Capability Maturity Model (CMM)

and CMMI (CMM Integration)

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

What is CMM?

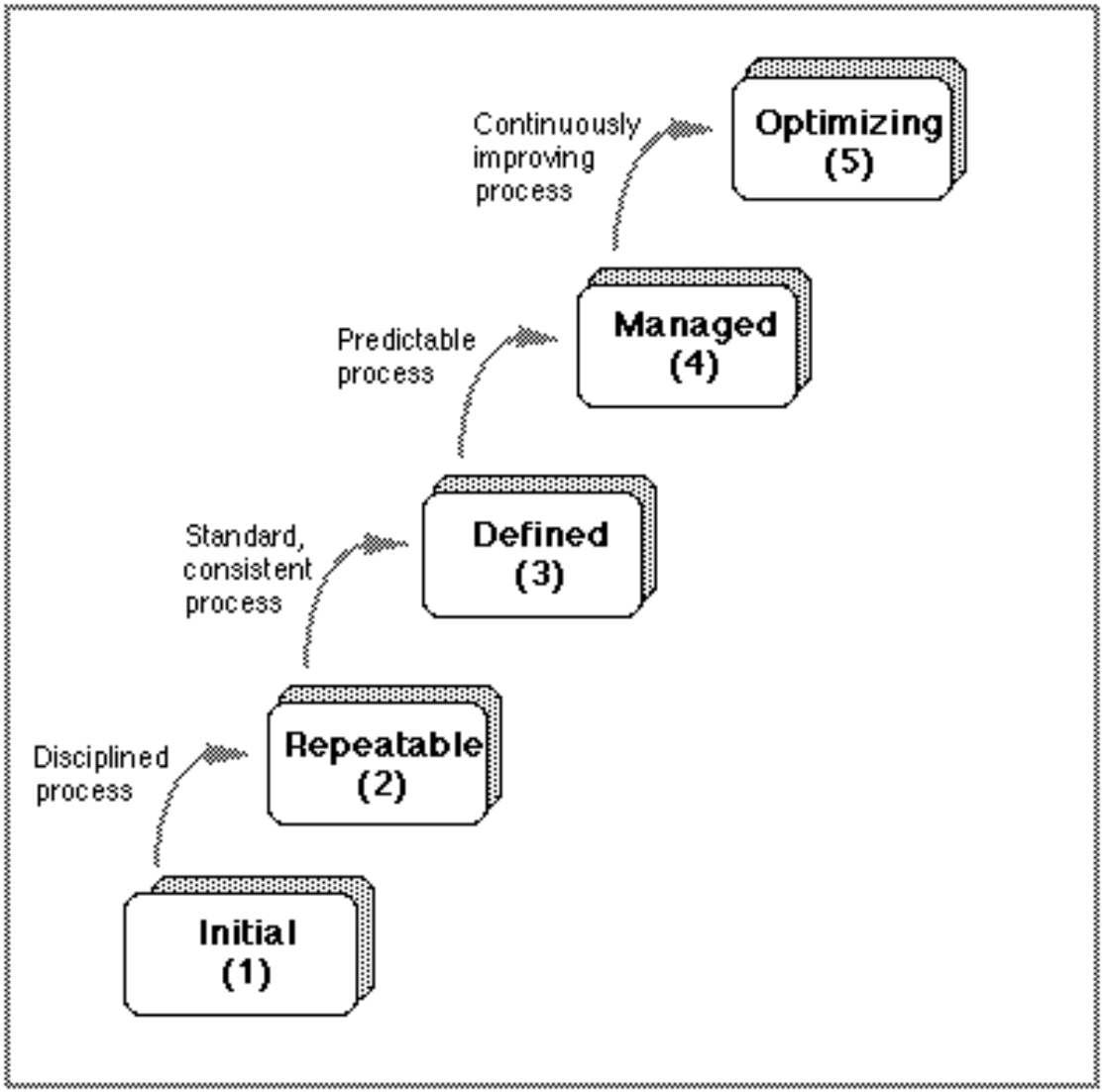
- A rating system for software **development organizations** (not software itself).
- Based on maturity of **processes**, not directly on software itself.
- Said to be derived from TQM (Total Quality Management, Peter Drucker) ideas.
- The following material is from the SEI (Software Engineering Institute) CMM web pages.

