**AALBORG UNIVERSITY**

# Software Process Improvement and CMM

Peter Dolog
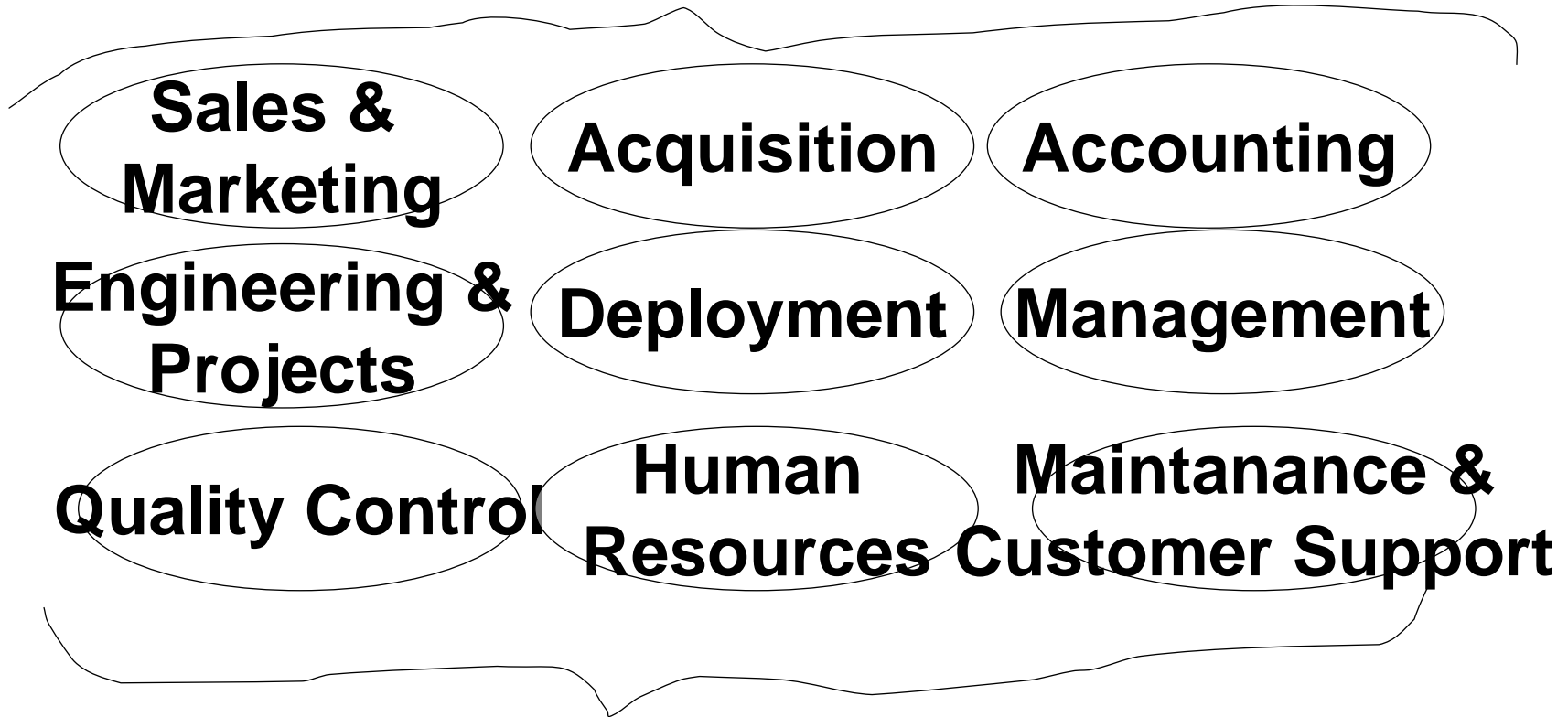dolog [at] cs [dot] aau [dot] dk
E2-201
Information Systems
March 20, 2007
!!! Next one is in one week: March 27, 2007 !!!

# Maturity Models - CMMI

# Software Company

### Input/subproducts

Sales & Marketing

Acquisition

Accounting

Engineering & Projects

Deployment

Management

Quality Control

Human Resources

Maintanance & Customer Support

### Software Product & Services

# CMMI Overview

www.sei.cmu.edu/cmmi/adoption/pdf/cmmi-overview05.pdf

**Carnegie Mellon
Software Engineering Institute**

Pittsburgh, PA 15213-3890

**CMMI**

# Capability Maturity Model® Integration (CMMI®) Overview

**Sponsored by the U.S. Department of Defense**
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# Software Engineering Institute (SEI℠)

Federally funded research
and development center
(FFRDC) established 1984

Awarded to Carnegie Mellon
University

Sponsored by the Office of the
Secretary of Defense/Acquisition,
Technology, and Logistics
(OSD/AT&L)

# Topics

This overview covers the following topics:

- **Common Process Problems**
- Process Improvement Basics
- Maturity Models
- The CMMI Concept
- The Benefits of Using CMMI
- More About CMMI
- CMMI Adoption
- The Bottom Line

# Settling for Less

Do these statements sound familiar? If they do, your organization may be settling for less than it is capable of and may be a good candidate for process improvement.

"I'd rather have it wrong than have it late.  We can always fix it later."

*- a senior software manager (industry)*

"The bottom line is schedule.  My promotions and raises are based on meeting schedule first and foremost."

*- a program manager (government)*

# Symptoms of Process Failure

## Commitments consistently missed
- Late delivery
- Last minute crunches
- Spiraling costs

## No management visibility into progress
- You're always being surprised.

## Quality problems
- Too much rework
- Functions do not work correctly.
- Customer complaints after delivery

## Poor morale
- People frustrated
- Is anyone in charge?

# Software-Intensive Systems

Software is becoming a larger part of many products and services.

Systems and software disciplines traditionally have not been well integrated.

The importance of software in systems has increased dramatically.

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# The Process Management Premise

The quality of a system is highly influenced by the quality of the process used to acquire, develop, and maintain it.

This premise implies a focus on processes as well as on products.

- This is a long-established premise in manufacturing (and is based on TQM principles as taught by Shewhart, Juran, Deming, and Humphrey).

- Belief in this premise is visible worldwide in quality movements in manufacturing and service industries (e.g., ISO standards).

# The Role of Process

Everyone realizes the importance of having a motivated, quality work force and the latest technology, but even the finest people can't perform at their best when the process is not understood or operating at its best.

