NORTHROP GRUMMAN

DEFINING THE FUTURE

The Explicit Relationship Between CMMI and Project Risks

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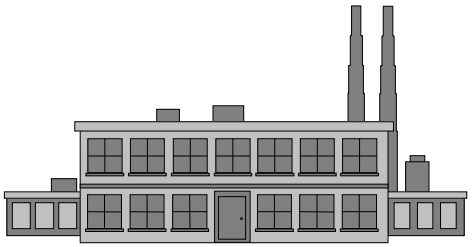
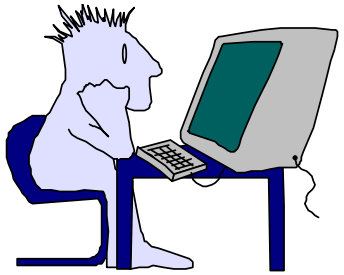
Objectives

- Describe the explicit relationship between process maturity and project risk
- Present a mapping between the Software Engineering Institute's Software Risk Taxonomy and the Capability Maturity Model Integration (CMMI)
- Illustrate how the mapping can guide
  - Project-level risk management
  - Organizational process improvement

Process Improvement versus Risk Management





Process Improvement

- Seek permanent change in practices and infrastructure
- Organizational-wide effort
- Multi-year initiative - assess, plan, implement, continue
- Long-term measurable benefits

Risk Management

- Seeks to avoid or minimize impact to project success
- Project activity
- Get-well quick - assess, handle, repeat
- Short-term relief

Goal

- **Provide a way to link the two concepts**

Do frequently occurring project risks point to a underlying process weakness?

Does an organization's current process capability suggest inherent risks for all projects?

- **Suggests a mapping between process maturity and risk**

SEI Software Risk Taxonomy

A. Product Engineering

1. Requirements
   a. Stability
   b. Completeness
   c. Clarity
   d. Validity
   e. Feasibility
   f. Precedent
   g. Scale

2. Design
   a. Functionality
   b. Difficulty
   c. Interfaces
   d. Performance
   e. Testability
   f. Hardware
   g. Non-Developmental Software

3. Code and Unit Test
   a. Feasibility
   b. Testing
   c. Coding/Implementation

4. Integration and Test
   a. Environment
   b. Product
   c. System

5. Engineering Specialties
   a. Maintainability
   b. Reliability
   c. Safety
   d. Security
   e. Human Factors
   f. Specifications

B. Development Environment

1. Development Process
   a. Formality
   b. Suitability
   c. Process Control
   d. Familiarity
   e. Product Control

2. Development System
   a. Capacity
   b. Suitability
   c. Usability
   d. Familiarity
   e. Reliability
   f. System Support
   g. Deliverability

3. Management Process
   a. Planning
   b. Project Organization
   c. Management Experience
   d. Program Interfaces

4. Management Methods
   a. Monitoring
   b. Personnel Management
   c. Quality Assurance
   d. Configuration Management

5. Work Environment
   a. Quality Attitude
   b. Cooperation
   c. Communication
   d. Morale

C. Program Constraints

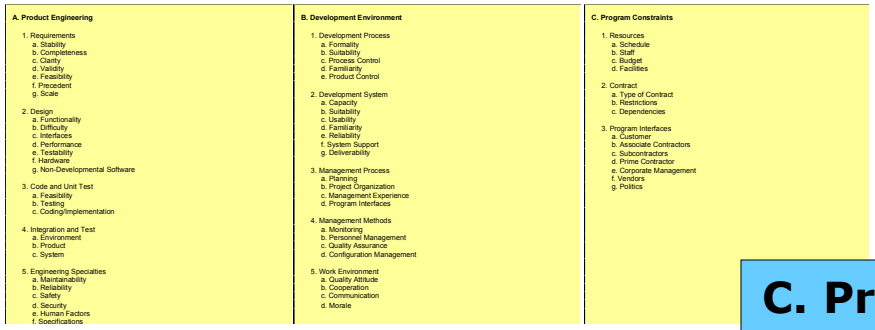
1. Resources
   a. Schedule
   b. Staff
   c. Budget
   d. Facilities

2. Contract
   a. Type of Contract
   b. Restrictions
   c. Dependencies

3. Program Interfaces
   a. Customer
   b. Associate Contractors
   c. Subcontractors
   d. Prime Contractor
   e. Corporate Management
   f. Vendors
   g. Politics

