

Chapter 8: Project Quality Management



Munawar
moenawar@gmail.com

Learning Objectives

- Understand the importance of project quality management for information technology products and services.
- Define project quality management and understand how quality relates to various aspects of information technology projects.
- Describe quality planning and its relationship to project scope management.
- Discuss the importance of quality assurance.
- List the three outputs of the quality control process.

Learning Objectives

- Understand the tools and techniques for quality control, such as Pareto analysis, statistical sampling, Six Sigma, quality control charts, and testing.
- Summarize the contributions of noteworthy quality experts to modern quality management.
- Describe how leadership, cost, organizational influences, expectations, cultural differences, standards, and maturity models relate to improving quality in information technology projects.
- Discuss how software can assist in project quality management.

The Importance of Project Quality Management

- Many people joke about the poor quality of IT products (see cars and computers joke on pages 290-291).
- People seem to accept systems being down occasionally or needing to reboot their PCs.
- But quality is very important in many IT projects.

What Is Quality?

- The International Organization for Standardization (ISO) defines **quality** as “the degree to which a set of inherent characteristics fulfils requirements” (ISO9000:2000).
- Other experts define quality based on:
 - **Conformance to requirements:** The project’s processes and products meet written specifications.
 - **Fitness for use:** A product can be used as it was intended.

What Is Project Quality Management?

- Project quality management ensures that the project will satisfy the needs for which it was undertaken.
- Processes include:
 - **Quality planning:** Identifying which quality standards are relevant to the project and how to satisfy them.
 - **Quality assurance:** Periodically evaluating overall project performance to ensure the project will satisfy the relevant quality standards.
 - **Quality control:** Monitoring specific project results to ensure that they comply with the relevant quality standards.

Quality Planning

- Implies the ability to anticipate situations and prepare actions to bring about the desired outcome.
- Important to prevent defects by:
 - Selecting proper materials.
 - Training and indoctrinating people in quality.
 - Planning a process that ensures the appropriate outcome.

Design of Experiments

- **Design of experiments** is a quality planning technique that helps identify which variables have the most influence on the overall outcome of a process.
- Also applies to project management issues, such as cost and schedule trade-offs.
- Involves documenting important factors that directly contribute to meeting customer requirements.

Scope Aspects of IT Projects

- **Functionality** is the degree to which a system performs its intended function.
- **Features** are the system's special characteristics that appeal to users.
- **System outputs** are the screens and reports the system generates.
- **Performance** addresses how well a product or service performs the customer's intended use.
- **Reliability** is the ability of a product or service to perform as expected under normal conditions.
- **Maintainability** addresses the ease of performing maintenance on a product.

Who's Responsible for the Quality of Projects?

- Project managers are ultimately responsible for quality management on their projects.
- Several organizations and references can help project managers and their teams understand quality.
 - International Organization for Standardization (www.iso.org)
 - IEEE (www.ieee.org)

Quality Assurance

- Quality assurance includes all the activities related to satisfying the relevant quality standards for a project.
- Another goal of quality assurance is continuous quality improvement.
- **Benchmarking** generates ideas for quality improvements by comparing specific project practices or product characteristics to those of other projects or products within or outside the performing organization.
- A **quality audit** is a structured review of specific quality management activities that help identify lessons learned that could improve performance on current or future projects.

Table 8-1. Table of Contents for a Quality Assurance Plan*

1.0 Draft Quality Assurance Plan	4.0 Quality Assurance Procedures
1.1 Introduction	4.1 Walkthrough Procedure
1.2 Purpose	4.2 Review Process
1.3 Policy Statement	4.2.1 Review Procedures
1.4 Scope	4.3 Audit Process
2.0 Management	4.3.1 Audit Procedures
2.1 Organizational Structure	4.4 Evaluation Process
2.2 Roles and Responsibilities	4.5 Process Improvement
2.2.1 Technical Monitor/Senior Management	5.0 Problem Reporting Procedures
2.2.2 Task Leader	5.1 Noncompliance Reporting Procedures
2.2.3 Quality Assurance Team	6.0 Quality Assurance Metrics
2.2.4 Technical Staff	Appendix
3.0 Required Documentation	Quality Assurance Checklist Forms

*U.S. Department of Energy

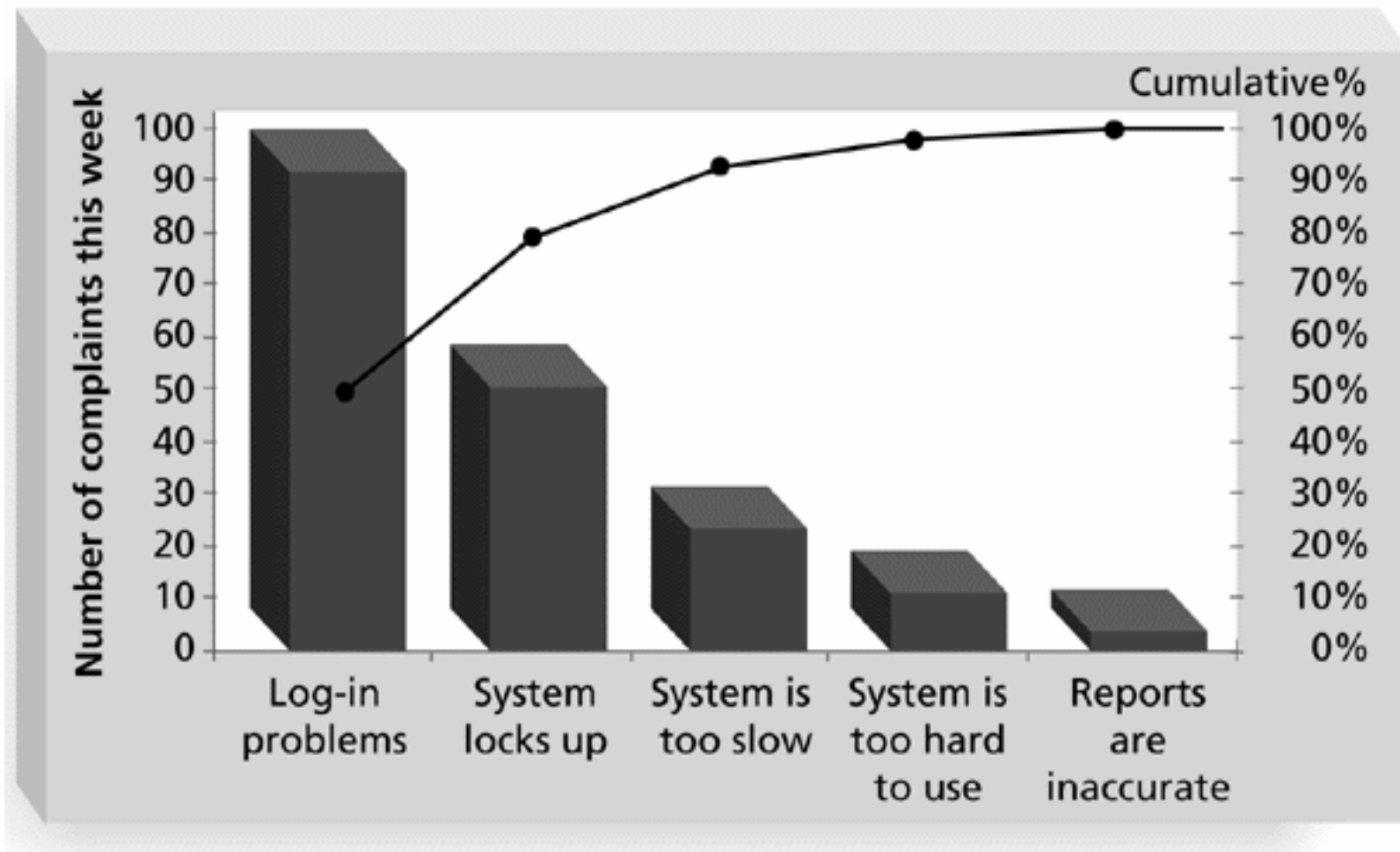
Quality Control

- The main outputs of quality control are:
 - Acceptance decisions
 - Rework
 - Process adjustments
- Some tools and techniques include:
 - Pareto analysis
 - Statistical sampling
 - Six Sigma
 - Quality control charts

Pareto Analysis

- **Pareto analysis** involves identifying the vital few contributors that account for the most quality problems in a system.
- Also called the 80-20 rule, meaning that 80 percent of problems are often due to 20 percent of the causes.
- **Pareto diagrams** are histograms, or column charts representing a frequency distribution, that help identify and prioritize problem areas.

Figure 8-1. Sample Pareto Diagram



Statistical Sampling and Standard Deviation

- **Statistical sampling** involves choosing part of a population of interest for inspection.
- The size of a sample depends on how representative you want the sample to be.
- Sample size formula:
$$\text{Sample size} = .25 \times (\text{certainty factor}/\text{acceptable error})^2$$
- Be sure to consult with an expert when using statistical analysis.

Six Sigma

- **Six Sigma** is “a comprehensive and flexible system for achieving, sustaining, and maximizing business success. Six Sigma is uniquely driven by close understanding of customer needs, disciplined use of facts, data, and statistical analysis, and diligent attention to managing, improving, and reinventing business processes.”*

*Pande, Peter S., Robert P. Neuman, and Roland R. Cavanagh, *The Six Sigma Way*, New York: McGraw-Hill, 2000, p. xi.

Basic Information on Six Sigma

- The target for perfection is the achievement of no more than **3.4 defects per million opportunities**.
- The principles can apply to a wide variety of processes.
- Six Sigma projects normally follow a five-phase improvement process called DMAIC.

DMAIC

- **DMAIC** is a systematic, closed-loop process for continued improvement that is scientific and fact based.
- DMAIC stands for:
 - **Define:** Define the problem/opportunity, process, and customer requirements.
 - **Measure:** Define measures, then collect, compile, and display data.
 - **Analyze:** Scrutinize process details to find improvement opportunities.
 - **Improve:** Generate solutions and ideas for improving the problem.
 - **Control:** Track and verify the stability of the improvements and the predictability of the solution.

How is Six Sigma Quality Control Unique?

- It requires an organization-wide commitment.
- Training follows the “Belt” system.
- Six Sigma organizations have the ability and willingness to adopt contrary objectives, such as reducing errors and getting things done faster.
- It is an operating philosophy that is customer focused and strives to drive out waste, raise levels of quality, and improve financial performance at *breakthrough* levels.

