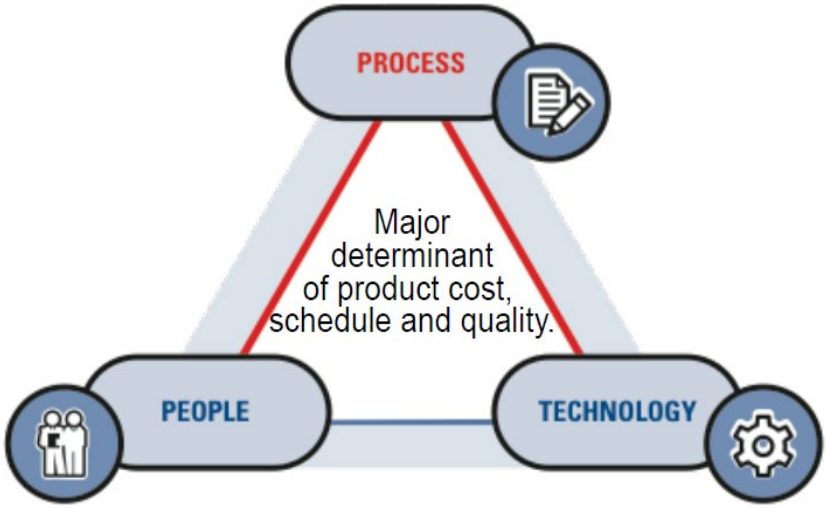
CSIT314 Software Development Methodologies

Introduction to Capability Maturity Model Integration (CMMI) model

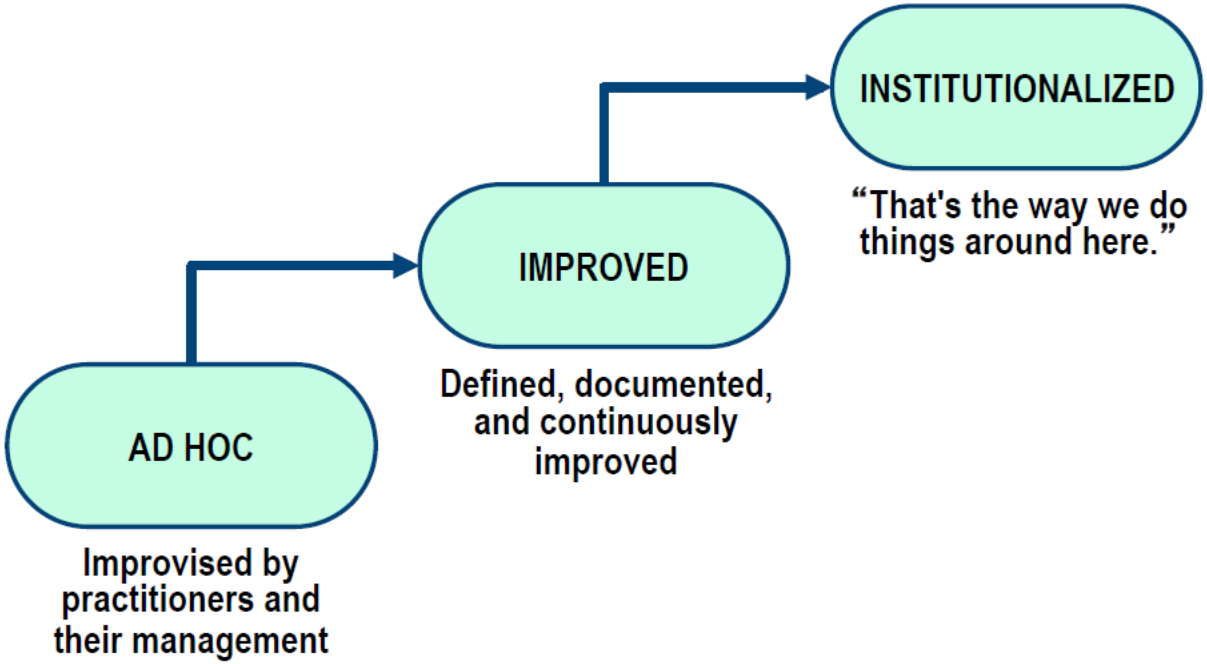
Acknowledgement: Lecture slides are adapted from *Software Engineering Institute CMMI.*

Definition of Process

- A set of interrelated activities, which transform inputs into outputs, to achieve a given purpose.
- The quality of a system is highly influenced by the quality of the process used to acquire, develop, and maintain it.
  - WHY?

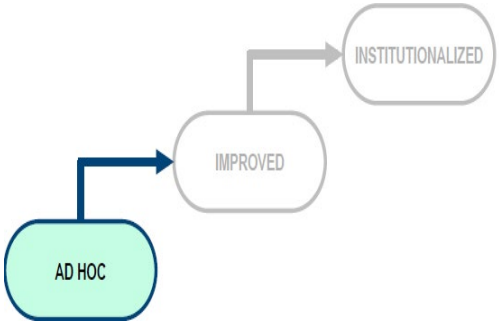


Evolutionary Improvement



Ad Hoc Processes

- Process descriptions are **not rigorously followed or enforced**.
- Performance is highly dependent on current practitioners.
- Understanding of the current status of a project is limited.
- Immature processes result in fighting fires:
  - There is no time to improve—instead, practitioners are constantly reacting.
  - Firefighters get burned.
  - Embers might rekindle later.