Software project risks are categorized by class, element, and attribute

Taxonomy-Based Questionnaire



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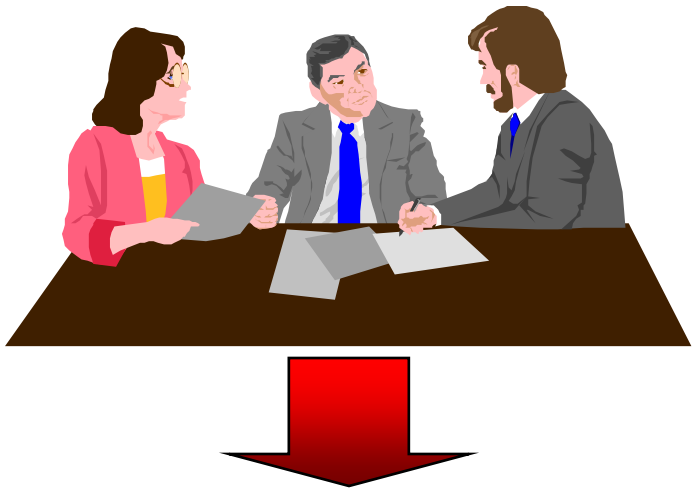


Specific Project Risks

C. Program Constraints

1. Resources

a. Schedule (*Is the schedule inadequate or unstable?)*

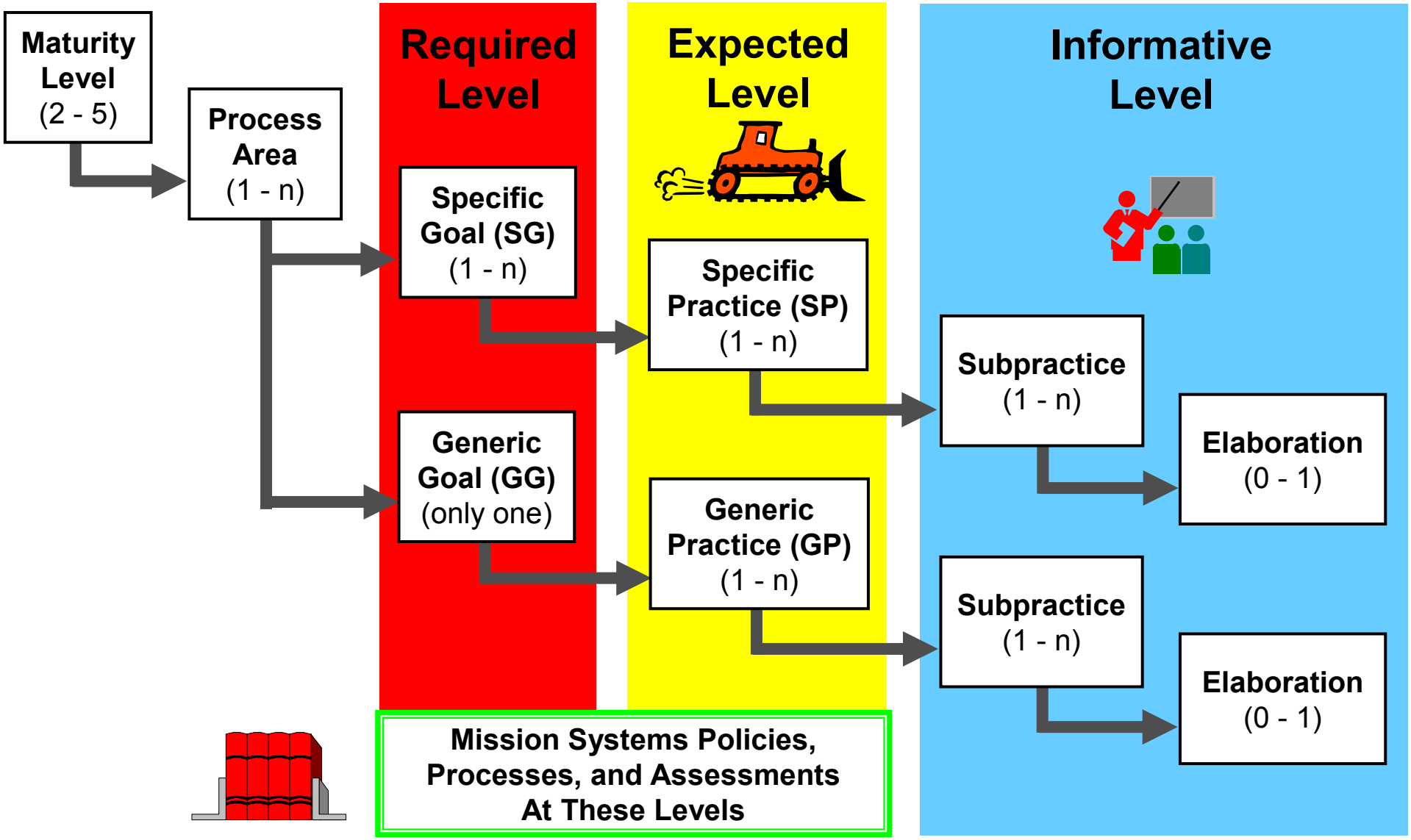
[144] Is the schedule realistic?