What is TQM?

TQM is management and control activities based on the leadership of top management and based on the involvement of all employees and all departments from planning and development to sales and service.

These management and control activities focus on quality assurance by which those qualities which satisfy the customer are built into products and services during the above processes and then offered to consumers.

CMM Levels


Optimizing
(5)
Continuously
improving
process
Managed
(4)
Predictable
process
Defined
(3)
Standard,
consistent
process
Repeatable
(2)
Disciplined
process
Initial
(1)

CMM Level 1: Initial

- The software development process is
  - ad hoc
  - even chaotic
- Few processes are defined, and success depends on individual effort and heroics.

CMM Level 2: Repeatable

- Basic project management processes are established to track
  - cost,
  - schedule
  - functionality.
- The necessary process discipline is in place to **repeat** earlier successes on projects with similar applications.

CMM Level 3: Defined

- The software process for both management and engineering activities is
  - documented,
  - standardized, and
  - integrated

  into a standard software process for the organization.
- All projects use an approved, tailored version of the organization's standard software process for developing and maintaining software.

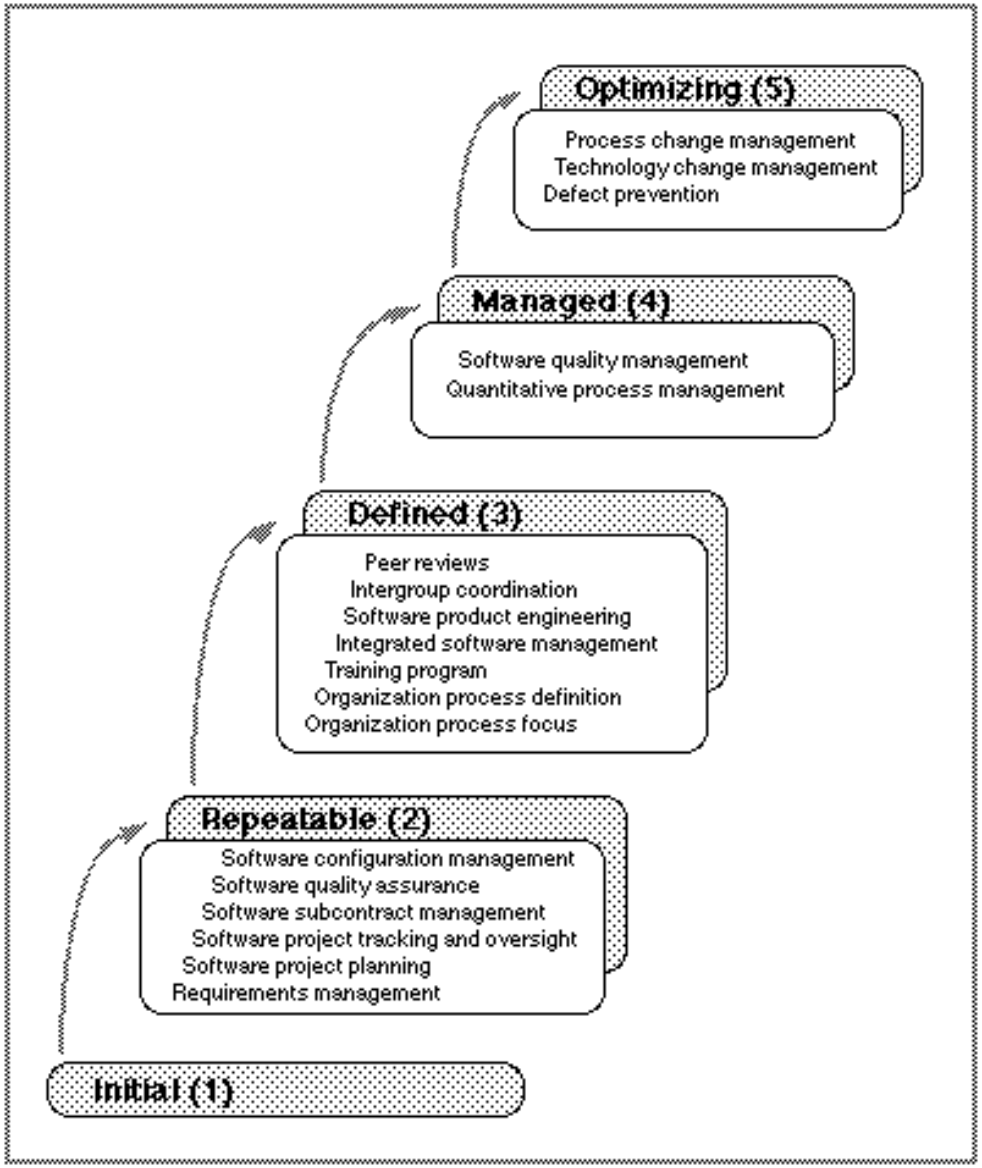
CMM Level 4: Managed

- Detailed measures of the software process and product quality are collected.
- Both the software process and products are quantitatively understood and controlled.

CMM Level 5: Optimizing

- Continuous process improvement is enabled by quantitative feedback from the process and from piloting innovative ideas and technologies.

Characteristics of Processes by Level



Process Areas for Level 2 (Repeatable)

- Requirements Management
- Software Project Planning
- Software Project Tracking and Oversight
- Software Subcontract Management
- Software Quality Assurance
- Software Configuration Management

Process Areas for Level 3 (Defined)

- Organization Process Focus
- Organization Process Definition
- Training Program
- Integrated Software Management
- Software Product Engineering
- Inter-group Coordination
- Peer Reviews

Process Areas for Level 4 (Managed)

- Quantitative Process Management
- Software Quality Management

Process Areas for Level 5 (Optimizing)

