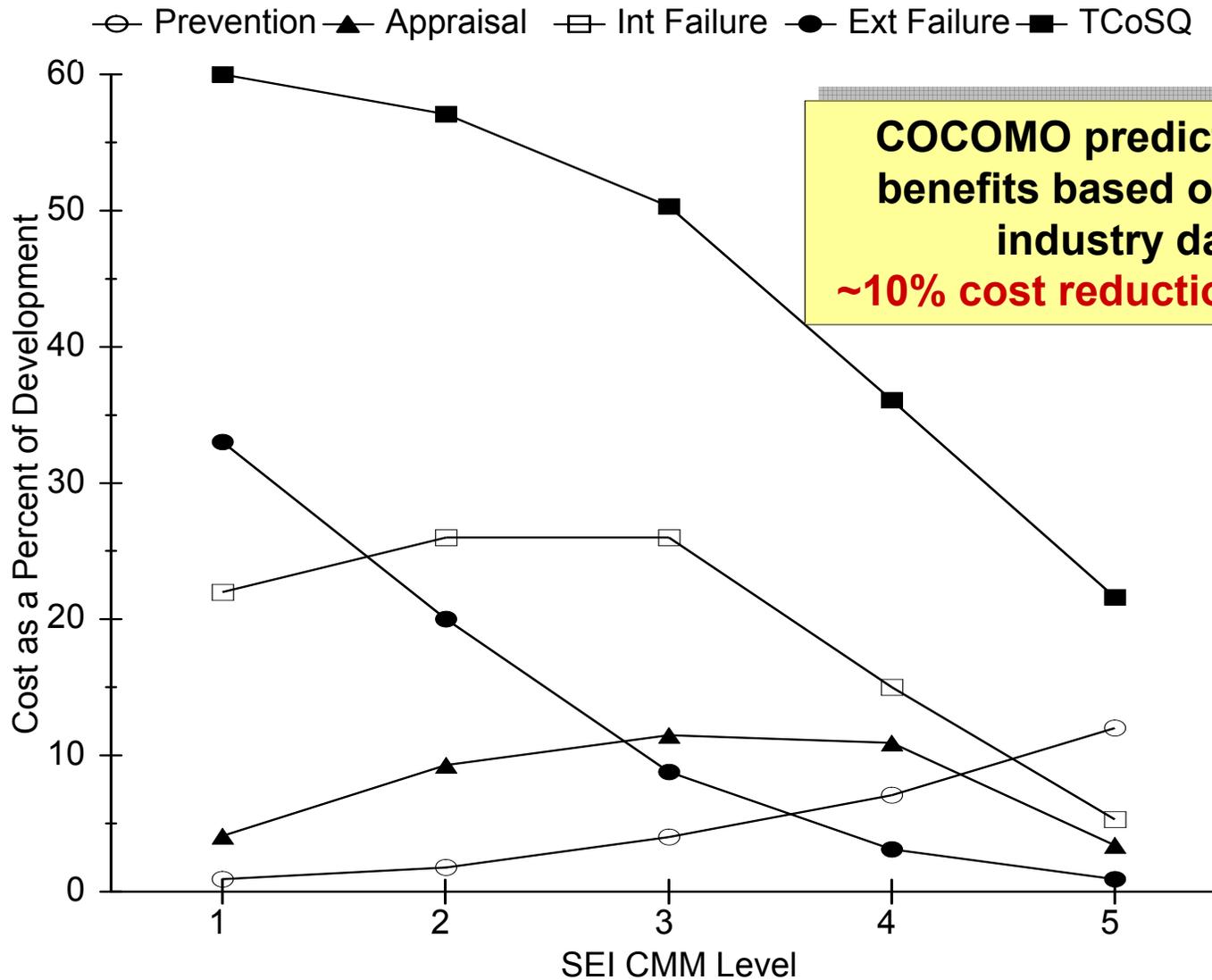
COCOMO predicts similar benefits based on current industry data:
~10% cost reduction per level