PEOPLE

TECHNOLOGY
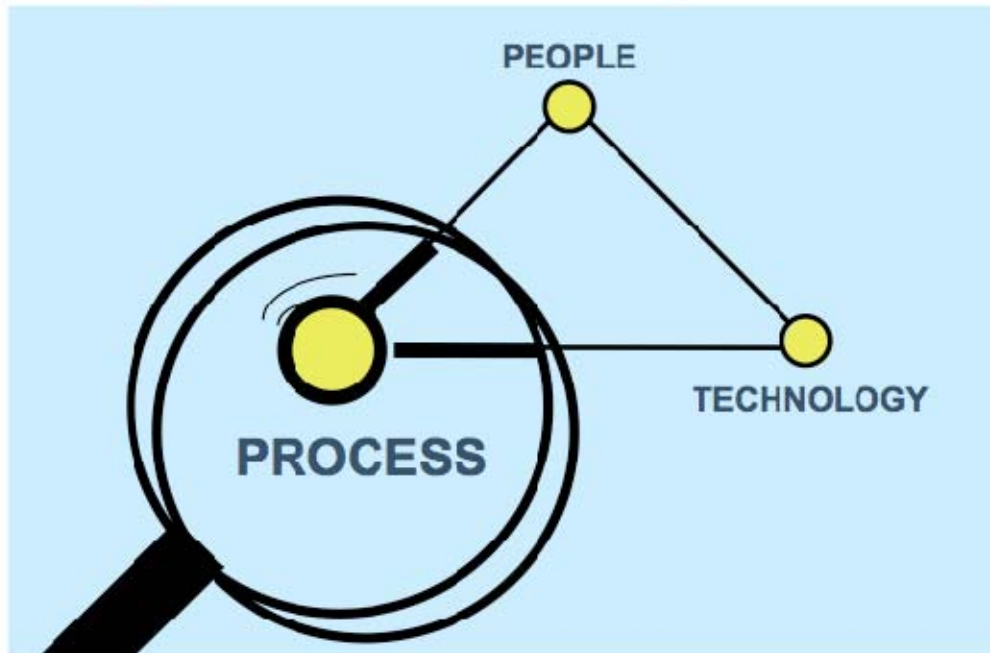
PROCESS

# Common Misconceptions

## I don't need process, I have
- really good people
- advanced technology
- an experienced manager

## Process
- interferes with creativity
- equals bureaucracy + regimentation
- isn't needed when building prototypes
- is only useful on large projects
- hinders agility in fast-moving markets
- costs too much

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# Maturity Models – An Overview

A maturity model is a structured collection of elements that describe characteristics of effective processes.

A maturity model provides
- a place to start
- the benefit of a community's prior experiences
- a common language and a shared vision
- a framework for prioritizing actions
- a way to define what *improvement* means for your organization

A maturity model can be used as a benchmark for assessing different organizations for equivalent comparison.
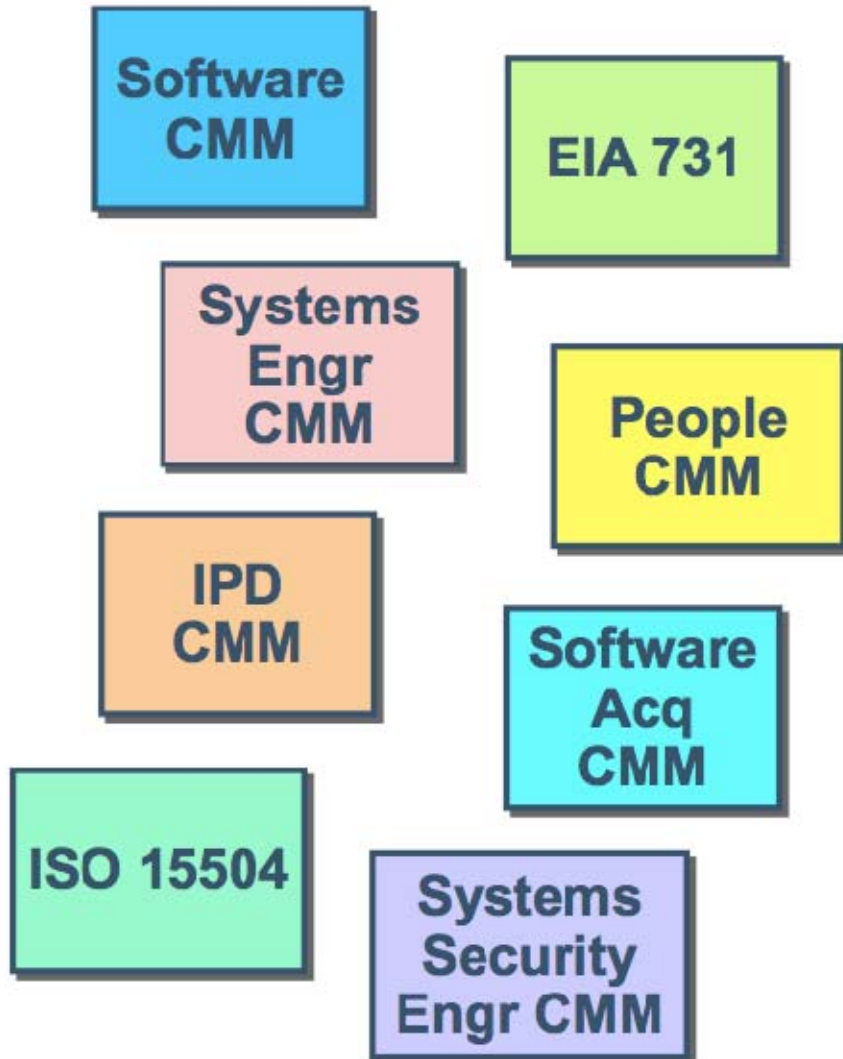
# What Is a CMM?

A Capability Maturity Model (CMM) is a reference model of mature practices in a specified discipline, used to improve and appraise a group's capability to perform that discipline.

CMMs differ by
- discipline (e.g., software engineering, systems engineering)
- structure (e.g., staged, continuous)
- definition of maturity (i.e., process improvement path)

# Multiple Process Models

**Software CMM**

**EIA 731**

**Systems Engr CMM**

**People CMM**

**IPD CMM**

**Software Acq CMM**

**ISO 15504**

**Systems Security Engr CMM**

Success of the Software CMM® caused development of other CMMs, but they

- had different structures, formats, terms, ways of measuring maturity

- caused confusion, especially when more than one was used together

- were difficult to integrate into a combined improvement program

- were difficult to use in supplier selection and sub-contracting

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# How CMMI Began

The CMMI Project was formed to
- build an initial set of integrated models
- improve best practices from source models based on lessons learned
- establish a framework to enable integration of future models
- create an associated set of appraisal and training products

Collaborative endeavor (over 100 people from nearly 30 organizations involved)
- Industry
- Government
- Software Engineering Institute (SEI)

# CMMI in a Nutshell

A CMMI model provides a structured view of process improvement across an organization.