- Defect Prevention
- Technology Change Management
- Process Change Management

Management view of software development at different CMM levels

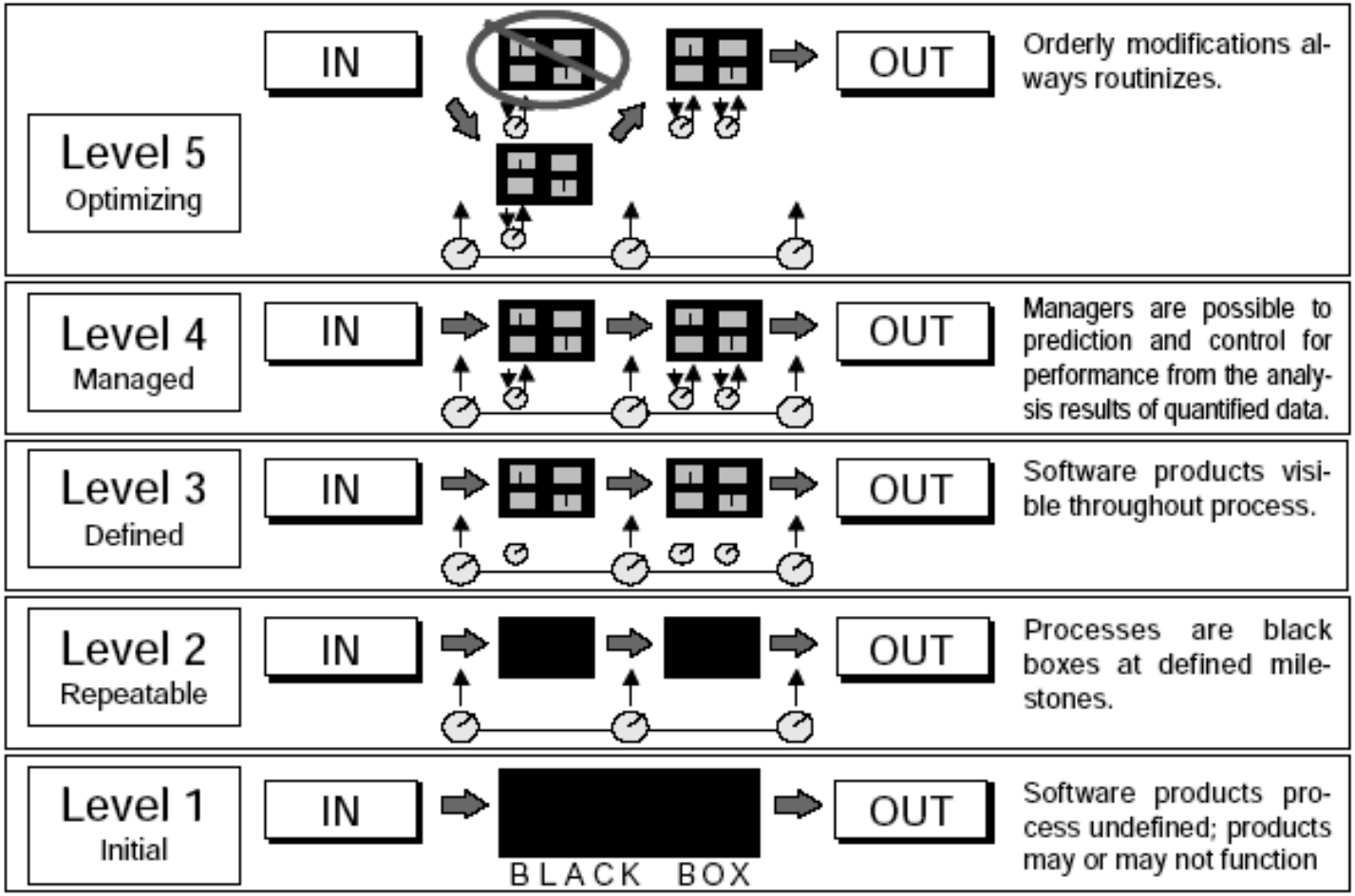


Fig.1 Management View of Process

Annotations for Management View of Software Development by CMM Level

- Level 1: an amorphous blob
- Level 2: a series of black-box stages with some visibility between stages on defined occasions
- Level 3: visibility into internal structure of stages; risk assessment possible
- Level 4: instrumented, quantitatively-controlled, predictable
- Level 5: continuous improvement of process