Where the Problem Sometimes Arises

- **Some organizations are driven to achieve a maturity level only for it's marketing value**

|	
Improvement goals are not set realistically ("Level 5 in '05")	No one takes the improvement effort seriously
Only some of the projects participate in the improvement effort	Personnel perceive CMM/CMMI as more expensive
Only some of the projects get appraised	The other projects don't implement
Insufficient resources (e.g., training, QA, metrics, consultants)	People don't learn the new behaviors or become proficient
Management doesn't enforce the process	The benefits are not realized

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CMMI Attacks Several Dimensions of the Problem

Project Performance

Organizational Performance

Quality/Rework

Institutionalization
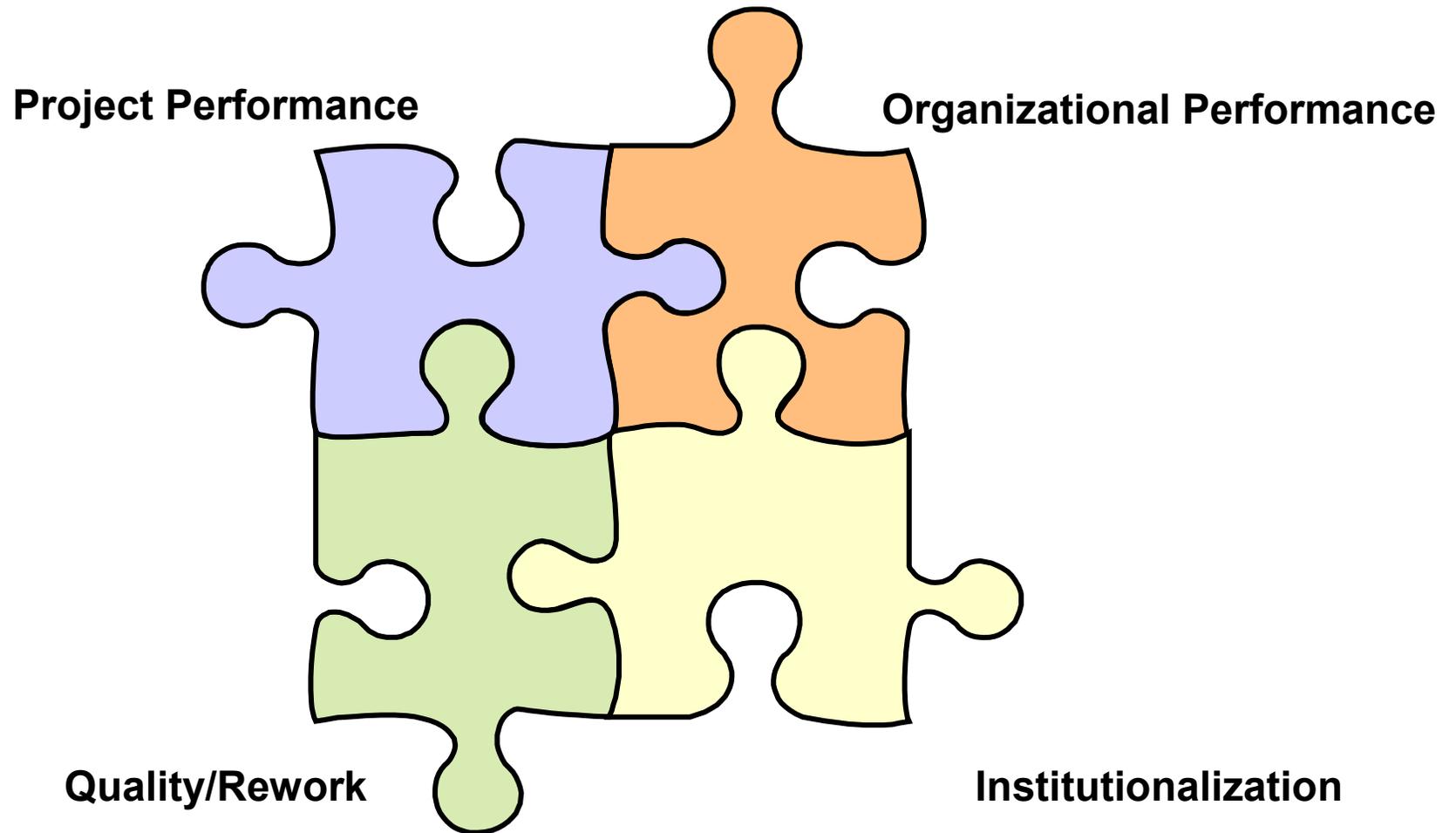
Project Performance