CMMI can help
- integrate traditionally separate organizations
- set process improvement goals and priorities
- provide guidance for quality processes
- provide a yardstick for appraising current practices

# The CMMI Products

## Models
Four Disciplines
- Systems Engineering (SE)
- Software Engineering (SW)
- Integrated Product and Process Development (IPPD)
- Supplier Sourcing (SS)

Two Representations
- Staged
- Continuous

## Modules
CMMI Acquisition Module

## Appraisal Method
Appraisal Requirements for CMMI (ARC)

SCAMPI Method Definition Document (MDD)

## Training
Four Courses
- Introduction to CMMI
- Intermediate Concepts of CMMI
- CMMI Instructor Training
- SCAMPI Lead Appraiser Training

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# CMMI Expected Business Benefits

Substantial reduction in systems integration and test time with greater probability of success

Cause integration of, and interaction among, the various engineering functions

Extend SW-CMM benefits to the total project & organization

Employ systems engineering principles in software development

Increase & improve SE content in programs

Leverage previous process improvement investments

# CMMI Expected Technical Benefits

Increased focus and consistency in

- requirements development and management

- systems design and development

- systems integration

- risk management

- measurement & analysis

- other engineering-related activities

# Enterprise-Wide Improvement

Organizations that want to pursue process improvement in multiple functional areas can use CMMI to do so with less additional investment for each additional function.

- CMMI enables process integration and product improvement.

- CMMI integrates multiple disciplines.

- CMMI provides a framework for integrating new disciplines as needs arise.

For detailed information about CMMI benefits, see the Performance Results Web page,
http://www.sei.cmu.edu/cmmi/results.html.

# Real World Benefits:
# Lockheed Martin M&DS

SW CMM ML2 (1993) to ML 3 (1996) to CMMI ML5 (2002)

## Results

- captured a greater percentage of available award fees; now receiving 55 percent more compared to the baseline that remained unrealized at SW-CMM level 2

### 1996 - 2002

- increased software productivity by 30%
- decreased unit software cost by 20%
- decreased defect find and fix costs by 15%
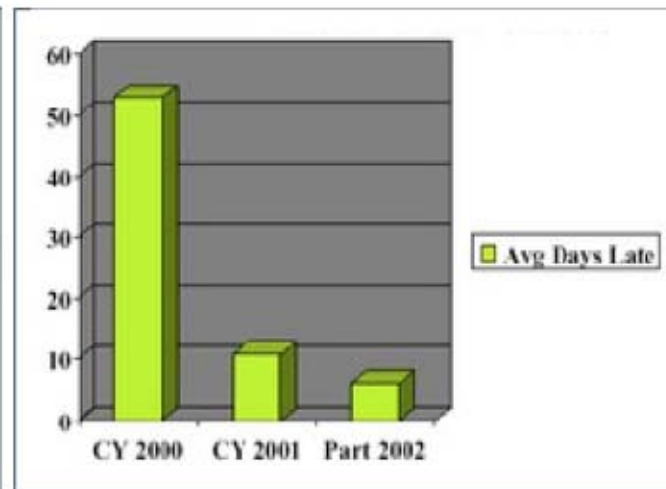
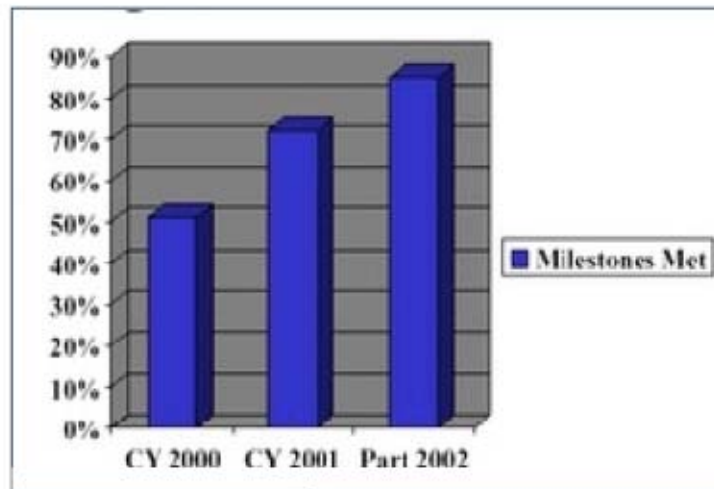(From proprietary sources with permission; August 2003.)

# Real World Benefits:
# Thales ATM

**CMMI** Level 4 helps THALES meet their business objectives:

- Ability to see into the future with a known level of confidence

- Increasing number of processes under statistical control

- Measurement-based process improvement

- **Return on investment due to**
  - earlier defect detection
  - improved risk management
  - better control of projects

(From CMMI Level 4 Preparation: The Story of the Chicken and the Egg. Anne De Goeyse and Anne Sophie Luce, Thales ATM; and Annie Kuntzmann-Combelles, Q-Labs France, ESEPG 2003.)

# Real World Benefits:
# Bosch Gasoline Systems

## CMM-based improvements

- **Predictability** – internal on-time delivery improved by 15%
- **Less Rework** – first pass yield improved by 10%
- **Product Quality** – reduction in error cases in the factory by one order of magnitude

## Next Steps include

- move to CMMI and applying it to software, system, and hardware
- expand process improvement program to include sales, hardware, and component development

(From Critical success factors for improvement in a large embedded systems organisation.  Wolfgang Stolz, Robert Bosch GmbH Gasoline Systems GS-EC/ESP and Hans-Jürgen Kugler, Q-Labs Software Engineering, ESEPG 2003.)

# Real World Benefits:
# J.P. Morgan Chase & Co.

1st CMM success 2001 – today, 28 teams at CMM Level 2

CMMI success – 1st team ML3 in 2003

Investment in Process Improvement = $4 million

**Results**
- Improved predictability of delivery schedule
- Reduction of post-release defects
- Reduced severity of post-release defects

And, from CMMI specifically
- Increased throughput = more releases per year

Goal to achieve CMMI throughout organization

(With permission from presentation to the SEI, September 2003.)

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# The CMMI Product Suite

The CMMI Product Suite integrates common elements and best features of multiple CMMs, providing
- common terminology
- common training
- an integrated appraisal method (SCAMPI$^{SM}$)
  - assessment for internal process improvement
  - evaluation for external (i.e., government) review

CMMI models help organizations improve their product and service development, acquisition, and maintenance processes.

The CMMI Product Suite includes a framework that will be extended to additional discipline areas (e.g., hardware, services).