- (Yes) (144.a) Is the estimation method based on historical data?
- (Yes) (144.b) Has the method worked well in the past?

[145] Is there anything for which adequate schedule was not planned?

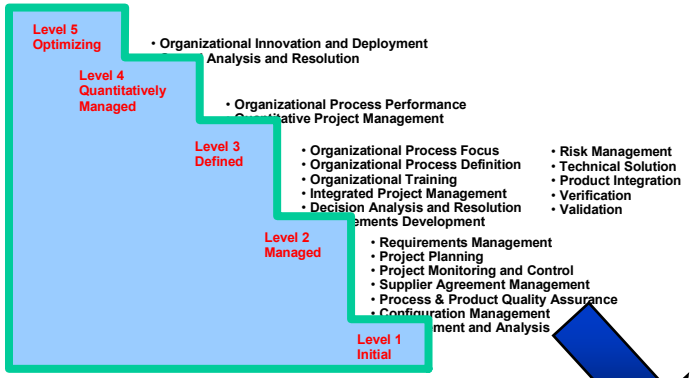
- Analysis and studies
- QA
- Training ...

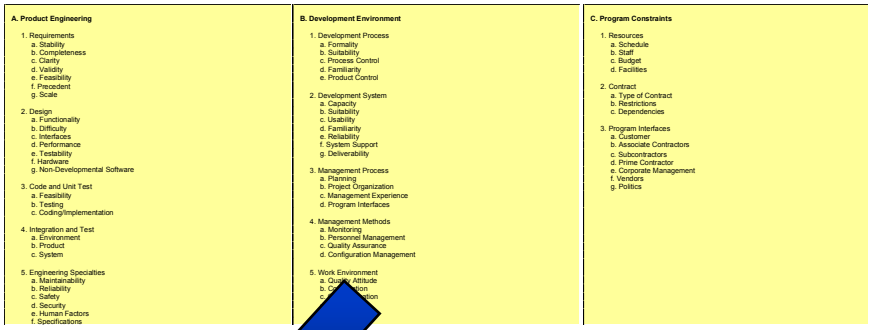
CMMI Internal Structure



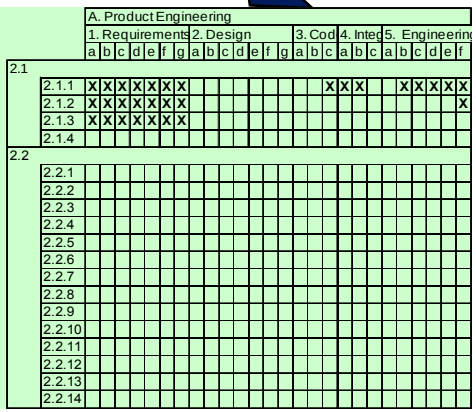
Process-Risk Mapping

- **Originally, we created a two-way mapping between the SW-CMM and the Software Risk Taxonomy (see references at the end)**





Requirements Management
Develop an understanding with the requirements providers on the meaning of the requirements
Obtain commitment to the requirements from the project participants
Manage changes to the requirements as they evolve during the project
Maintain bidirectional traceability among the requirements and project plans
Software Project Planning
Establish a top-level breakdown structure to estimate the scope of the project
Establish and maintain estimates of the attributes of the work products and tasks
Define the project life-cycle phases upon which to scope the planning effort
Estimate the project effort and cost for the work products and tasks based on estimation rationale
Identify and analyze project risks
Plan for the management of project data
Plan for necessary resources to perform the project
Plan for knowledge and skills needed to perform the project
Plan the involvement of identified stakeholders
Establish and maintain the overall project plan content
Review all plans that affect the project to understand project commitments
Reconcile the project plan to reflect available and estimated resources
Obtain commitment from relevant stakeholders responsible for plan execution
Software planning data are recorded.