Examples of Six Sigma Organizations

- Motorola, Inc. pioneered the adoption of Six Sigma in the 1980s and saved about \$14 billion.*
- Allied Signal/Honeywell saved more than \$600 million a year by reducing the costs of reworking defects and improving aircraft engine design processes.**
- General Electric uses Six Sigma to focus on achieving customer satisfaction.

*Pande, Peter S., Robert P. Neuman, and Roland R. Cavanagh, *The Six Sigma Way*. New York: McGraw-Hill, 2000, p. 7.

**Ibid. p. 9.

Six Sigma and Project Management

- Joseph M. Juran stated, “All improvement takes place project by project, and in no other way.”*
- It’s important to select projects carefully and apply higher quality where it makes sense; companies that use Six Sigma do not always boost their stock values.
- As Mikel Harry puts it, “I could genetically engineer a Six Sigma goat, but if a rodeo is the marketplace, people are still going to buy a Four Sigma horse.”**
- Six Sigma projects must focus on a quality problem or gap between the current and desired performance and not have a clearly understood problem or a predetermined solution.

*“What You Need to Know About Six Sigma,” *Productivity Digest* (December 2001), p. 38.

**Clifford, Lee, “Why You Can Safely Ignore Six Sigma,” *Fortune* (January 22, 2001), p. 140.

Six Sigma Projects Use Project Management

- The training for Six Sigma includes many project management concepts, tools, and techniques.
- For example, Six Sigma projects often use business cases, project charters, schedules, budgets, and so on.
- Six Sigma projects are done in teams; the project manager is often called the team leader, and the sponsor is called the champion.

Six Sigma and Statistics

- The term *sigma* means standard deviation.
- **Standard deviation** measures how much variation exists in a distribution of data.
- Standard deviation is a key factor in determining the acceptable number of defective units found in a population.
- Six Sigma projects strive for no more than 3.4 defects per million opportunities, yet this number is confusing to many statisticians.

Six Sigma Uses a Conversion Table

- Using a normal curve, if a process is at six sigma, there would be no more than two defective units per billion produced.
- Six Sigma uses a scoring system that accounts for time, an important factor in determining process variations.
- **Yield** represents the number of units handled correctly through the process steps.
- A **defect** is any instance where the product or service fails to meet customer requirements.
- There can be several opportunities to have a defect.

Figure 8-2. Normal Distribution and Standard Deviation

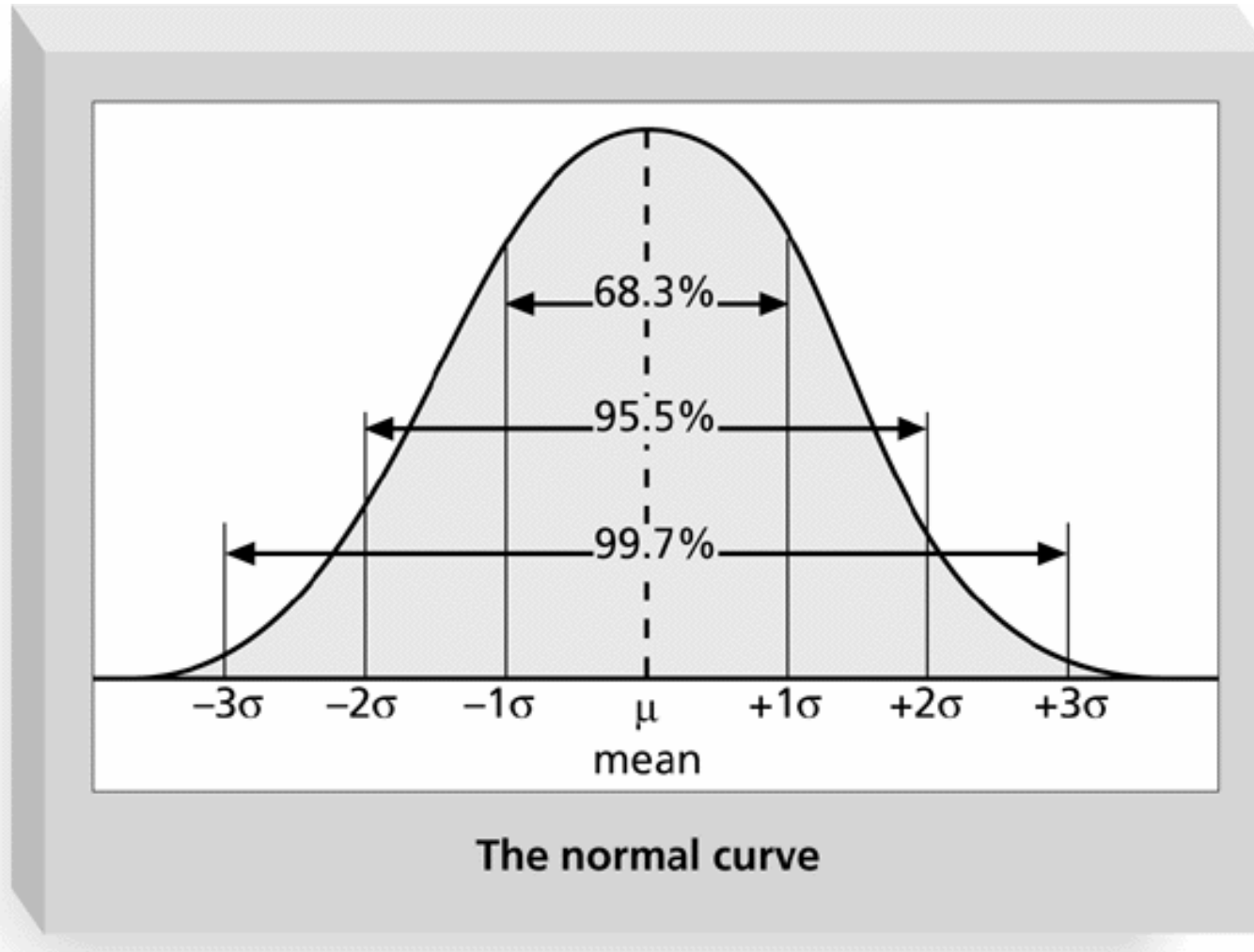


Table 8-3. Sigma and Defective Units

Specification Range (in +/- Sigmas)	Percent of Population Within Range	Defective Units Per Billion
1	68.27	317,300,000
2	95.45	45,400,000
3	99.73	2,700,000
4	99.9937	63,000
5	99.999943	57
6	99.9999998	2

Table 8-4: Six Sigma Conversion Table

SIGMA	YIELD	DEFECTS PER MILLION OPPORTUNITIES (DPMO)
1	31.0%	690,000
2	69.2%	308,000
3	93.3%	66,800
4	99.4%	6,210
5	99.97%	230
6	99.99966%	3.4

The Six Sigma convention for determining defects is based on the above conversion table. It accounts for a 1.5 sigma shift to measure the number of defects per million opportunities instead of the number of defects per unit.

Quality Control Charts and the Seven Run Rule

- A control chart is a graphic display of data that illustrates the results of a process over time. It helps prevent defects and allows you to determine whether a process is in control or out of control.
- The seven run rule states that if seven data points in a row are all below the mean, above the mean, or are all increasing or decreasing, then the process needs to be examined for non-random problems.

Six 9s of Quality

- **Six 9s of quality** is a measure of quality control equal to 1 fault in 1 million opportunities.
- In the telecommunications industry, it means 99.9999 percent service availability or *30 seconds of down time a year*.
- This level of quality has also been stated as the target goal for the number of errors in a communications circuit, system failures, or errors in lines of code.

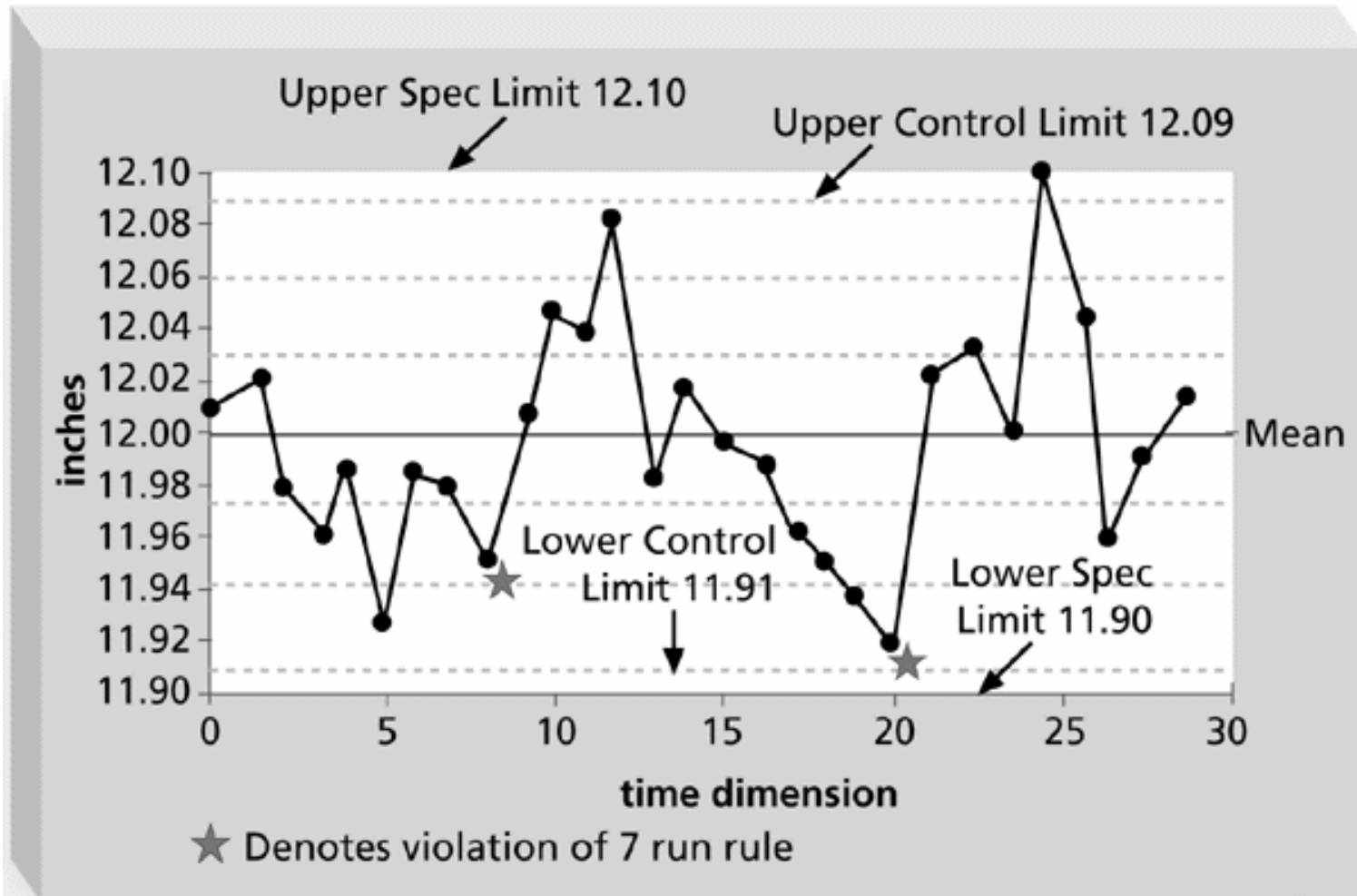
Quality Control Charts

- A **control chart** is a graphic display of data that illustrates the results of a process over time.
- The main use of control charts is to prevent defects, rather than to detect or reject them.
- Quality control charts allow you to determine whether a process is in control or out of control.
 - When a process is in control, any variations in the results of the process are created by random events; processes that are in control do not need to be adjusted.
 - When a process is out of control, variations in the results of the process are caused by non-random events; you need to identify the causes of those non-random events and adjust the process to correct or eliminate them.