# Bodies of Knowledge Captured in CMMI Models

Organizations select the bodies of knowledge most relevant to achieving their business objectives. Bodies of knowledge available in CMMI models include
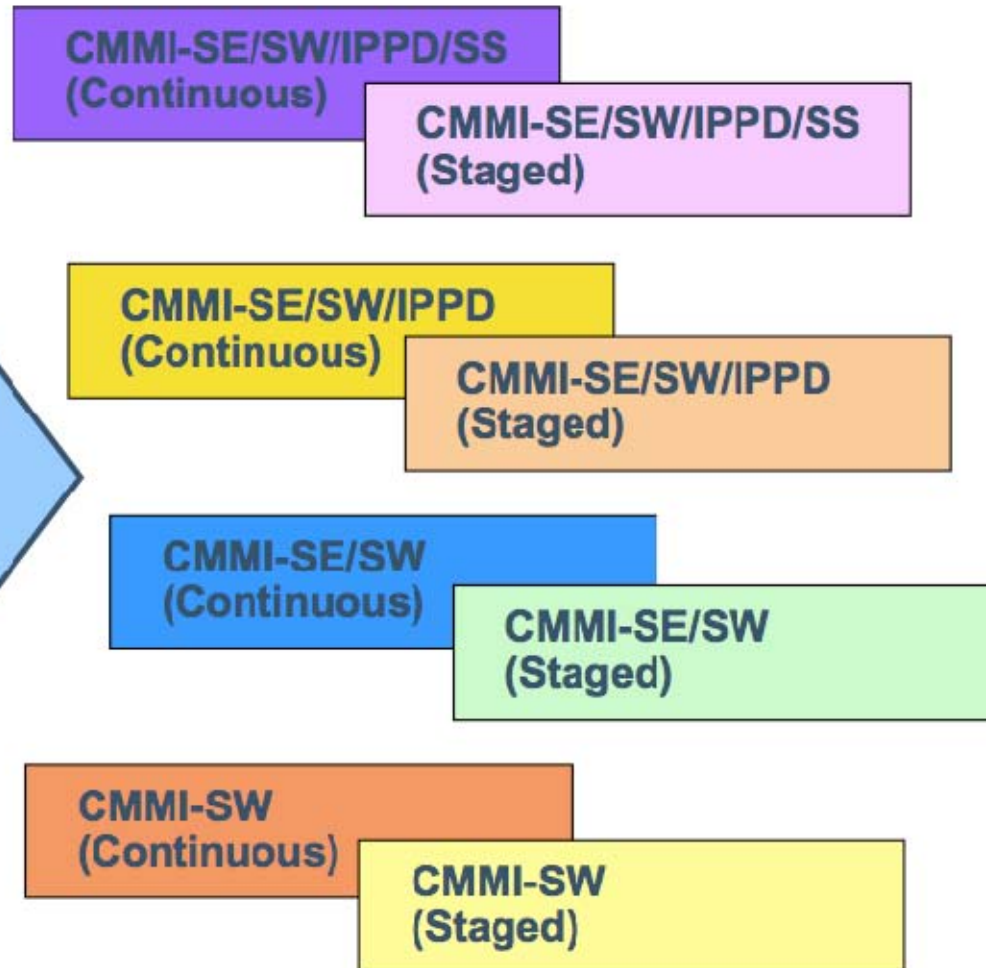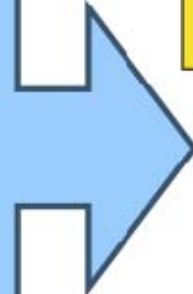
- systems engineering (SE)

- software engineering (SW)

- integrated product and process development (IPPD)

- supplier sourcing (SS)

# Understanding CMMI Representations

There are two types of representations in the CMMI models:
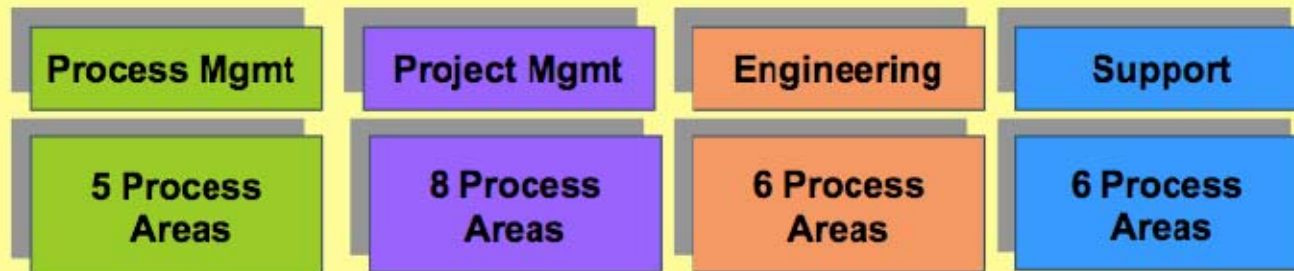- staged
- continuous

A representation allows an organization to pursue different improvement paths.

The organization and presentation of the data are different in each representation. However, the content is the same.

# Continuous View of CMMI

**Continuous**

| Process Mgmt | Project Mgmt | Engineering | Support |
|---|---|---|---|
| **5 Process Areas** | **8 Process Areas** | **6 Process Areas** | **6 Process Areas** |

- Organizational Process Focus
- Organizational Process Definition
- Organizational Training
- Organizational Process Performance
- Organizational Innovation and Deployment

- Requirements Management
- Requirements Development
- Technical Solution
- Product Integration
- Verification
- Validation

- Project Planning
- Project Monitoring and Control
- Supplier Agreement Management
- Integrated Project Management
- Risk Management
- Integrated Teaming
- Integrated Supplier Management
- Quantitative Project Management

- Configuration Management
- Process and Product Quality Assurance
- Measurement and Analysis
- Decision Analysis and Resolution
- Organizational Environment for Integration
- Causal Analysis and Resolution

# Continuous Representation

Allows you to select the order of improvement that best meets your organization's business objectives and mitigates your organization's areas of risk

Enables comparisons across and among organizations on a process-area-by-process-area basis

Provides an easy migration from EIA 731 (and other models with a continuous representation) to CMMI

Uses predefined sets of process areas to define an improvement path for an organization
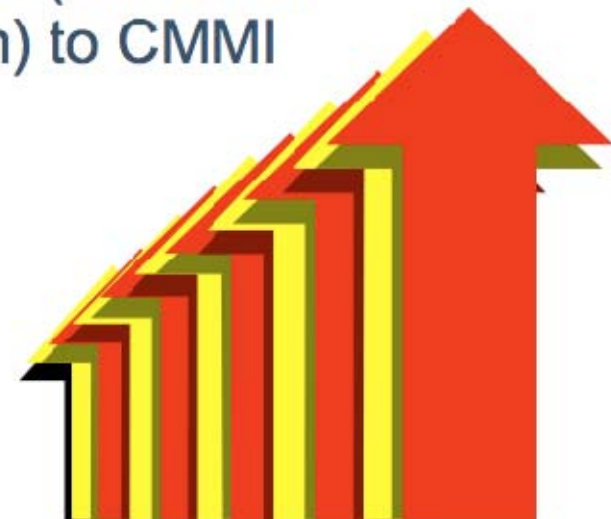
# Capability Levels