Probability of meeting target as a function of CMM level

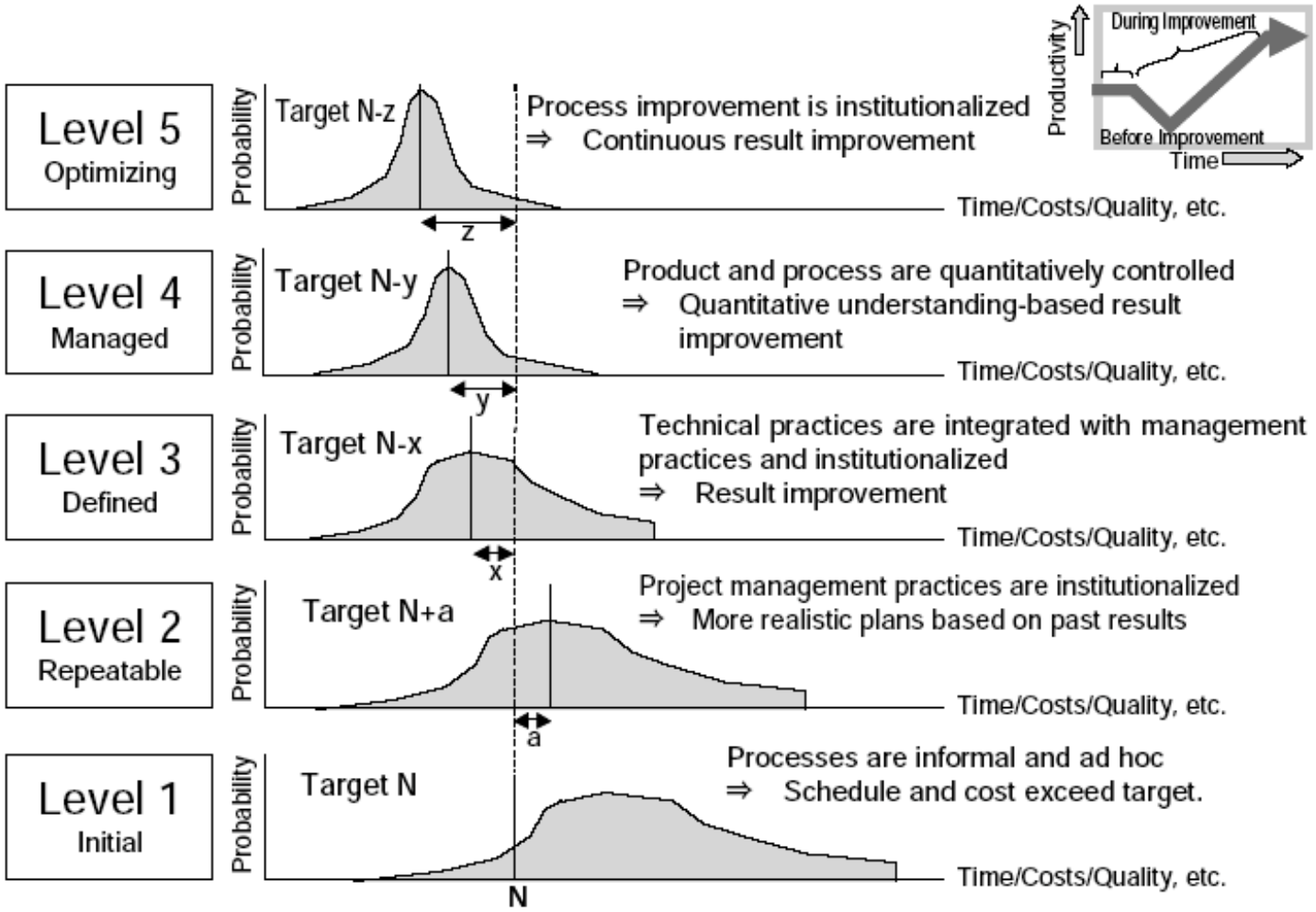
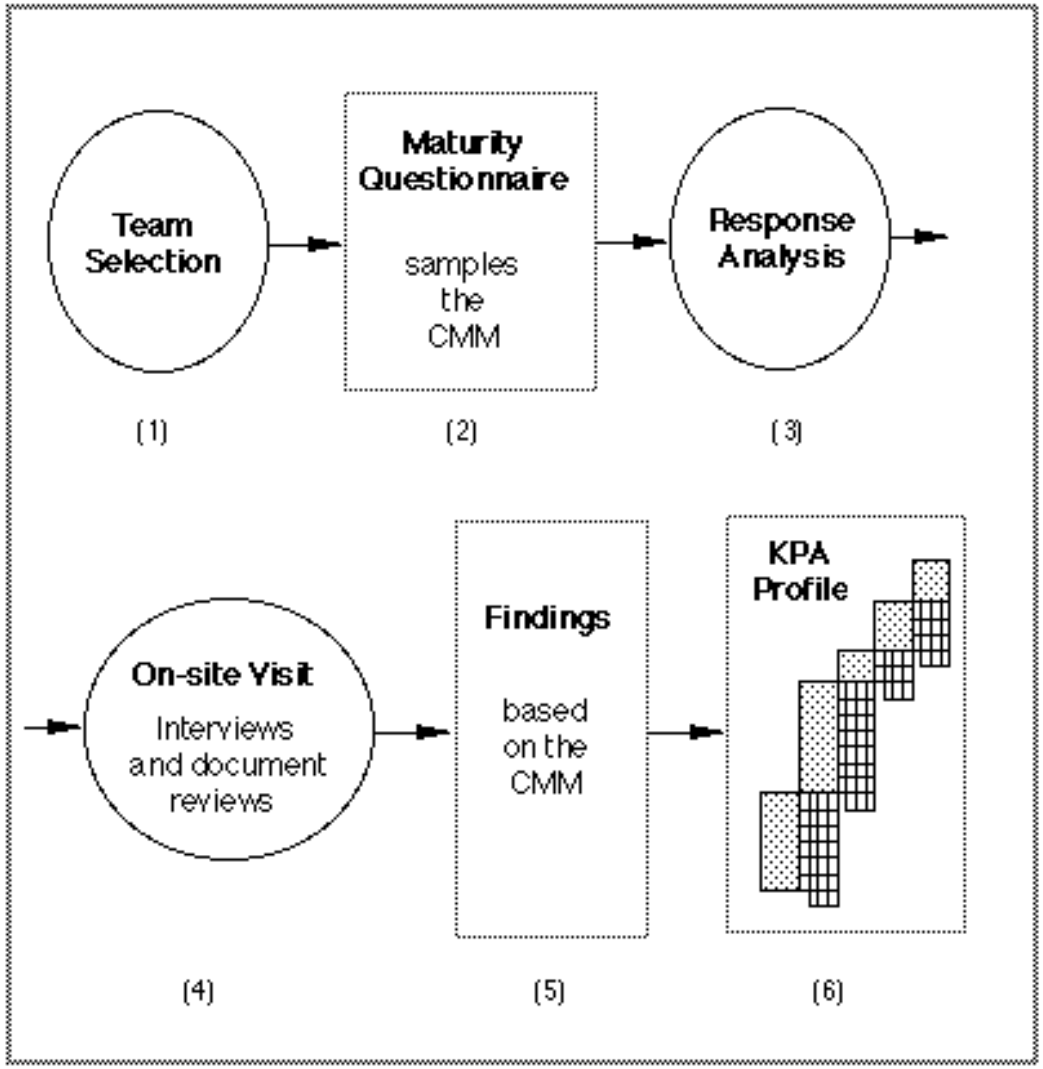