The Seven Run Rule

- You can use quality control charts and the seven run rule to look for patterns in data.
- The **seven run rule** states that if seven data points in a row are all below the mean, above the mean, or are all increasing or decreasing, then the process needs to be examined for non-random problems.

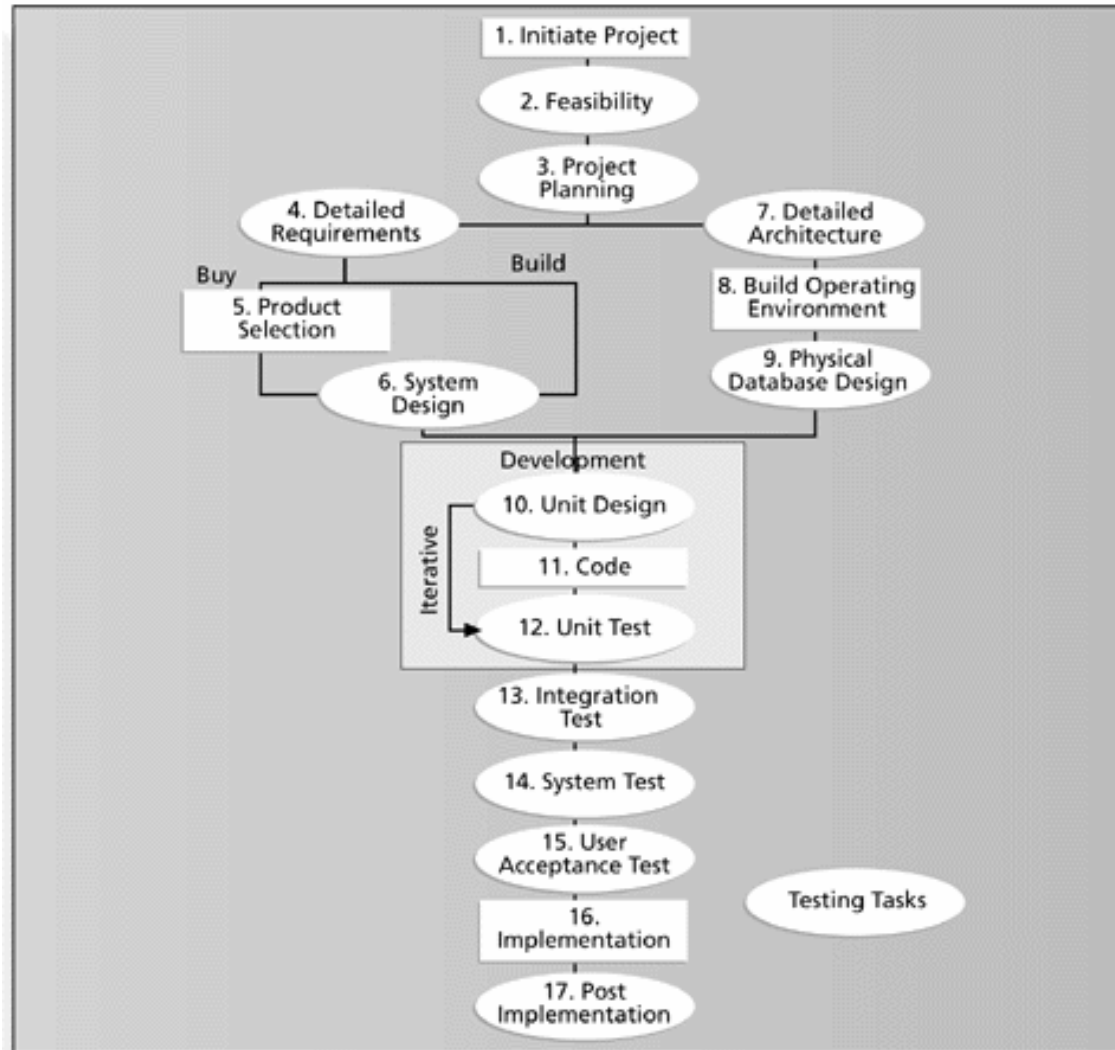
Figure 8-3. Sample Quality Control Chart



Testing

- Many IT professionals think of testing as a stage that comes near the end of IT product development.
- Testing should be done during almost every phase of the IT product development life cycle.

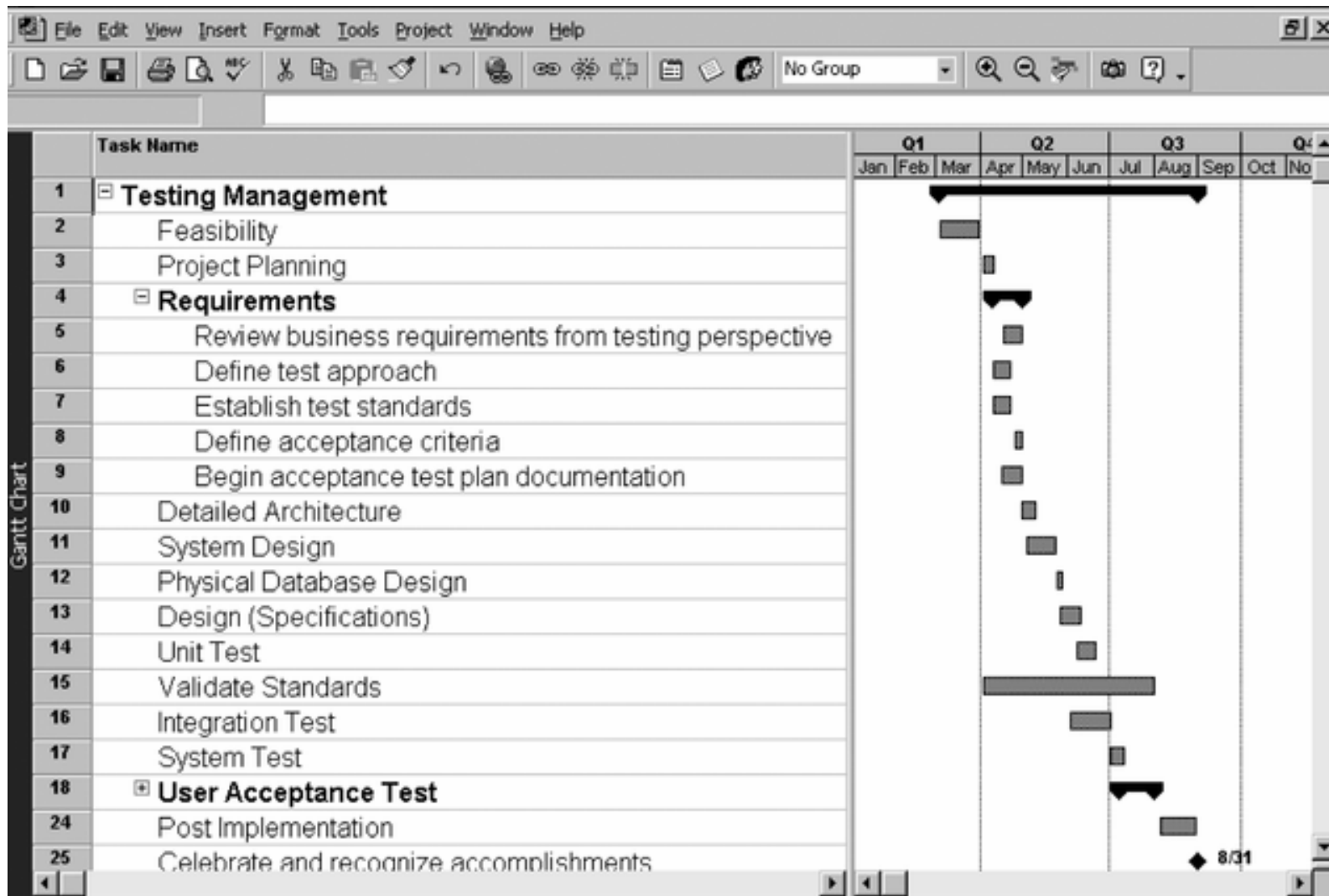
Figure 8-4. Testing Tasks in the Software Development Life Cycle



Types of Tests

- **Unit testing** tests each individual component (often a program) to ensure it is as defect-free as possible.
- **Integration testing** occurs between unit and system testing to test functionally grouped components.
- **System testing** tests the entire system as one entity.
- **User acceptance testing** is an independent test performed by end users prior to accepting the delivered system.

Figure 8-5. Gantt Chart for Building Testing into a Systems Development Project Plan



Testing Alone Is Not Enough

- Watts S. Humphrey, a renowned expert on software quality, defines a **software defect** as anything that must be changed before delivery of the program.
- Testing does not sufficiently prevent software defects because:
 - The number of ways to test a complex system is huge.
 - Users will continue to invent new ways to use a system that its developers never considered.
- Humphrey suggests that people rethink the software development process to provide *no* potential defects when you enter system testing; developers must be responsible for providing error-free code at each stage of testing.

Modern Quality Management

- Modern quality management:
 - Requires customer satisfaction.
 - Prefers prevention to inspection.
 - Recognizes management responsibility for quality.
- Noteworthy quality experts include Deming, Juran, Crosby, Ishikawa, Taguchi, and Feigenbaum.