A capability level is a well-defined evolutionary plateau describing the organization's capability relative to a particular process area.
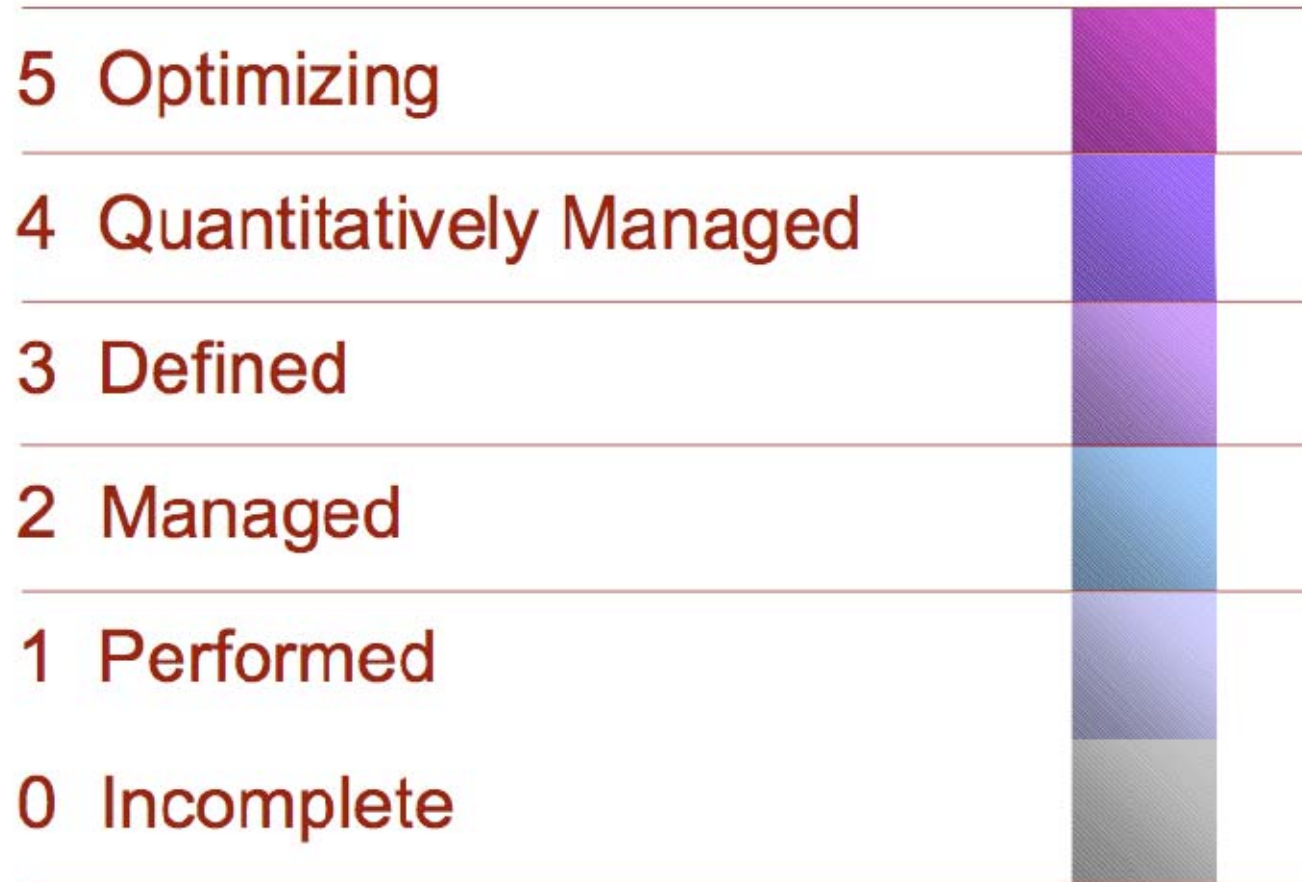
There are six capability levels.

Each level is a layer in the foundation for continuous process improvement.

Thus, capability levels are cumulative (i.e., a higher capability level includes the attributes of the lower levels).
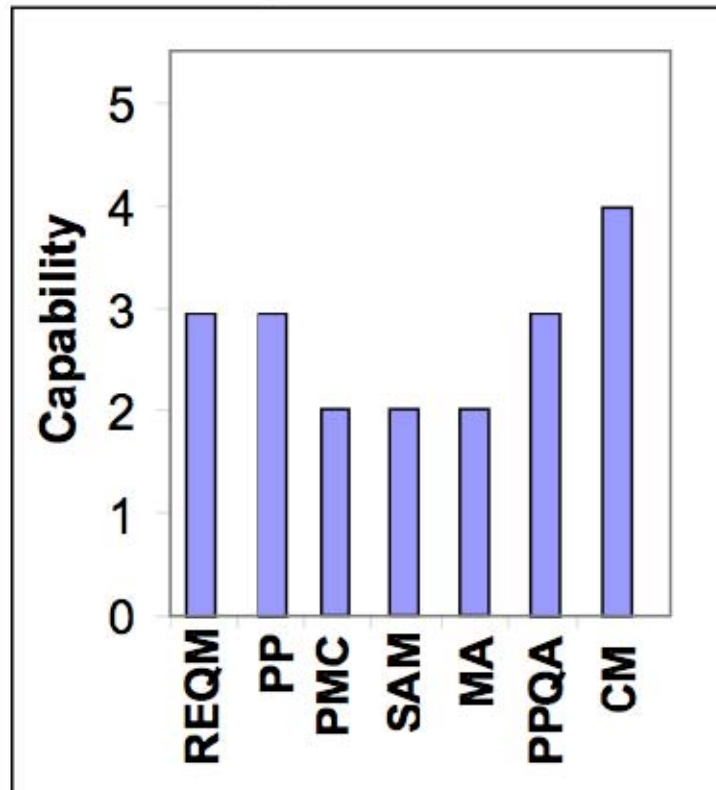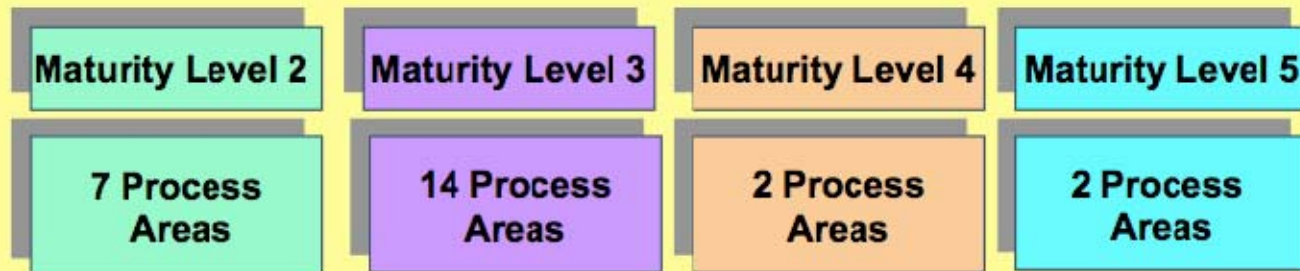
# Representing Capability Levels for Individual Process Areas

The process area capability of an implemented process can be represented by a bar.