Fig.2 Evolution of Process Capability

Evaluation Process to Determine CMM Level



KPA =

key process area

Samples of Goals for Reaching a Particular Level (see http://www2.umassd.edu/SWPI/sei/tr24f/tr24_xa.html for full list)

- Level 2 (Repeatable):
  - Requirements are controlled and activities are kept consistent with requirements
  - Estimates and commitments are documented
  - Results are tracked against the plan and corrective actions taken when needed
  - Quality assurance is conducted
  - Configuration management is conducted

Samples of Goals for Reaching a Particular Level

- Level 3 (Defined):
  - Process improvement activities are in place across all areas defined in level 2.
  - Training, peer reviews, intergroup coordination, etc.
- Level 4 (Managed):
  - Quantitiative controls
- Level 5 (Optimizing):
  - Process evolution strategy

CMMI vs. CMM

- “CMMI” refers to the integration of diverse tool sets and appraisal methods related to CMM.

References

- Mark C. Paulk, Bill Curtis, Mary Beth Chrissis, and Charles V. Weber, "Capability Maturity Model, Version 1.1," IEEE Software, Vol. 10, No. 4, July 1993, pp. 18-27.

- Carnegie Mellon University, Software Engineering Institute, The Capability Maturity Model: Guidelines for Improving the Software Process, Addison-Wesley, 1995.

- http://www.sei.cmu.edu/activities/cmm/cmm.articles.html

- http://www2.umassd.edu/SWPI/sei/tr24f/tr24.html

ISO 9001

- What is it?
  - ISO = International Organization of Standards, in Geneva (similar to ANSII, except international rather than “American”)
  - ISO 9000 was adopted 1978; ISO 9001 is one of five documents in ISO 9000.
  - It is a certification method for processes, a “stamp of approval” of sorts
  - Applies to manufacturing processes, not just software

ISO 9000 Rationale

ISO 9000 is a series of international quality management standards adopted by 71 countries. **Many large corporations now require** their suppliers to be registered to an ISO 9000 standard. Registration to an ISO 9000 standard is becoming a prerequisite for doing business for second- and third-tier suppliers.

ISO 9000 standards provide **guidelines on quality management and assurance**. The focus is on the QMS of a supplier's engineering and production processes. This focus was selected in the belief that a high-quality process results in the production of high-quality goods and services.

Registration to an ISO 9000 standard provides **third-party assurance** that a supplier has a documented QMS that satisfies the standard's requirements, and that the ISO program has been implemented at the company's facility.

ISO 9000 quality standards are not specific to any industry; rather, they are general to any manufacturing process. Their application to any particular business is subject to interpretation.

ISO 9000 quality standards emphasize achieving customer satisfaction through prevention of non-conformance rather than through testing.

See http://strategis.ic.gc.ca/SSG/it02464e.html

Software Developers and ISO 9001 Registration

Software companies that wish to register their QMS to an ISO 9000 standard must implement the ISO 9001 standard requirements outlined in Appendix C.

The ISO 9001 standard is the most comprehensive quality standard in the ISO 9000 series. It applies to companies that wish to register their design, development, and production processes. Registration to ISO 9001 certifies that a company's QMS and the processes used to design, develop, produce, install, and service a product or service meet the 20 requirements specified in Appendix C.

"High-quality software is not produced by accident; it has to be planned from the start of the project, and the characteristics of quality must be built into the product. It is no good producing a system, discovering major errors at the testing stage and then trying to correct them to produce a quality product; quality cannot be added as an extra ingredient at the end of a project." Darrel Ince, Introduction to Software Project Management and Quality Assurance. London, UK: McGraw-Hill, 1993, p. 169.

THE 20 REQUIREMENTS OF ISO 9001 (1)

1 Management Responsibility
2 Quality System
3 Contract Review
4 Design Control
5 Document and Data Control
6 Purchasing
7 Control of Customer-Supplied Product
8 Product Identification and Traceability
9 Process Control
10 Inspection and Testing

(continued)

THE 20 REQUIREMENTS OF ISO 9001 (2)

11 Control of Inspection, Measuring, and Test Equipment
12 Inspection and Test Status
13 Control of Non-conforming Product
14 Corrective and Preventive Action
15 Handling, Storage, Packaging, Preservation, and Delivery
16 Control of Quality Records
17 Internal Quality Audits
18 Training
19 Servicing
20 Statistical Techniques

ISO 9001 vs. CMM

Comparison of ISO 9001 and the Capability Maturity Model for Software, Technical Report CMU/SEI-94-TR-012

Paulk, M.

The results of the analysis indicate that, although an **ISO 9001-compliant** organization would not necessarily satisfy all of the level 2 key process areas, it **would satisfy most of the CMM level 2 goals and many level 3 goals**.

Because there are practices in the CMM that are not addressed in ISO 9000, it is possible for a **level 1** organization to receive 9001 registration; similarly, there are areas addressed by ISO 9001 that are not addressed in the CMM. **A level 3 organization would have little difficulty in obtaining ISO 9001 certification**, and a level 2 organization would have significant advantages in obtaining certification.