Quality Experts

- Deming was famous for his work in rebuilding Japan and his 14 Points for Management.
- Juran wrote the *Quality Control Handbook* and ten steps to quality improvement.
- Crosby wrote *Quality is Free* and suggested that organizations strive for zero defects.
- Ishikawa developed the concepts of quality circles and fishbone diagrams.
- Taguchi developed methods for optimizing the process of engineering experimentation.
- Feigenbaum developed the concept of total quality control.

Deming's 14 Points

1. Create constancy of purpose toward improvement of products and services, with the aim to become competitive and to stay in business, and to provide jobs.
2. Adopt the new philosophy. We are in a new economic arena. Western management must awaken to the challenge, must learn their responsibilities, and take on leadership for change.
3. Cease dependencies on inspection to achieve quality. Eliminate the need for inspection on a mass basis by building quality into the product in the first place.
4. End the practice of awarding business on the basis of price tag. Instead minimize total cost. Move toward a single supplier for any one item, on a long-term relationship of loyalty and trust.
5. Improve constantly and forever the system of production and service, to improve quality and productivity, and thus constantly decrease costs.

Deming's 14 Points

6. Institute training on the job.
7. Institute leadership
8. Drive out fear, so that everyone may work effectively for the company.
9. Break down barriers between departments.
10. Eliminate slogans, exhortations, and targets for the workforce asking for zero defects and new levels of productivity
11. a) Eliminate work standards (quotas) on the factory floor. Substitute leadership
b) Eliminate management by objective and by numbers.
12. Create pride in the job being done.
13. Institute a vigorous program of education and self-improvement.
14. Put everybody in the company to work to accomplish the transformation.

Juran's Quality Planning Road Map (Quality Trilogy)

- Quality Planning
 1. Identify who are the customers.
 2. Determine the needs of those customers.
 3. Translate those needs into our language.
 4. Develop a product that can respond to those needs.
 5. Optimize the product features so as to meet our needs as well as customer needs.
- Quality Improvement
 6. Develop a process that is able to produce the product.
 7. Optimize the process.
- Quality Control
 8. Prove that the process can produce the product under operating conditions.
 9. Transfer the process to Operations.

Philip Crosby (1926 – 2001)

- Advocated
 - “Do it right the first time”
 - “Zero defects”
 - “Quality is free”
 - “Non-conformance costs organizations money”

Philip Crosby (1926 – 2001)

- Make it clear that management is committed to quality.
- Form quality improvement teams with representative from each department.
- Determine where current and potential quality problem lie.
- Evaluate the cost of quality and explain its use as a management tool.
- Raise the quality awareness and personal concern of all employees.
- Take actions to correct problems identified through previous steps.
- Establish a committee for the zero-defects program.

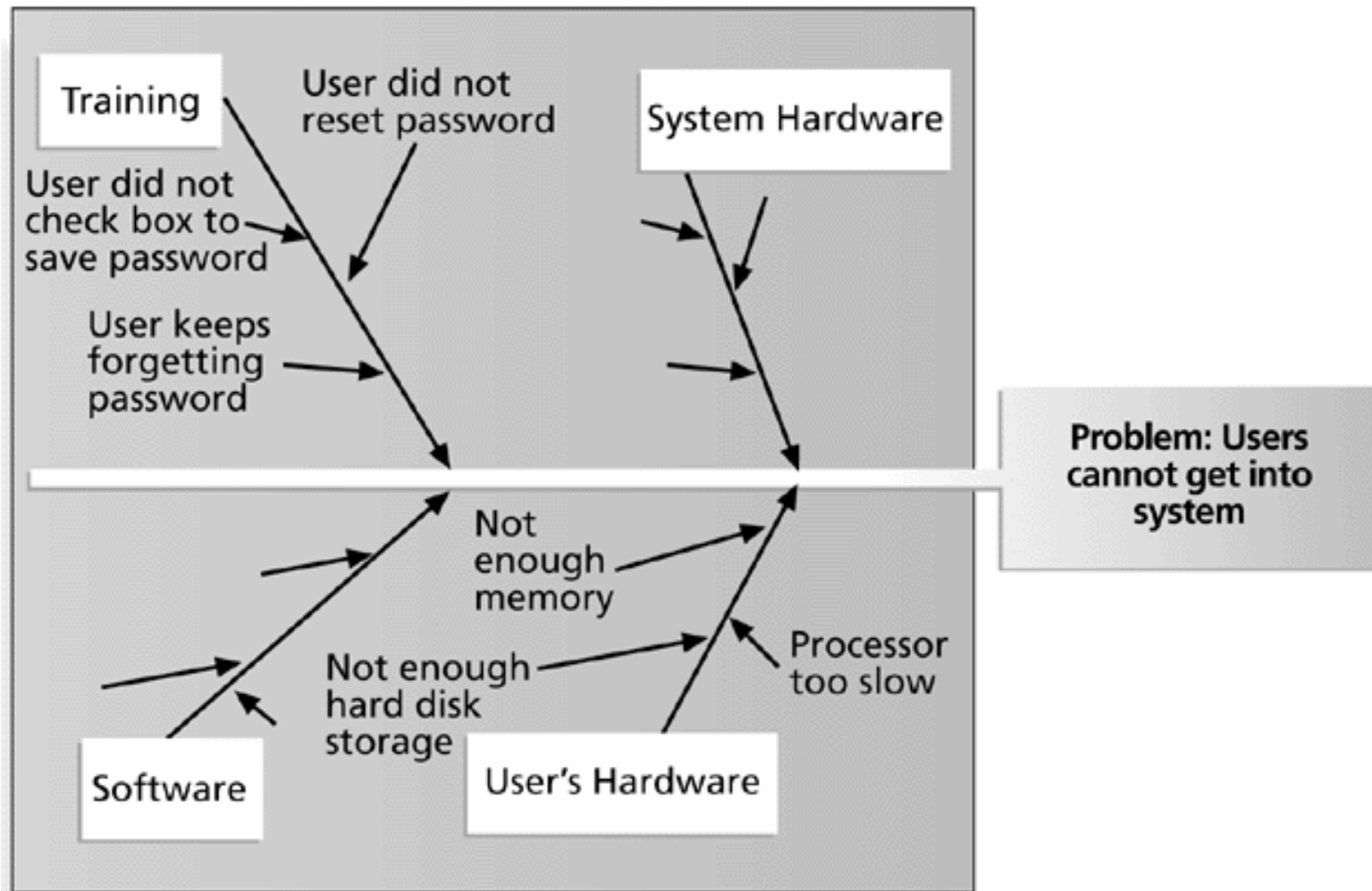
Philip Crosby (1926 – 2001)

- Train supervisors to actively carry out their part of the quality improvement program.
- Hold's “zero-defects day” to let all employees realize that there has been changed.
- Encourage individuals to establish improvement goals for themselves and their groups.
- Encourage employees to communicate to management the obstacles they face in attaining their improvement goals.
- Recognize and appreciate those who participate.
- Establish quality councils to communicate on a regular basis.
- Do it all over again to emphasize that the quality improvement program never ends.

Taguchi and Robust Design Methods

- Key concepts are that quality should be designed into the product and not inspected into it and that quality is best achieved by minimizing deviation from the target value.

Figure 8-6. Sample Fishbone or Ishikawa Diagram



Malcolm Baldrige Award

- The **Malcolm Baldrige National Quality Award** originated in 1987 to recognize companies that have achieved a level of world-class competition through quality management.
- Given by the President of the United States to U.S. businesses.
- Three awards each year in different categories:
 - Manufacturing
 - Service
 - Small business
 - Education and health care

ISO Standards

- **ISO 9000** is a quality system standard that:
 - Is a three-part, continuous cycle of planning, controlling, and documenting quality in an organization.
 - Provides minimum requirements needed for an organization to meet its quality certification standards.
 - Helps organizations around the world reduce costs and improve customer satisfaction.
- **ISO 15504**, sometimes known as SPICE (Software Process Improvement and Capability dEtermination), is a framework for the assessment of software processes.

Improving Information Technology Project Quality

- Several suggestions for improving quality for IT projects include:
 - Establish leadership that promotes quality.
 - Understand the cost of quality.
 - Focus on organizational influences and workplace factors that affect quality.
 - Follow maturity models.

Leadership

- As Joseph M. Juran said in 1945, “It is most important that top management be quality-minded. In the absence of sincere manifestation of interest at the top, little will happen below.”*
- A large percentage of quality problems are associated with management, not technical issues.

*American Society for Quality (ASQ), (www.asqc.org/about/history/juran.html).

The Cost of Quality

- The **cost of quality** is the cost of conformance plus the cost of nonconformance.
 - **Conformance** means delivering products that meet requirements and fitness for use.
 - **Cost of nonconformance** means taking responsibility for failures or not meeting quality expectations.
- A 2002 study reported that software bugs cost the U.S. economy \$59.6 billion each year and that one third of the bugs could be eliminated by an improved testing infrastructure.*

*RTI International, “Software Bugs Cost U.S. Economy \$59.6 Billion Annually, RTI Study Finds,” July 1, 2002.

Table 8-5. Costs Per Hour of Downtime Caused by Software Defects

Business	Cost per Hour Downtime
Automated teller machines (medium-sized bank)	\$14,500
Package shipping service	\$28,250
Telephone ticket sales	\$69,000
Catalog sales center	\$90,000
Airline reservation center (small airline)	\$89,500

Five Cost Categories Related to Quality

- **Prevention cost:** Cost of planning and executing a project so it is error-free or within an acceptable error range.
- **Appraisal cost:** Cost of evaluating processes and their outputs to ensure quality.
- **Internal failure cost:** Cost incurred to correct an identified defect before the customer receives the product.
- **External failure cost:** Cost that relates to all errors not detected and corrected before delivery to the customer.
- **Measurement and test equipment costs:** Capital cost of equipment used to perform prevention and appraisal activities.

Organizational Influences, Workplace Factors, and Quality

- Study by DeMarco and Lister showed that organizational issues had a much greater influence on programmer productivity than the technical environment or programming languages.
- Programmer productivity varied by a factor of one to ten across organizations, but only by 21 percent within the same organization.
- Study found no correlation between productivity and programming language, years of experience, or salary.
- A dedicated workspace and a quiet work environment were key factors to improving programmer productivity.