- **Now, we have generalized the Taxonomy to include SE, and are mapping it to the CMMI**

A Closer Look At the Matrix

		A. Product Engineering																								
		1. Requirements							2. Design							3. Cod			4. Integ			5. Engineering				
		a	b	c	d	e	f	g	a	b	c	d	e	f	g	a	b	c	a	b	c	a	b	c	d	e	f
Requirements Management	2.1																										
Develop an understanding with the requirements providers on the meaning of the requirements	2.1.1	X	X	X	X	X	X	X										X	X	X			X	X	X	X	X
Obtain commitment to the requirements from the project participants	2.1.2	X	X	X	X	X	X	X																			X
Manage changes to the requirements as they evolve during the project	2.1.3	X	X	X	X	X	X	X																			
Maintain bidirectional traceability among the requirements and project plans	2.1.4																										
Software Project Planning	2.2																										
Establish a top-level breakdown structure to estimate the scope of the project	2.2.1																										
Establish and maintain estimates of the attributes of the work products and tasks	2.2.2																										
Define the project life-cycle phases upon which to scope the planning effort	2.2.3																										
Estimate the project effort and cost for the work products and tasks based on estimation rationale	2.2.4																										
Identify and analyze project risks	2.2.5																										
Plan for the management of project data	2.2.6																										
Plan for necessary resources to perform the project	2.2.7																										
Plan for knowledge and skills needed to perform the project	2.2.8																										
Plan the involvement of identified stakeholders	2.2.9																										
Establish and maintain the overall project plan content	2.2.10																										
Review all plans that affect the project to understand project commitments	2.2.11																										
Reconcile the project plan to reflect available and estimated resources	2.2.12																										
Obtain commitment from relevant stakeholders responsible for plan execution	2.2.13																										
Software planning data are recorded.	2.2.14																										

Risk Identification Methodology

("If…Then...")

Project characteristics & constraints
Corporate experience
Project results
Templates, questionnaires

→ **Risk Identification** → *Risk list*

Determines the subset of risks that warrant further analysis

Approaches

- **Brainstorming**
- **Subject Matter Expert (SME) Interviews**
- **Taxonomy-based risk identification (SEI, WBS)**
- **Lessons Learned, checklists**
- **Evaluating key** assumptions **and drivers**
- **CAIV studies**
- **TPMs, Metrics**
- **Simulations, Fault tree analyses, Decision analyses**
- **Design and project reviews, TIMs**
- **Problem reports and test results, especially via** trend analysis

Use of Project Risk Assessments

- **Collect current risks for all projects; use Taxonomy to categorize and identify common areas of risk across projects**
- **Use mapping to identify underlying process weaknesses**

- **In an organization of 10 projects, 8 perceive a risk in**
  - **A. 2.c. Requirements Instability**
- **Mapping: Underlying weaknesses in Requirements Management**
  - **SP 1.1: Develop an understanding with the requirements providers on the meaning of the requirements.**
  - **SP 1.2: Obtain commitment to the requirements from the project participants.**
  - **SP 1.3: Manage changes to the requirements as they evolve during the project.**
- **Project risk mitigation: concentrate on these activities**
- **Organizational process improvement: implementation and institutionalization of these activities**

Use of Organization Maturity Assessments

- **Assess organizational maturity across all projects; identify CMMI deficiencies**
- **Use mapping to identify potential project risks**
- **CMMI-based assessment findings indicate weakness in:**
  - —*Requirements Management, SP 1.1:*
    Develop an understanding with the requirements providers on the meaning of the requirements.
- **Mapping suggests potential project risks in:**
  A. Product Requirements
    1. Requirements
       a. Stability
       b. Completeness
       c. Clarity
       d. Validity
       e. Feasibility
       f. Precedent
       g. Scale
- **Projects are forewarned of potential risk**

Higher Levels of CMMI Maturity Lead to Lower Risk

- **Level 2 expects a start at risk management**
  - Project Planning SP 2.2 Identify and analyze project risks.
- **Level 3 provides the Risk Management Process Area**
  - Establishes a defined process with additional breadth of subject and organizational coverage
  - Risk sources and categories used to more effectively identify and handle risks.
- **Level 4 quantitatively defines the impact of risk on project success**
  - Process volatility a major source of risk
  - Data allows better prioritization and control of risks
- **Level 5 activities produce action proposals which often address sources of high risk**
  - Requirement volatility
  - Architectural interfaces
  - Software code complexity

Conclusions

- **The process-risk mapping provides a powerful tool**
  - **Identifies systemic sources of project risk**
  - **Targets high-value organizational process improvement needs**

- **References**
  - **"Taxonomy Based Risk Identification," Marv Carr, et al, CMU/SEI-93-TR-6, Software Engineering Institute, June 1993**
  - **"Capability Maturity Model Integration (CMMI[SM])", Version 1.1, Staged Representation, CMU/SEI-2002-TR-002, December 2001**
  - **"Systemic Process Improvement Strategies for Risk Mitigation ", Rick Hefner and Marv Carr, Fourth SEI Conference on Software Risk, Nov 1995**