- *Can you think of an example of Ad Hoc processes?*

Improved Processes

- Process descriptions are **consistent** with the way work actually is done.
- Processes are supported **visibly** by management and others.
- They are **well controlled**—process fidelity is evaluated and enforced.
- There is **constructive** use of product and process measurement.
- Technology is introduced in a disciplined manner.

- *Can you think of an example of Improved Processes?*

Institutionalized Processes

- The organization builds an infrastructure that contains effective, usable, and consistently applied processes.
- The organizational culture conveys the process.
- Management nurtures the culture.
- Culture is conveyed through role models and recognition.
- Institutionalized processes endure after the people who originally defined them have gone.

- *Can you think of an example of Institutionalized Processes?*

Why capability counts?

- See this video clip

https://www.youtube.com/watch?v=FzNeUFnyous

What is CMMI?

- CMMI (Capability Maturity Model Integration) is a proven industry framework to improve product quality and development efficiency for both hardware and software
  - Sponsored by US Department of Defence in cooperation with Carnegie Mellon University and the Software Engineering Institute (SEI)
  - Many companies have been involved in CMMI definition such as Motorola and Ericsson
  - CMMI has been established as a model to improve business results

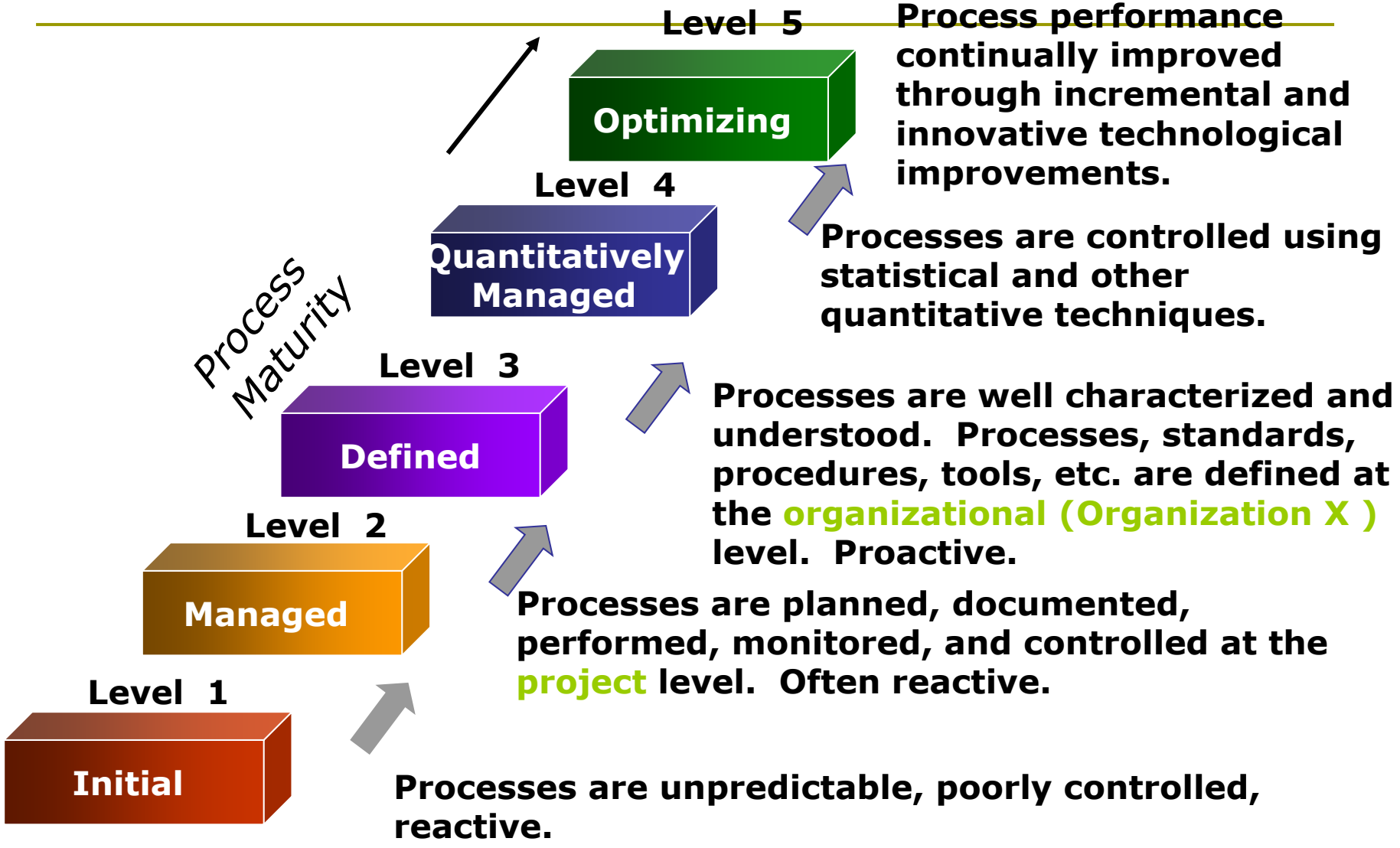
What is CMMI?