Project performance problems often arise because of incomplete or unrealistic planning
- Forgotten activities
- Unconscious decisions
- Overly-optimistic estimates

When cost/schedule pressure arises, people abandon the plans, leading to more problems
- Individual judgment versus best use of resources

CMMI

Identifies the elements of good planning
- Proven engineering processes
- Estimates based on historical data, using these processes

When cost/schedule pressure arises, CMM/CMMI practices track and correct
- Reactive (L2)
- Proactive, risk management (L3)
- Quantitative management (L4)

QA, management ensures processes/plans are followed

- *Train project managers on how to use the tools (estimation, earned value, risk management)*
- *Project managers (not organizational staff) must be responsible for implementing the improved processes*
- *Demand realistic, data-driven estimates*

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Organizational Performance

- **Each project's processes are unique**
  - Personnel must re-learn with each project
  - Difficulty moving people from project to project
  - Historical data of little use in estimation

- **No way to compare project-to-project**
  - Which process was best?
  - What did we learn?

CMMI

- **Standard organizational process, tailored to fit each project**
  - Can be documented, trained, supported by templates
  - Over time, people learn the process

- **Common processes/measures allow better use of historical data**
  - Calibrate cost estimation models
  - Project to project comparisons
  - Over time, the organization can optimize the process

- *Develop an organizational process(es) which fits the full range of your projects (small/large, all life cycles and project types)*
- *Capture and use historical data (measurement repository)*
- *Capture and share project documents (process asset library)*

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Rework/Quality

Focus on "faster and cheaper" leads to skipping of essential steps
- Key steps are not obvious, often counter intuitive

Fixing latent defects often accounts for 30-40% of project cost
- The cost of defects (rework) is seldom measured

CMMI

A disciplined engineering and management process
- Do it right the first time
- CMM/CMMI identifies the essential steps

Peer reviews find defects early, where it is cost effective to fix them
- Requirements, designs, code, plans, etc.
- Often more efficient and effective than testing
- Many types (Fagan inspections, walkthroughs, desk checks, etc.)

- *Focus on eliminating defects, not on faster and cheaper*
- *Measure the cost of finding and fixing defects*
- *Invest time in learning different methods of peer review and when each is effective*

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Institutionalization

Some improvement efforts focus on quick fixes
- Driven by yearly budget cycles
- Expectation that results will be immediate

It is tempting to reduce overhead to reduce cost
- Training
- Staff support to projects
- Use of outside process experts

CMMI

Short-term investment for long-term gain
- Initial investment in the cost of change, learning curve, new overhead structures
- Long-term benefits in increased productivity

Organizational infrastructure exists to support the policies and process
- Measurement repositories

- *Expect 18-24 months before benefits begin to be realized*
- *Senior management must demand that <u>everyone</u> follow the new processes*
- *QA can be the organization's strongest tool – if they are focused!*