# Staged View of CMMI

**Staged**

| Maturity Level 2 | Maturity Level 3 | Maturity Level 4 | Maturity Level 5 |
|---|---|---|---|
| 7 Process Areas | 14 Process Areas | 2 Process Areas | 2 Process Areas |

- Requirements Management
- Project Planning
- Project Monitoring and Control
- Supplier Agreement Management
- Measurement and Analysis
- Process and Product Quality Assurance
- Configuration Management

- Organizational Training
- Integrated Project Management
- Risk Management
- Integrated Teaming
- Integrated Supplier Management
- Decision Analysis and Resolution
- Organizational Environment for Integration

- Requirements Development
- Technical Solution
- Product Integration
- Verification
- Validation
- Organizational Process Focus
- Organizational Process Definition

- Organizational Process Performance
- Quantitative Project Management

- Organizational Innovation and Deployment
- Causal Analysis and Resolution

# Staged Representation

Provides a proven sequence of improvements, each serving as a foundation for the next

Provides a single rating that summarizes appraisal results and permits comparisons across and among organizations

Provides an easy migration from the SW-CMM to CMMI

Allows an organization to select a specific process area and improve relative to it
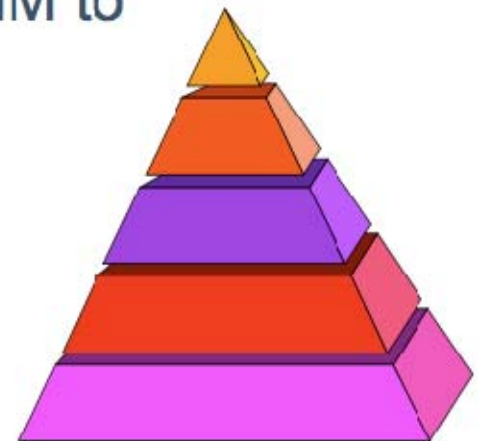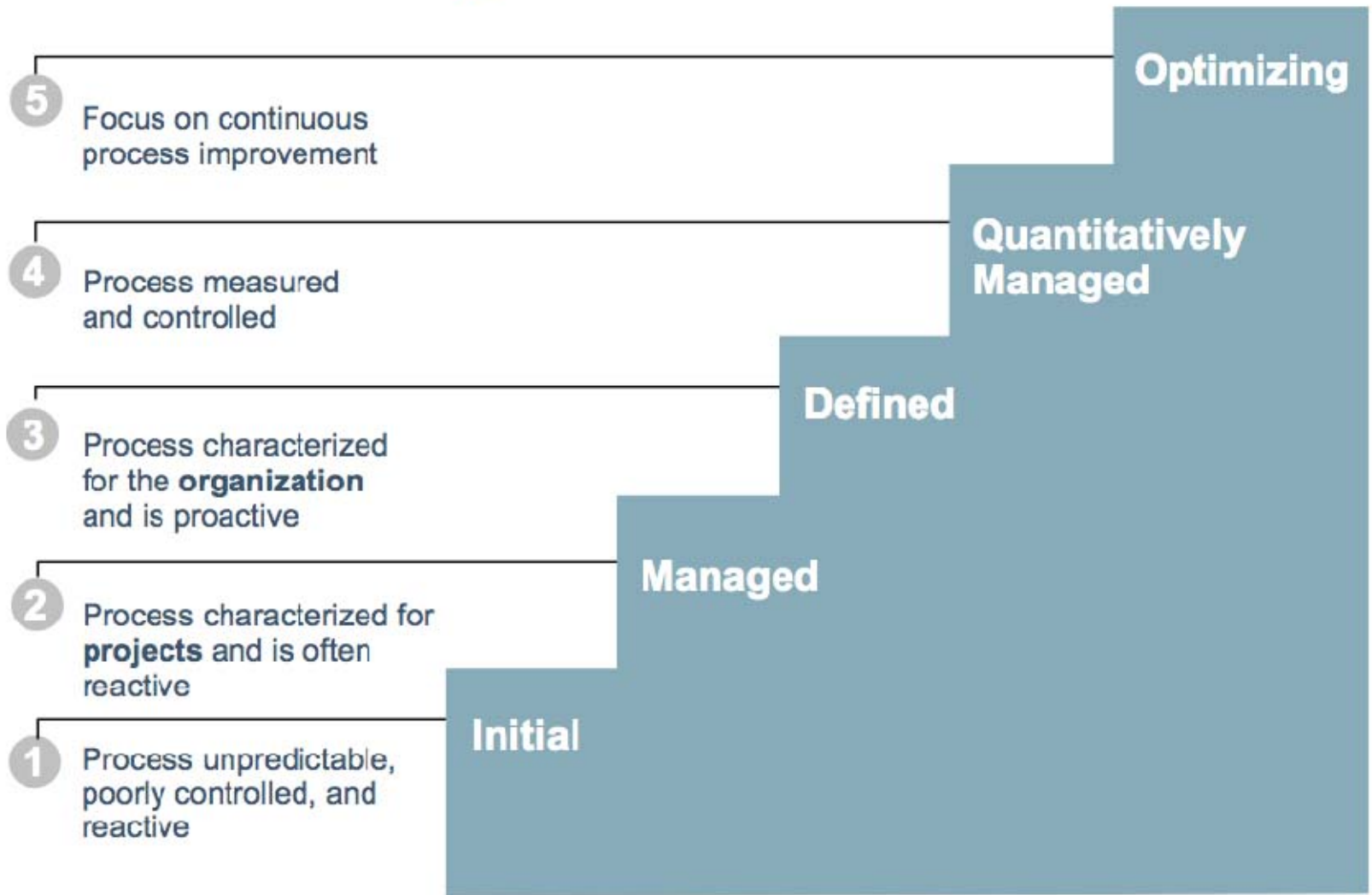
# Maturity Levels

A maturity level is a well-defined evolutionary plateau of process improvement.

There are five maturity levels.

Each level is a layer in the foundation for continuous process improvement using a proven sequence of improvements, beginning with basic management practices and progressing through a predefined and proven path of successive levels.