Expectations and Cultural Differences in Quality

- Project managers must understand and manage stakeholder expectations.
- Expectations also vary by:
 - Organization's culture
 - Geographic regions

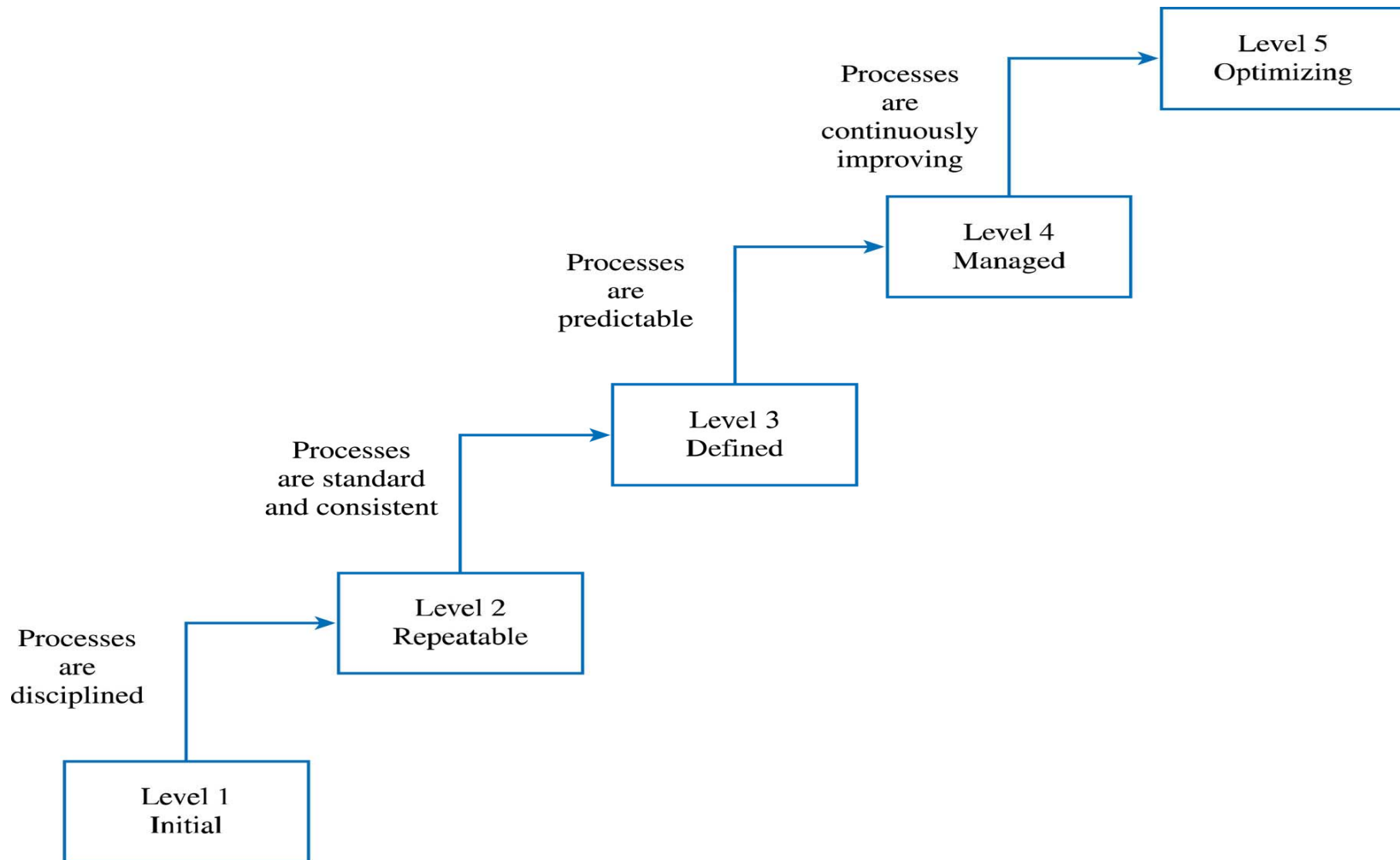
Maturity Models

- **Maturity models** are frameworks for helping organizations improve their processes and systems.
 - The **Software Quality Function Deployment Model** focuses on defining user requirements and planning software projects.
 - The Software Engineering Institute's **Capability Maturity Model** is a five-level model laying out a generic path to process improvement for software development in organizations.

The Capability Maturity Model (CMM)

- Software Engineering Institute (SEI) at Carnegie-Mellon University
- a set of recommended practices for a set of key process areas specific to software development.
- guidance as to how an organization can best control its processes for developing and maintaining software.
- path for helping organizations evolve their current software processes toward software engineering and management excellence

Levels of Software Process Maturity



Levels of Software Process Maturity

- Level 1: Initial - Characterized by an immature software organization in which the software process is ad hoc and often reactive to crises. Does not have a stable environment for software projects, and success of a project rests largely with the people on the project and not the processes that they follow.

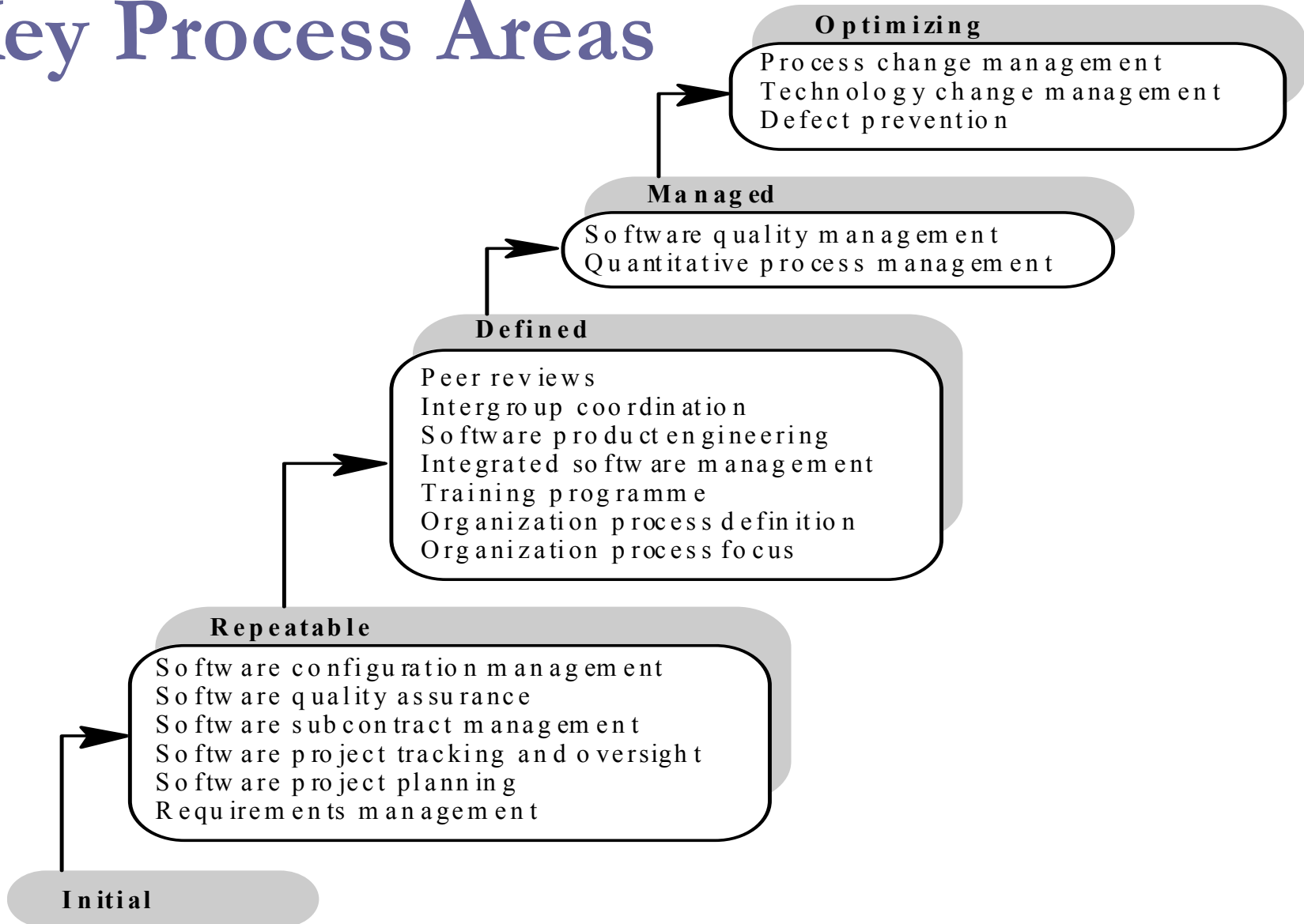
Levels of Software Process Maturity

- Level 2: Repeatable - Basic policies, processes, and controls for managing a software project are in place. Previous project successes can be repeated by other project teams on other projects.
- Level 3: Defined - Software engineering and management processes are documented and standardized throughout the organization and become the organizations standard process.

Levels of Software Process Maturity

- Level 4: Managed - Quantitative metrics for measuring and assessing productivity and quality are established for both software products and processes which are characterized as being quantifiable and predictable.
- Level 5: Optimizing- At the highest level of software process maturity, the whole organization is focused on continuous process improvement.