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Benefits

- **The typical benefits are:**
  - Reduced cost
  - Faster schedules
  - Greater productivity
  - Higher quality
  - Increased customer satisfaction
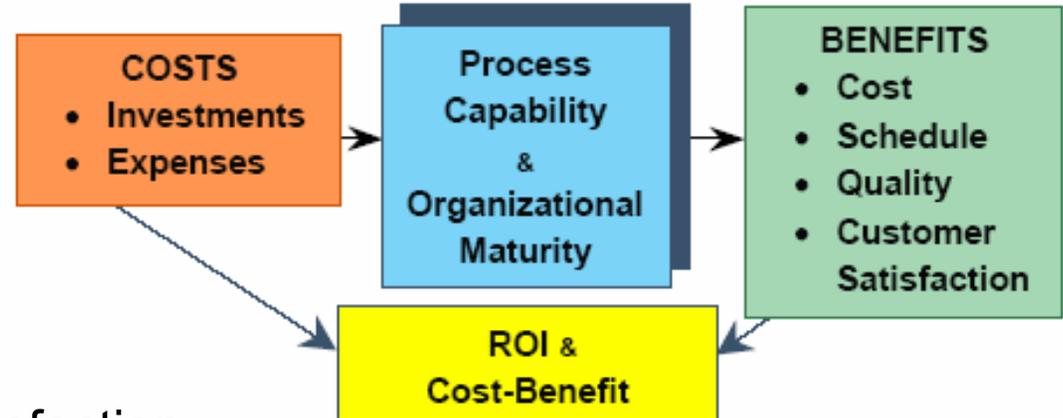
- **Over 40 published studies on the benefits of CMM**
  - DoD DACS website: http://www.thedacs.com/databases/roi/

- **Similar results starting to be seen for CMMI**
  - "Demonstrating the Impact and Benefits of CMMI: An Update and Preliminary Results," Software Engineering Institute, CMU/SEI-2003-SR-009, Oct 2003
  - http://www.sei.cmu.edu/cmmi/results/results-by-category.html

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# Typical CMMI Benefits Cited in Literature

- **Reduced Costs**
  - 33% decrease in the average cost to fix a defect (Boeing)
  - 20% reduction in unit software costs (Lockheed Martin)
  - Reduced cost of poor quality from over 45 percent to under 30 percent over a three year period (Siemens)
  - 10% decrease in overall cost per maturity level (Northrop Grumman)

- **Faster Schedules**
  - 50% reduction in release turnaround time (Boeing)
  - 60% reduction in re-work following test (Boeing)
  - Increase from 50% to 95% the number of milestones met (General Motors)

- **Greater Productivity**
  - 25-30% increase in productivity within 3 years (Lockheed Martin, Harris, Siemens)

- **Higher Quality**
  - 50% reduction of software defects (Lockheed Martin)

- **Customer Satisfaction**
  - 55% increase in award fees (Lockheed Martin)

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Organizational Infrastructure Required for CMMI Level 3

Policies, Processes, Templates & Tools
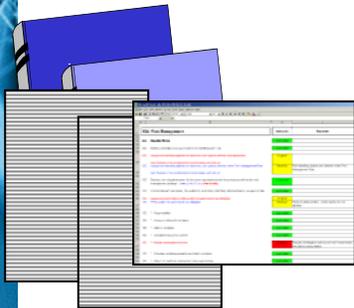
Process Group

Training Program

Process Improvement

Measurement Repositories Predictive Modeling
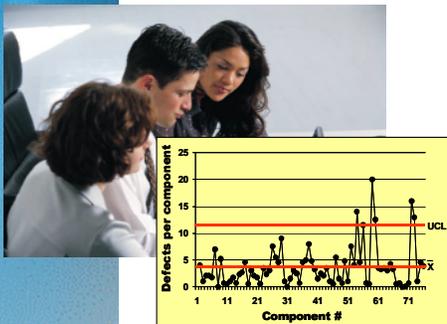
Best-Practice Libraries
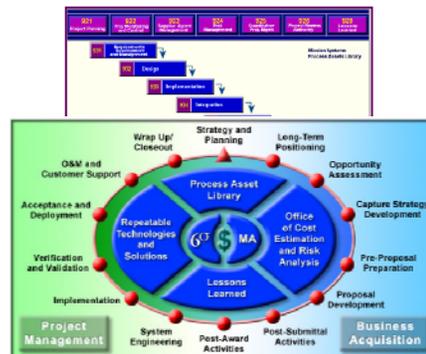
Audits & Appraisals
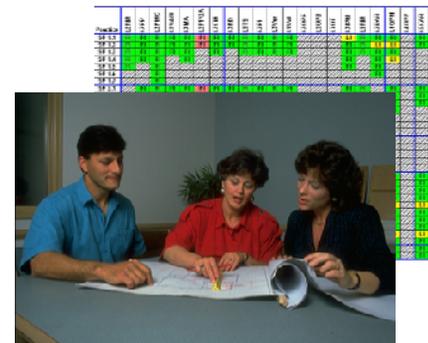
Communications