# The Maturity Levels



**5** Focus on continuous process improvement — **Optimizing**

**4** Process measured and controlled — **Quantitatively Managed**

**3** Process characterized for the **organization** and is proactive — **Defined**

**2** Process characterized for **projects** and is often reactive — **Managed**

**1** Process unpredictable, poorly controlled, and reactive — **Initial**

# Maturity Levels Should Not Be Skipped

Each maturity level provides a necessary foundation for effective implementation of processes at the next level.

- Higher level processes have less chance of success without the discipline provided by lower levels.
- The effect of innovation can be obscured in a noisy process.

Higher maturity level processes may be performed by organizations at lower maturity levels, with the risk of not being consistently applied in a crisis.

# Comparing the Representations

Both representations provide ways of implementing process improvement to achieve business goals.

Both representations provide the same essential content but organized in different ways.

| Continuous Representation | Staged Representation |
|---|---|
| Maximum flexibility for order of process improvement | Predefined and proven path with case study and ROI data |
| Focuses on improvement within process areas | Focuses on organizational improvement |
| Improvement of process areas can occur at different rates | Overall results summarized in a maturity level |
| Source selection investigation can target risky areas at any level | Maturity levels are common discriminators |

# One Model; Two Representations

**CMMI-SE/SW Staged**

**Overview**
Learn about the model

**Maturity Level 2**
REQM, PP, PMC,
SAM, MA, PPQA, CM

**Maturity Level 3**
REQD, TS, PI, VER,
VAL, OPF, OPD, OT,
IPM, RSKM, DAR

**Maturity Level 4**
OPP, QPM

**Maturity Level 5**
OID, CAR

**Appendixes**

**CMMI-SE/SW Continuous**

**Overview**
Learn about the model

**Process Management**
OPF, OPD, OT,
OPP, OID

**Project Management**
PP, PMC, SAM
IPM, RSKM, QPM

**Engineering**
REQM, REQD, TS,
PI, VER, VAL

**Support**
CM, PPQA, MA,
CAR, DAR

**Appendixes**

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# Organizations Using CMMI

| | | |
|---|---|---|
| Accenture | Bank of America | BMW |
| Boeing | Bosch | Ericsson |
| Dyncorp | EDS | Fujitsu |
| FAA | Fannie Mae | Hitachi |
| General Dynamics | General Motors | Infosys |
| Honeywell | IBM Global Services | KPMG |
| Intel | J. P. Morgan | Motorola |
| L3 Communications | Lockheed Martin | NEC |
| NASA | NDIA | NRO |
| Nokia | Northrop Grumman | Polaris |
| NTT Data | OUSD (AT&L) | SAIC |
| Raytheon | Reuters | TRW |
| Samsung | Social Security Administration | U.S. Navy |
| U.S. Air Force | U.S. Army | Zurich Financial Services |
| U.S. Treasury Department | Wipro | |

# CMMI Products Available

Version 1.1 of the CMMI Product Suite was released in December, 2001.

The disciplines available in CMMI models include systems engineering, software engineering, integrated product and process development, and supplier sourcing.

The SCAMPI appraisal method combines internal assessment and external evaluation methods into one.

An implementation guide for government evaluation was published in April, 2002.

A module for interpreting CMMI for acquisition organizations was published in February 2004.

# CMMI Acquisition Module

Provides concise guidance for establishing and strengthening acquisition practices

- Not another model–used in conjunction with CMMI
- Excerpts from CMMI with additions and amplifications pertinent to an acquisition environment

Helps to establish a common language and framework for process improvement across the supply chain

Can be used on less formal appraisals for gap analysis; identification of strengths, weaknesses, and risks; and identification of improvement opportunities

Cannot be used for formal appraisals yielding maturity level ratings

# CMMI Service Providers (as of 2/28/05)

SEI Partners are consultants licensed by the SEI to provide appraisal services and/or training services.
- There are 134 SEI Partners that can offer the *Introduction to CMMI* training course.
- There are 179 SEI Partners that can offer SCAMPI appraisal services.

Instructors and appraisers are authorized by the SEI. There are currently 253 SEI-authorized *Introduction to CMMI* V1.1 Instructors and 364 SEI-authorized Lead Appraisers.

Since the release of CMMI in 2000, there have been many people trained in CMMI:
- *Introduction to CMMI*: 30,009
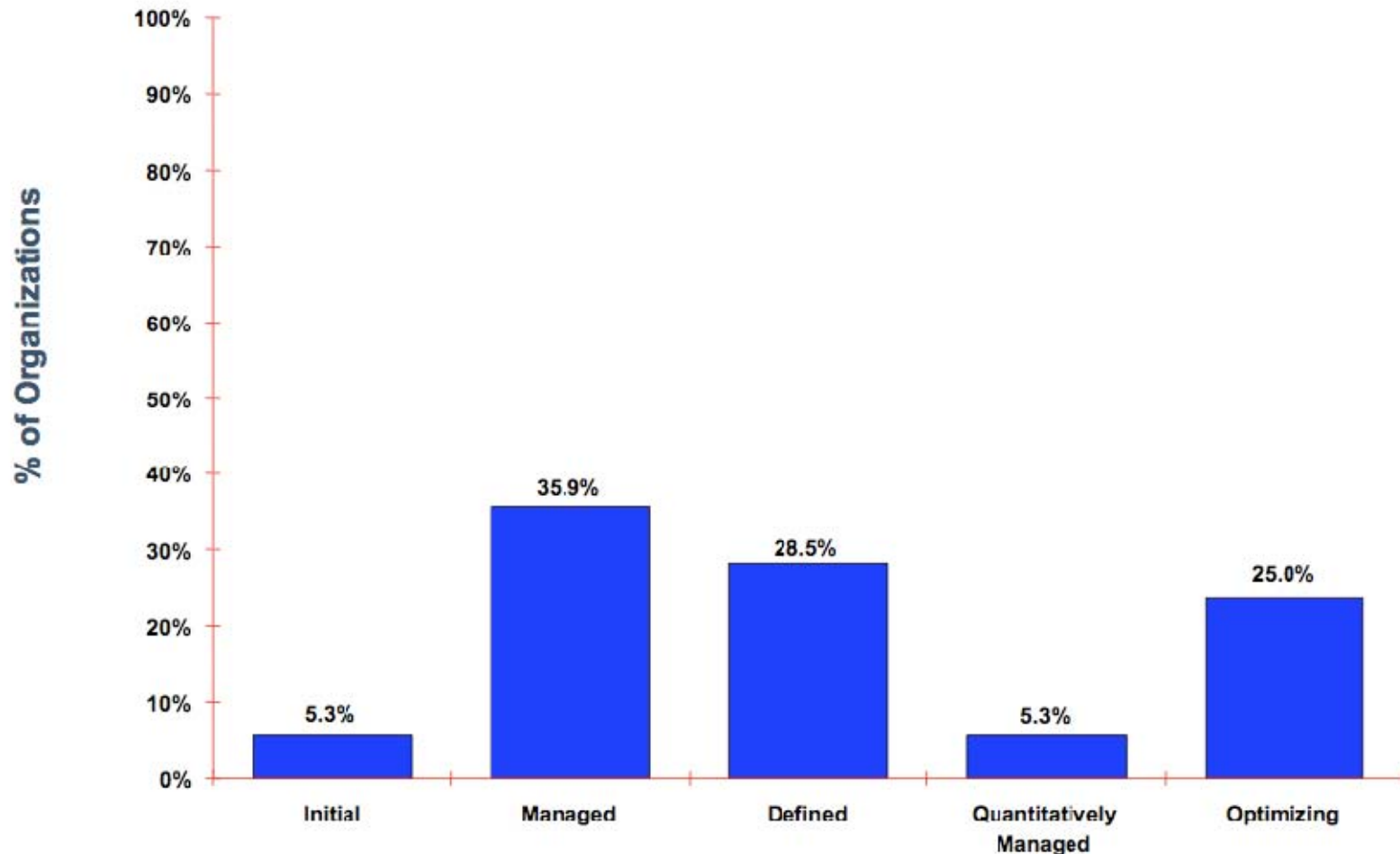- *CMMI Instructor Training*: 318