Key Process Areas



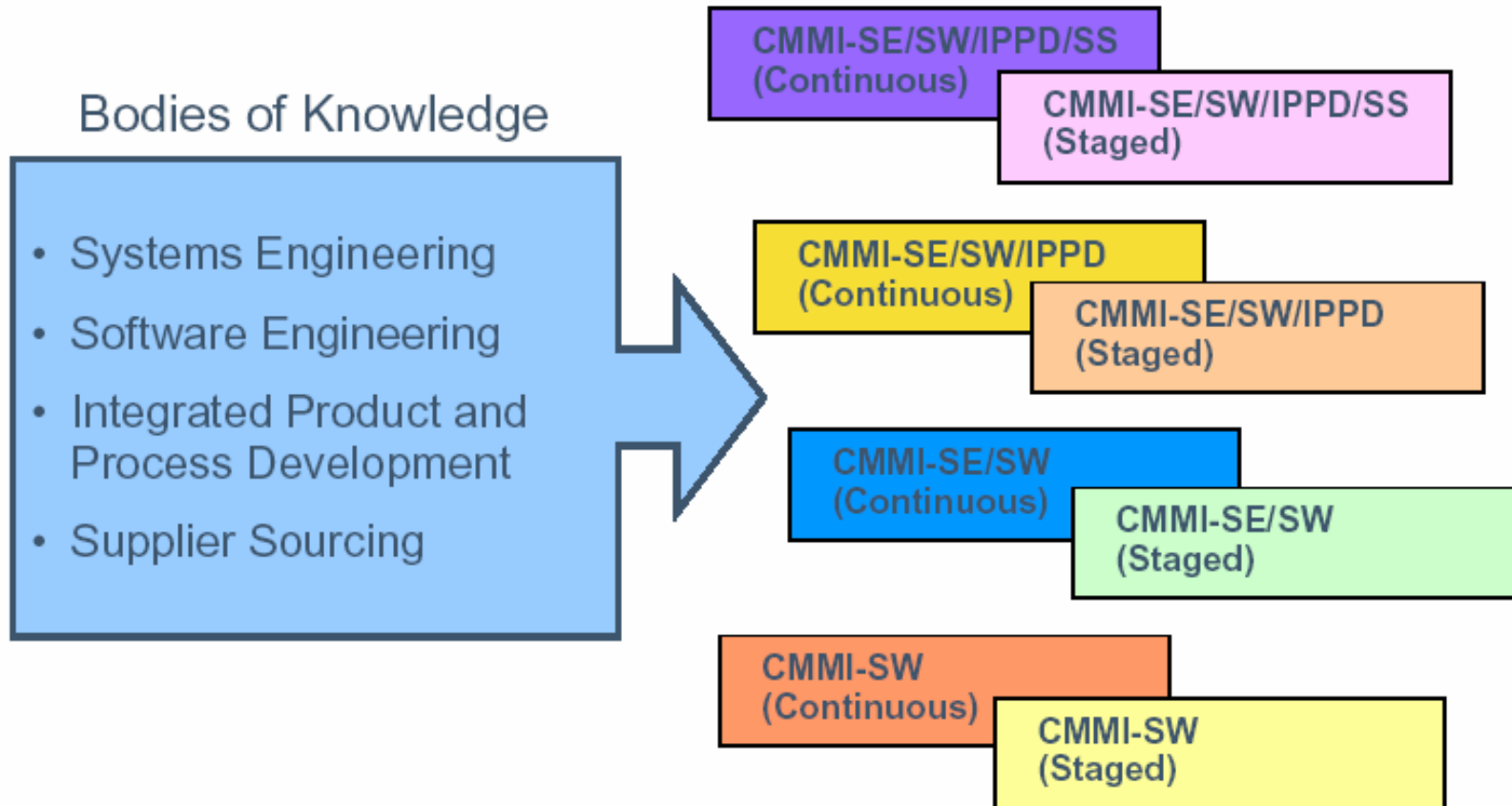
CMMI

- 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

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)

CMMI Models



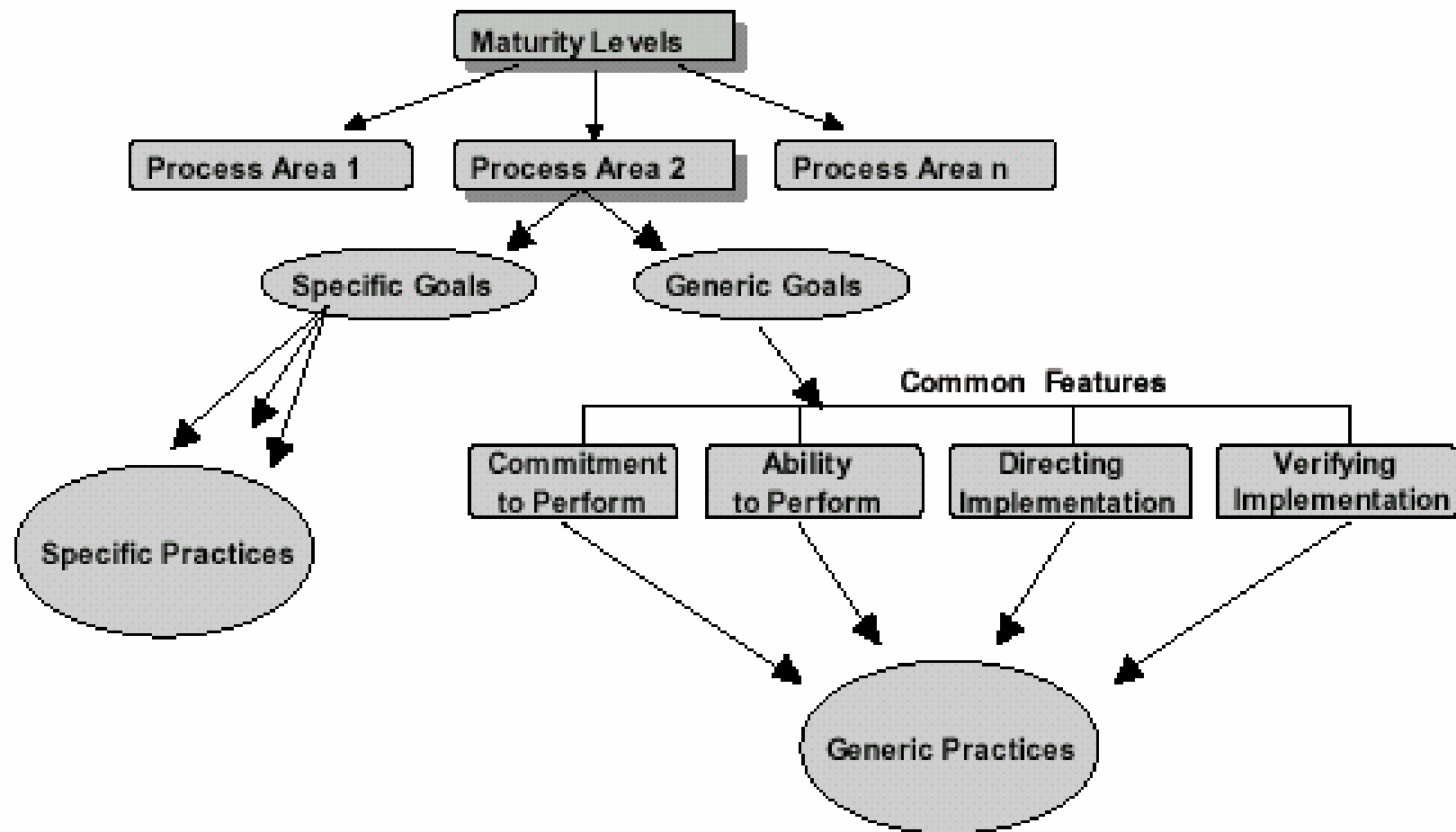
Understanding CMMI Representations

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

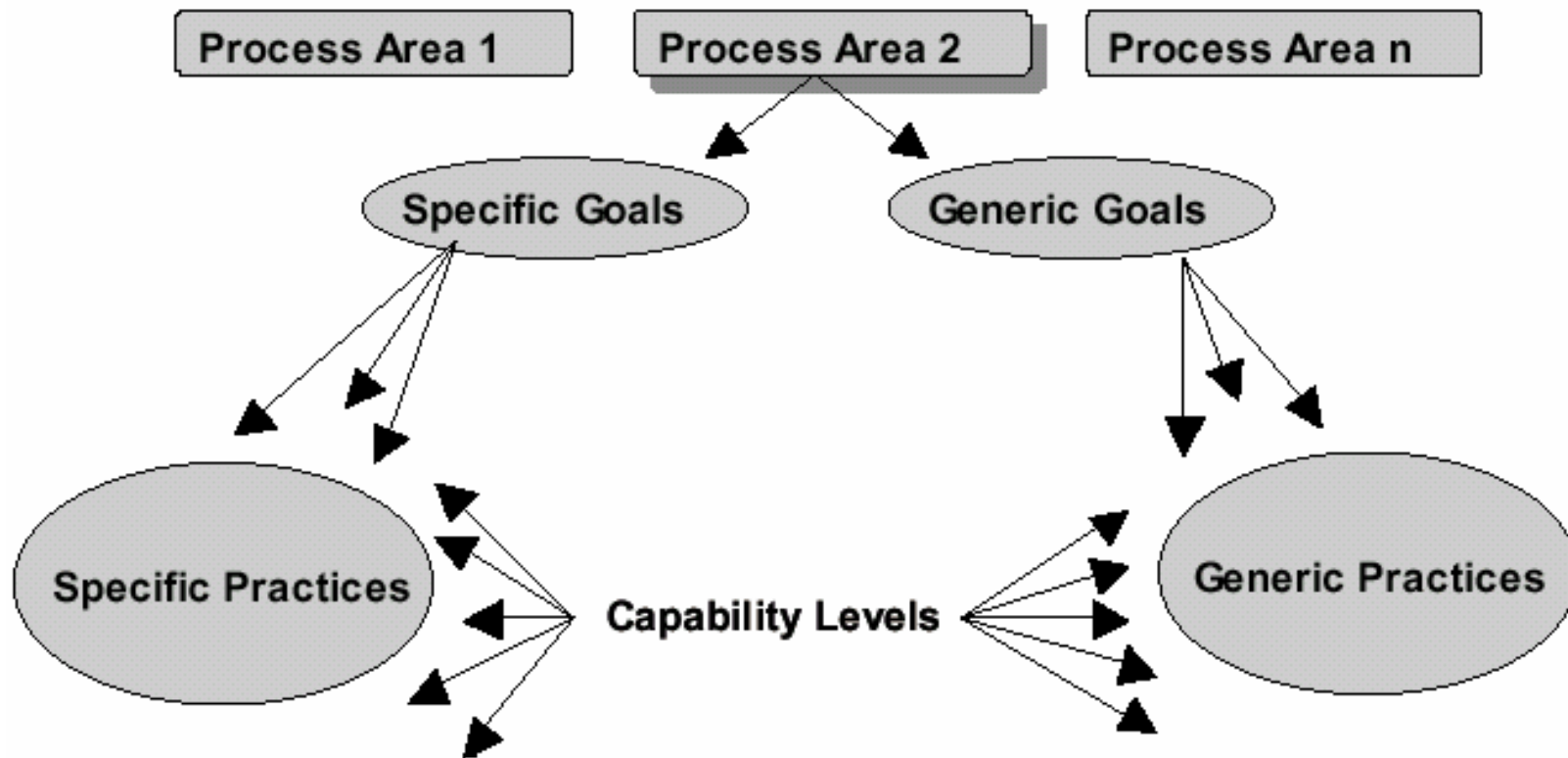
CMMI

- The CMMI defines each process area in terms of “specific goals” and the “specific practices” required to achieve these goals.
- *Specific goals* establish the characteristics that must exist if the activities implied by a process area are to be effective.
- *Specific practices* refine a goal into a set of process-related activities.