Developing and maintaining mature processes requires significant time and investment in infrastructure

Northrop Grumman Mission Systems Approach

Mission Success Requires Multiple Approaches

Risk Management

Systems Engineering

Independent Reviews

Training, Tools, & Templates

Program Effectiveness

Mission Assurance

Process Effectiveness

Operations Effectiveness

Dashboards for Enterprise-Wide Measurement

Communications & Best-Practice Sharing

Robust Governance Model (Policies, Processes, Procedures)
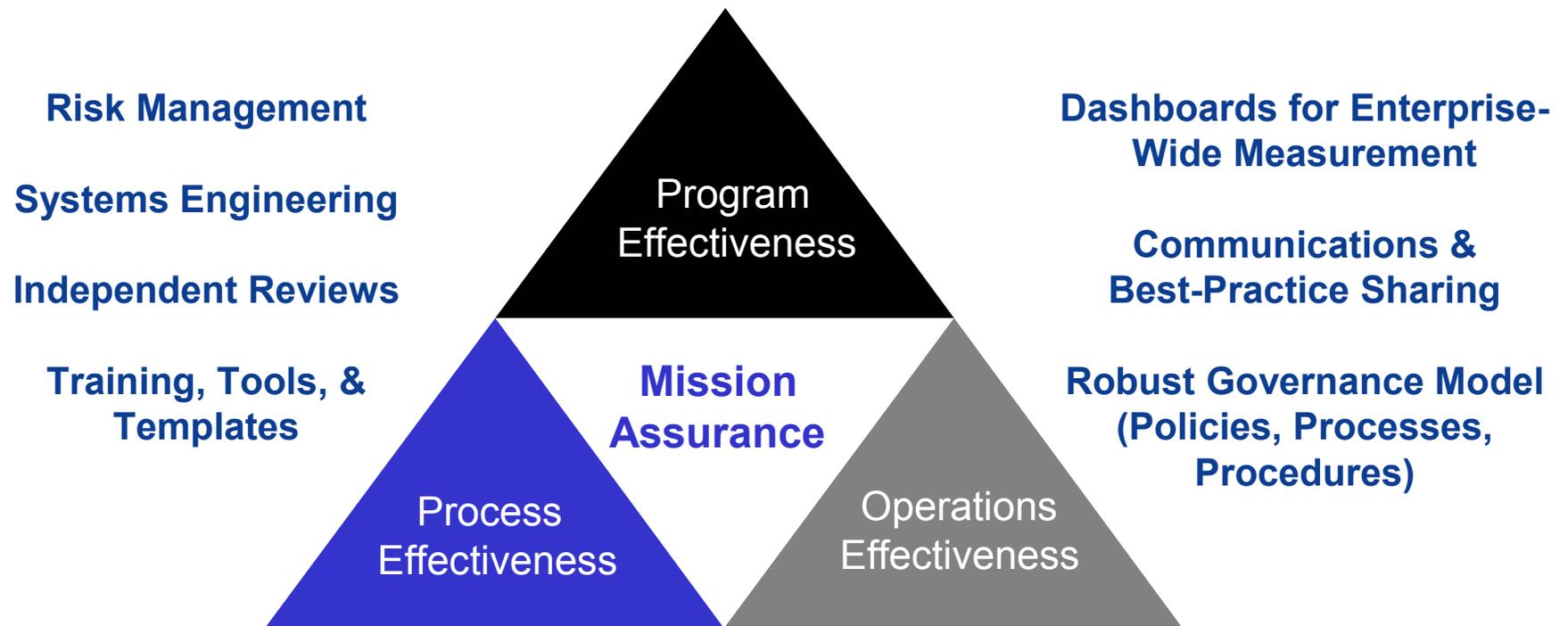
CMMI Level 5 for Software, Systems, and Services