# CMMI Appraisals

The following data shows the number of SCAMPI
V1.1 Class A appraisals that were conducted since
the April 2002 release through August 2004 and
reported to the SEI by September 2004:

| | |
|---|---|
| 424 | appraisals |
| 385 | organizations |
| 206 | participating companies |
| 33 | reappraised organizations |
| 1,704 | projects |
| 50.6% | non-USA organizations |

Categories of Reporting Organizations (9/28/04)
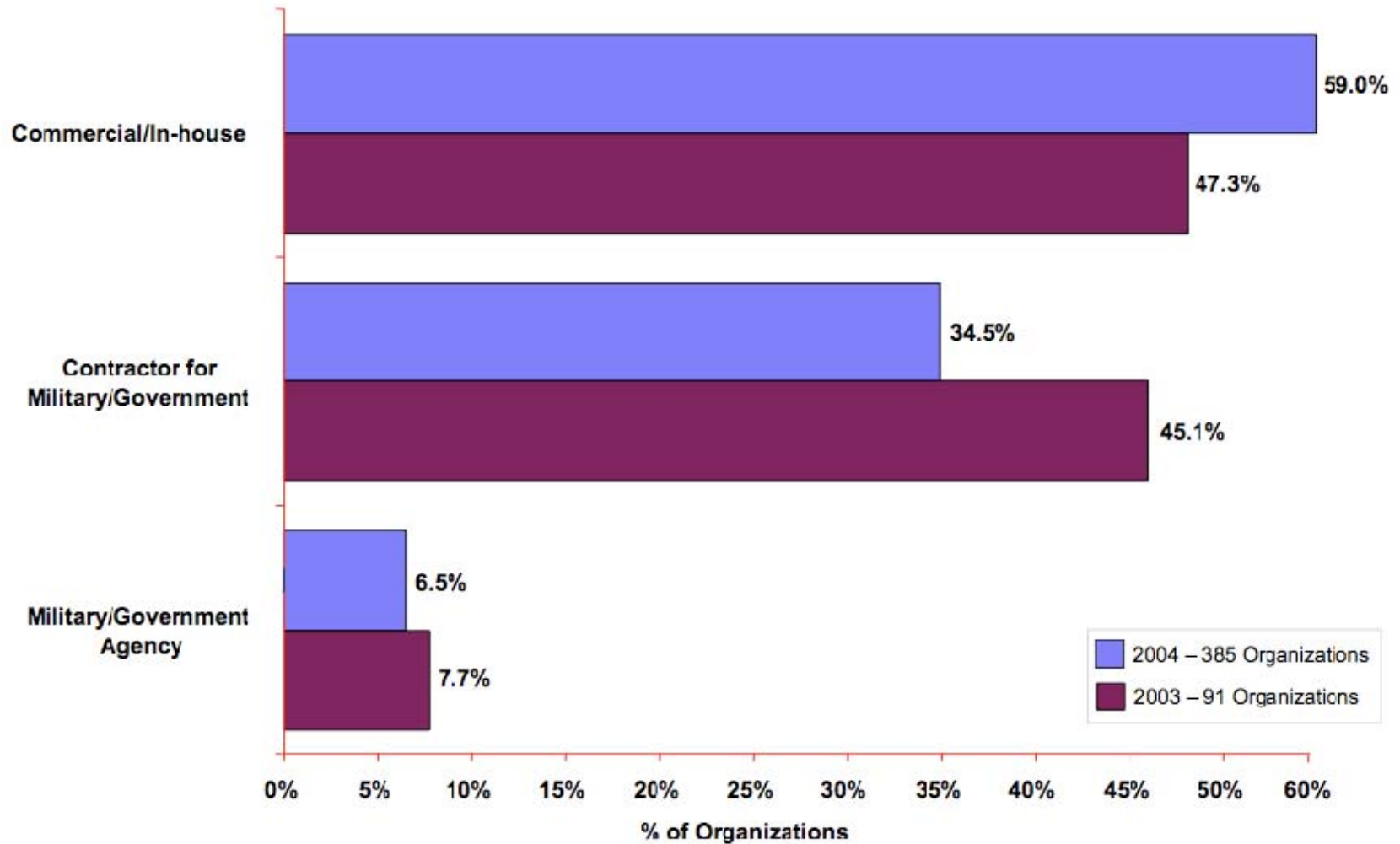
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# The Bottom Line

Process improvement should be done to help the business— not for its own sake.



"In God we trust, all others bring data."

*- W. Edwards Deming*

# CMMI Can Benefit You

CMMI provides

- a common, integrated vision of improvement for all elements of an organization

- efficient, effective improvement and appraisal across multiple disciplines

- improvements to best practices incorporated from the Software CMM, EIA 731, IPD-CMM and others

- a means of representing new discipline-specific information in a standard, proven process-improvement context

# CMMI Benefits

CMMI-based process improvement benefits include

- improved schedule and budget predictability

- improved cycle time

- increased productivity

- improved quality (as measured by defects)

- increased customer satisfaction

- improved employee morale

- increased return on investment

- decreased cost of quality

# Improve Your Bottom Line

Improvement means different things to different organizations.

- What are your business goals?

- How do you measure progress?

Improvement is a long-term, strategic effort.

- What is the expected impact on the bottom line?

- How will impact be measured?

# For More Information About CMMI

Go to CMMI Web site:

http://www.sei.cmu.edu/cmmi
http://seir.sei.cmu.edu

Contact SEI Customer Relations:

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