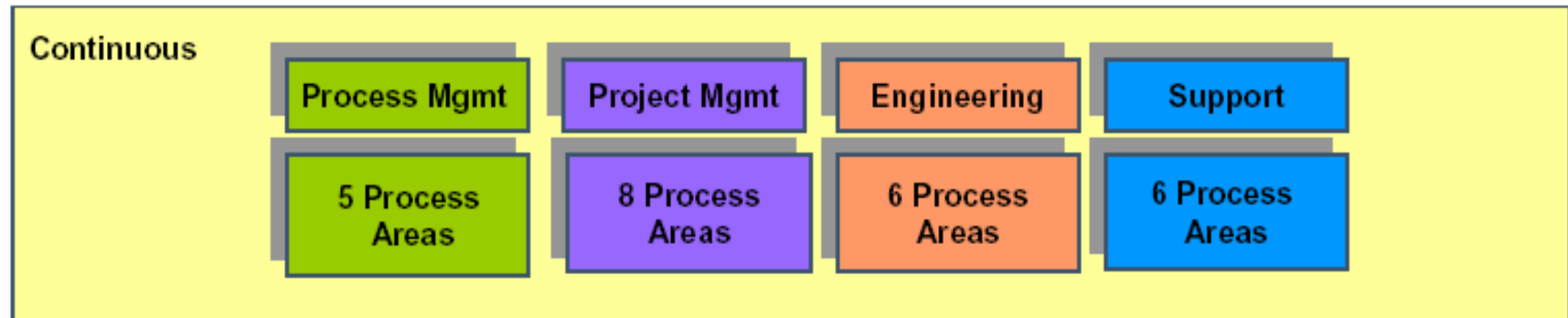
Structure of Staged Representation



Structure of Continuous Representation



Continuous View of CMMI



- 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

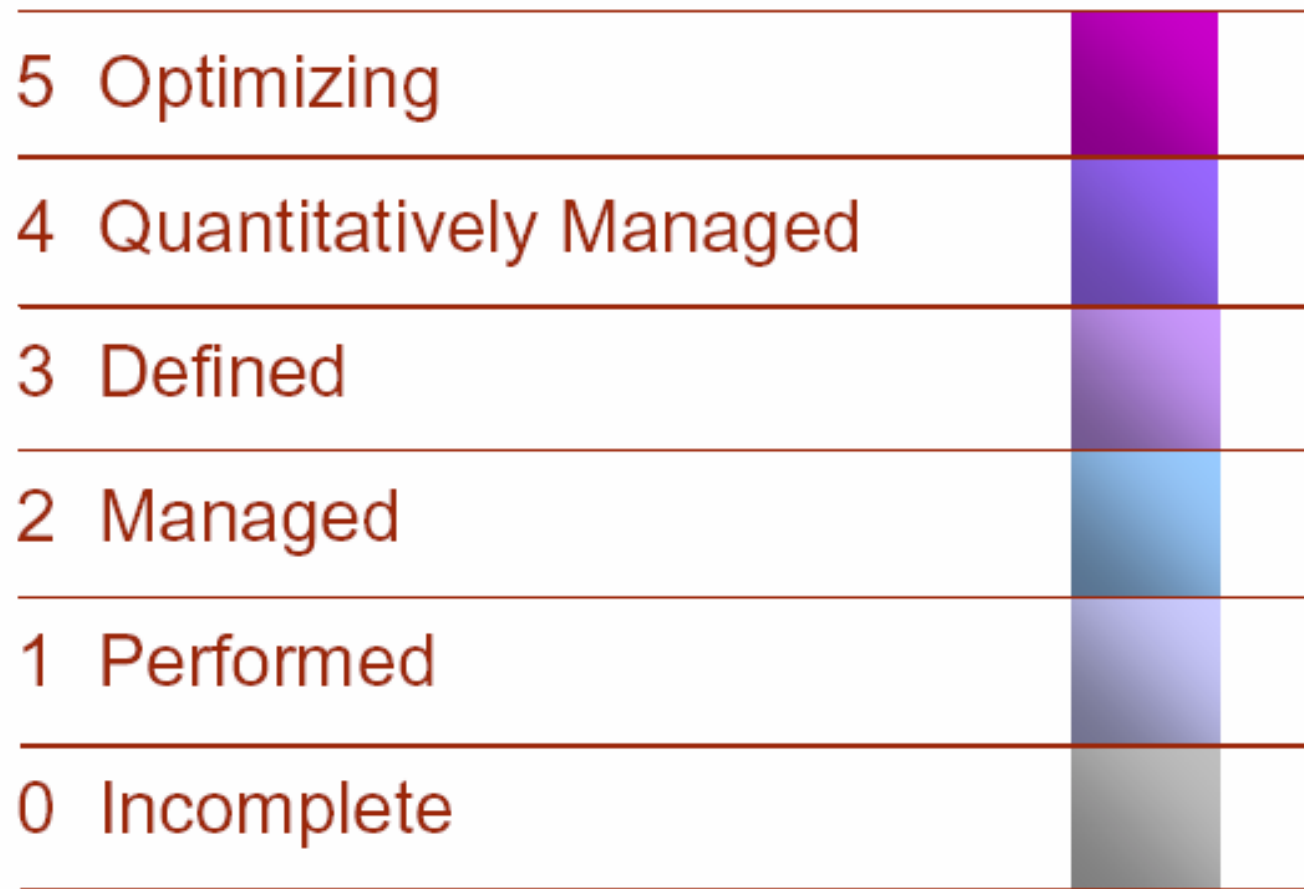
Continuous Representation

- 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: Continuous Representation

- 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).

The Capability Levels: Continuous Representation



Capability Level 0: Incomplete

- An incomplete process is a process that is either not performed or partially performed. One or more of the specific goals of the process area are not satisfied.

Capability Level 1: Performed

- A performed process is a process that satisfies the specific goals of the process area. It supports and enables the work needed to produce identified output work products using identified input work products.
- A critical distinction between an incomplete process and a performed process is that a performed process satisfies all of the specific goals of the process area.

Capability Level 2: Managed

- A managed process is a performed (capability level 1) process that is also planned and executed in accordance with policy, employs skilled people having adequate resources to produce controlled outputs, involves relevant stakeholders; is monitored, controlled, and reviewed; and is evaluated for adherence to its process description.
- The process may be instantiated by an individual project, group, or organizational function.
- Management of the process is concerned with the institutionalization of the process area and the achievement of other specific objectives established for the process, such as cost, schedule, and quality objectives.

Capability Level 3: Defined

- At the defined capability level, the organization is interested in deploying standard processes that are proven and that therefore take less time and money than continually writing and deploying new processes. Because the process descriptions, standards, and procedures are tailored from the organization's set of standard processes and related organizational process assets, defined processes are appropriately consistent across the organization.

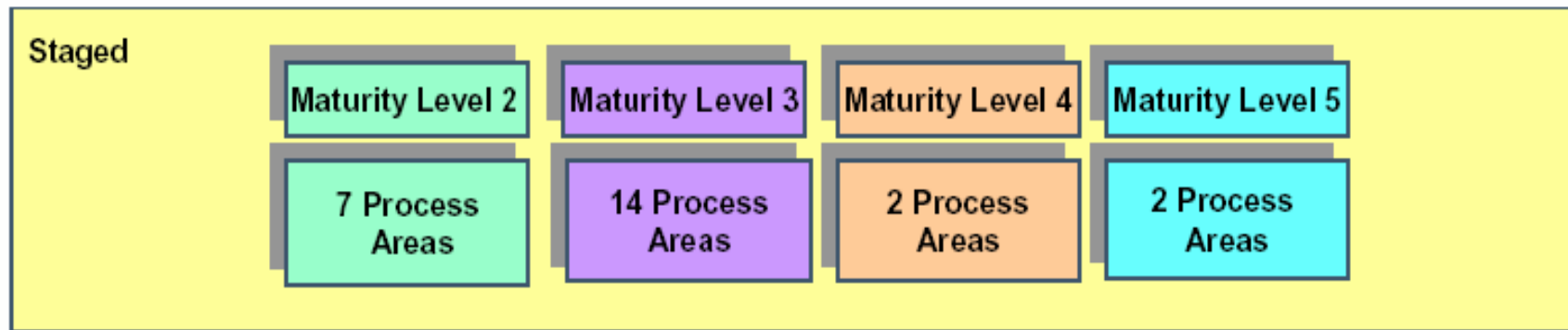
Capability Level 4: Quantitatively Managed

- A quantitatively managed process is a defined (capability level 3) process that is controlled using statistical and other quantitative techniques.
- Quantitative objectives for quality and process performance are established and used as criteria in managing the process.
- The quality and process performance are understood in statistical terms and are managed throughout the life of the process.
- The quality and process performance measures are incorporated into the organization's measurement repository to support future fact-based decision making.

Capability Level 5: Optimizing

- An optimizing process focuses on continually improving the process performance through both incremental and innovative technological improvements.
- Process improvements that would address root causes of process variation and measurably improve the organization's processes are identified, evaluated, and deployed as appropriate.
- These improvements are selected based on a quantitative understanding of their expected contribution to achieving the organization's process-improvement objectives versus the cost and impact to the organization.
- The process performance of the organization's processes is continually improved.