ISO 9001 and AS-9100 Certification

Six Sigma

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Process Effectiveness

Audits & Appraisals
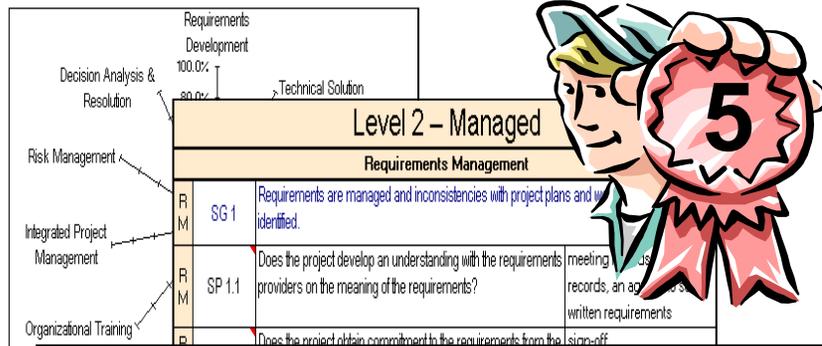
20 Northrop Grumman sites externally appraised at CMMI Level 5

Staff Competence & Training

- CMMI & Six Sigma courses
- Policies & processes course
- Standard Training Modules for each job function: engineering, project management, QA, CM, etc.

Process Asset Library

Communications & Collaboration

Assuring mission success by making the people and processes more informed and effective

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Program Effectiveness

- **Six Sigma connects process improvement and business value**

DEFINE → Charter team, map process & specify CTQs

MEASURE → Measure process performance

ANALYZE → Identify & quantify root causes

IMPROVE → Select, design & implement solution

CONTROL → Institutionalize improvement, ongoing control

- **Six Sigma projects can help focus and measure CMMI-driven process improvements**
  - Identify the customer's needs, maximize the value/cost
  - Tools for management by variation (CMMI Levels 4 and 5)

- **Results to date**
  - 4000 Green Belts, 200 Black Belts, 12 Master Black Belts
  - 500 completed Six Sigma projects, 250 in progress
  - Significant benefit to our customer – lower costs, better performance

> *Assuring mission success by identifying the customer's needs and reducing defects*

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Operational Effectiveness

People

Parametric Modeling Experts
Risk and Predictive Modeling Analysis
Certified Function Point Specialists
Six Sigma Black Belts

Presence

Professional Society Board Members
Active on Government Working groups
Key participants on Milestone reviews)

Tools

Commercial Modeling Tools
Northrop Grumman Developed Tools

Process

Structured Project Reporting, Training
Standardization of Data, Metrics Manual, Approval
CMMI Measurement,

Process Capability Data Repository

Software, Hardware, Accounting Productivity, Defects, Maintenance Phase Relationships, Systems Engineering Functions, Lessons Learned

Product

Risk Analysis
Cost Estimates
Cost Estimation Relationships
Program Benchmarking
Life Cycle Productivity Analysis
Software Sizing and Modeling
Predictive Modeling
Quantitative Management

Programs

Monitor, Manage, Report, Update and Calibrate

Assuring mission success by providing independent cost, schedule and risk realism

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Lessons Learned

- **Process improvement means changing the process**
  - More important to learn the new behaviors than to "go through the motions"

- **Resistance often comes from fear of failure**
  - Walk the talk -- management at all levels must communicate the need for continuous improvement
  - Focus on learning from your mistakes and getting better
  - Training and assistance helps people in trying new processes

- **Six Sigma is a strong enabler for process improvement**
  - Focus on data, measurement systems, process improvement
  - Tying improvements to business goals
  - Allows the projects and organization to optimize the CMMI practices for maximum customer benefit

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