Staged View of CMMI



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

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

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

- Organizational Process Performance
- Quantitative Project Management

- Organizational Innovation and Deployment
- Causal Analysis and Resolution

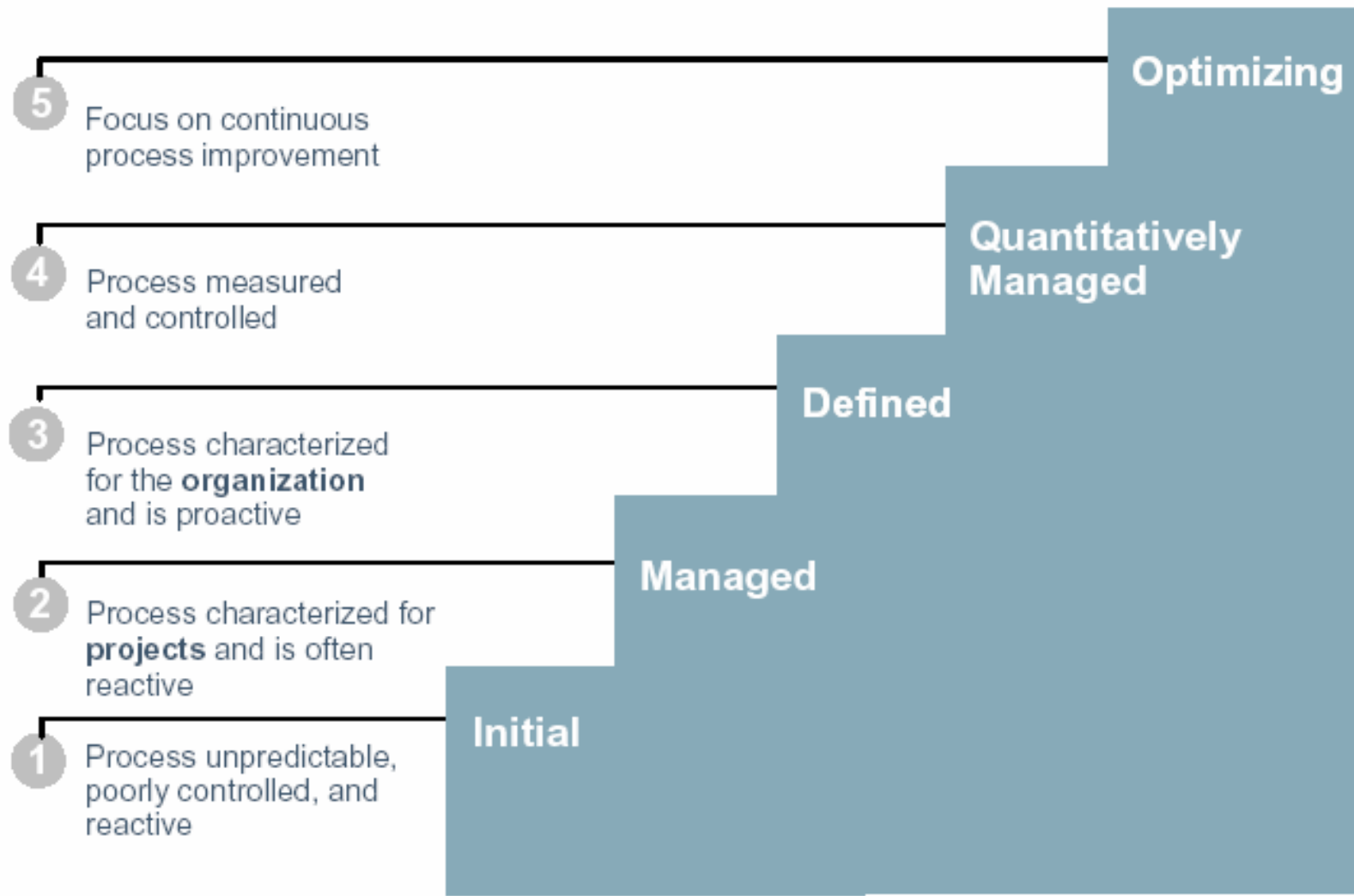
Staged Representation

- 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: Staged Representation

- 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: Staged Representation



Maturity Level 1: Initial

- Processes are usually ad hoc and chaotic.
- The organization usually does not provide a stable environment.
- Success in these organizations depends on the competence and heroics of the people in the organization and not on the use of proven processes.
- In spite of this ad hoc, chaotic environment, maturity level 1 organizations often produce products and services that work; however, they frequently exceed the budget and schedule of their projects.
- Organizations are characterized by a tendency to over commit, abandon processes in the time of crisis, and not be able to repeat their past successes.

Maturity Level 2: Managed

- The projects of the organization have ensured that requirements are managed and that processes are planned, performed, measured, and controlled.
- The process discipline reflected by maturity level 2 helps to ensure that existing practices are retained during times of stress.
- When these practices are in place, projects are performed and managed according to their documented plans.
- The status of the work products and the delivery of services are visible to management at defined points
- Commitments are established among relevant stakeholders and are revised as needed.
- Work products are reviewed with stakeholders and are controlled. The work products and services satisfy their specified requirements, standards, and objectives.

Maturity Level 3: Defined

- Processes are well characterized and understood, and are described in standards, procedures, tools, and methods.
- The organization's set of standard processes. These standard processes are used to establish consistency across the organization.
- Projects establish their defined processes by tailoring the organization's set of standard processes according to tailoring guidelines.

Maturity Level 4: Quantitatively Managed

- An organization has achieved all the specific goals of the process areas assigned to maturity levels 2, 3, and 4 and the generic goals assigned to maturity levels 2 and 3.
- Subprocesses are selected that significantly contribute to overall process performance.
- These selected subprocesses are controlled using statistical and other quantitative techniques.
- The performance of processes is controlled using statistical and other quantitative techniques, and is quantitatively predictable. At maturity level 3, processes are only qualitatively predictable.

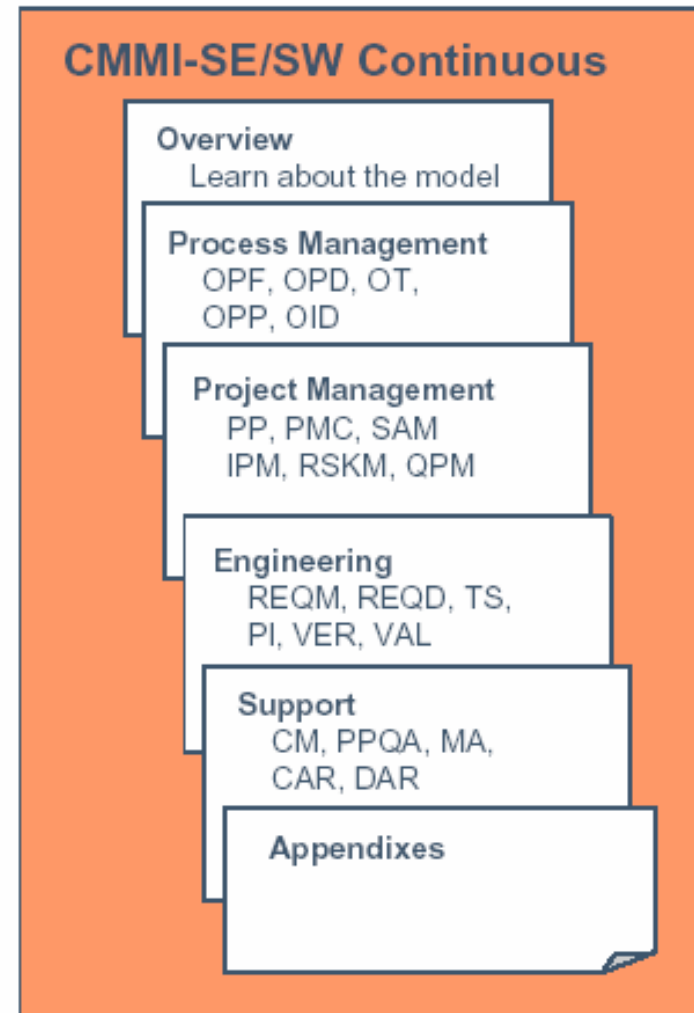
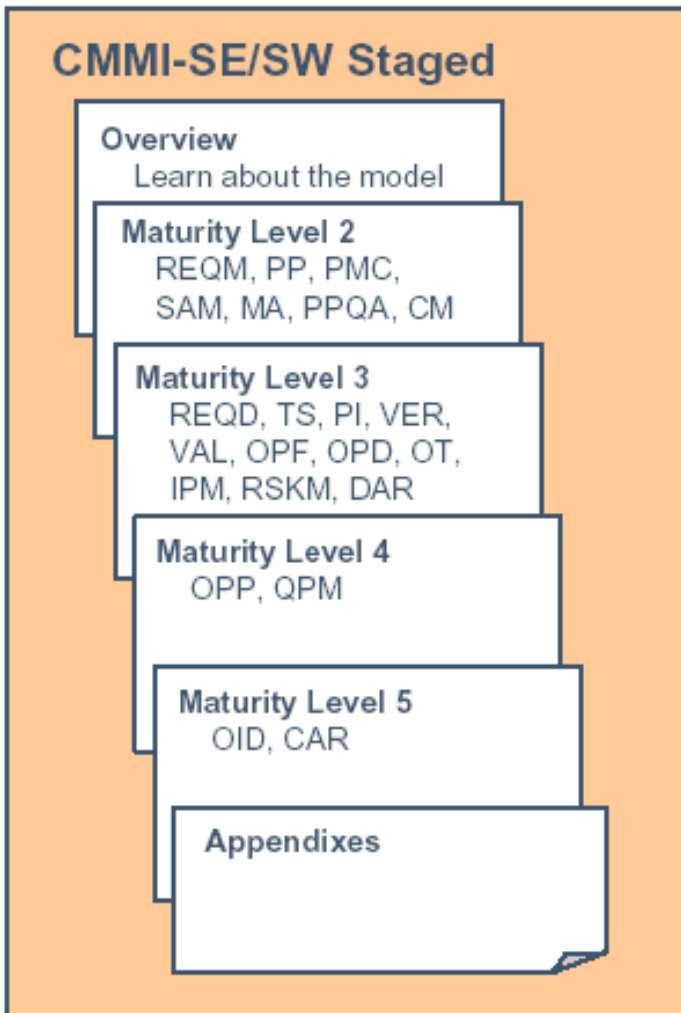
Maturity Level 5: Optimizing

- Processes are continually improved based on a quantitative understanding of the common causes of variation³ inherent in processes.
- Maturity level 5 focuses on continually improving process performance through both incremental and innovative technological improvements.
- Quantitative process-improvement objectives for the organization are established, continually revised to reflect changing business objectives, and used as criteria in managing process improvement.
- The effects of deployed process improvements are measured and evaluated against the quantitative process-improvement objectives.
- Both the defined processes and the organization's set of standard processes are targets of measurable improvement activities.

Comparing the Representations

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 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

PMI's Maturity Model

- PMI released the Organizational Project Management Maturity Model (OPM3) in December 2003.
- Model is based on market research surveys sent to more than 30,000 project management professionals and incorporates 180 best practices and more than 2,400 capabilities, outcomes, and key performance indicators.
- Addresses standards for excellence in project, program, and portfolio management best practices and explains the capabilities necessary to achieve those best practices.

Using Software to Assist in Project Quality Management

- Spreadsheet and charting software helps create Pareto diagrams, fishbone diagrams, and so on.
- Statistical software packages help perform statistical analysis.
- Specialized software products help manage Six Sigma projects or create quality control charts.
- Project management software helps create Gantt charts and other tools to help plan and track work related to quality management.

Chapter Summary

- Project quality management ensures that the project will satisfy the needs for which it was undertaken.
- Main processes include:
 - Quality planning
 - Quality assurance
 - Quality control