- CMMI, staged, uses 5 levels to describe the maturity of the organization, same as predecessor CMM
  - Vastly improved version of the CMM
  - Emphasis on business needs, integration and institutionalization

CMMI for Process Improvement

- Use CMMI in process improvement activities as:
  - a collection of **best practices**
  - framework for organizing and prioritizing activities
  - support for the coordination of **multi-disciplined activities** that might be required to successfully build a product
  - means to emphasize the alignment of the **process improvement objectives** with **organizational business objectives**

CMMI Staged Representation - 5 Maturity Levels



Maturity Level 1 Initial

- Maturity Level 1 deals with performed processes.
- Processes are unpredictable, poorly controlled, reactive.
- The process performance may not be stable and may not meet specific objectives such as quality, cost, and schedule, but useful work can be done.

Maturity Level 2 Managed at the Project Level

- Maturity Level 2 deals with managed processes.
- A managed process is a performed process that is also:
  - Planned and executed in accordance with policy
  - Employs skilled people
  - Adequate resources are available
  - Controlled outputs are produced
  - Stakeholders are involved
  - The process is reviewed and evaluated for adherence to requirements
- Processes are planned, documented, performed, monitored, and controlled at the project level. Often reactive.
- The managed process comes closer to achieving the specific objectives such as quality, cost, and schedule.

Maturity Level 3
Defined at the Organization Level

- Maturity Level 3 deals with defined processes.
- A defined process is a managed process that:
  - Well defined, understood, deployed and executed across the entire **organization**. Proactive.
  - Processes, standards, procedures, tools, etc. are defined at the organizational (Organization X) level. Project or local tailoring is allowed, however it must be based on the organization's set of standard processes and defined per the organization's tailoring guidelines.
- Major portions of the organization cannot "opt out."

CMMI Process Areas

- Within each of the 5 Maturity Levels, there are basic functions that need to be performed – these are called **Process Area**s (PAs).
- CMMI process areas are classified into four groups:
  - Process Management
  - Project Management
  - Engineering
  - Support
- Each process area is defined by a set of **goals** and **practices**
- There are 22 process areas

CMM Process Areas (cont.)

- Support:
  - Causal Analysis & Resolution
    - identify causes of defects and other problems and take action to prevent them from occurring in the future
  - Decision Analysis & Resolution
    - analyze possible decisions using a formal evaluation process that evaluates identified alternatives against established criteria.

Adapted from https://www.tutorialspoint.com/cmmi/cmmi-process-areas.htm

CMM Process Areas (cont.)

- Support:
  - Measurement & Analysis
    - develop and sustain a measurement capability that is used to support management information needs.
  - Process & Product Quality Assurance
    - provide staff and management with objective insight into processes and associated work products.
  - Configuration Management
    - establish and maintain the integrity of work products using configuration identification, configuration control, configuration status accounting, and configuration audits.

Adapted from https://www.tutorialspoint.com/cmmi/cmmi-process-areas.htm

CMM Process Areas (cont.)

- Project Management:
  - Quantitative Project Management
    - quantitatively manage the project's defined process to achieve the project's established quality and process-performance objectives.
  - Integrated Project Management
    - establish and manage the project and the involvement of the relevant stakeholders according to an integrated and defined process that is tailored from the organization's set of standard processes.

Adapted from https://www.tutorialspoint.com/cmmi/cmmi-process-areas.htm

CMM Process Areas (cont.)

- Project Management:
  - Risk Management
    - to identify potential problems before they occur so that risk-handling activities can be planned and invoked as needed across the life of the product or project to mitigate adverse impacts on achieving objectives.
  - Project Planning
    - establish and maintain plans that define project activities.

Adapted from https://www.tutorialspoint.com/cmmi/cmmi-process-areas.htm

CMM Process Areas (cont.)

- Project Management:
  - Project Monitoring & Control
    - provide an understanding of the project's progress so that appropriate corrective actions can be taken when the project's performance deviates significantly from the plan.
  - Supplier Agreement Management
    - manage the acquisition of products from suppliers for which there exists a formal agreement.

Adapted from https://www.tutorialspoint.com/cmmi/cmmi-process-areas.htm

CMM Process Areas (cont.)

- Engineering:
  - Requirements Development
    - to produce and analyze customer, product, and product-component requirements.
  - Technical Solution
    - design, develop, and implement solutions to requirements. Solutions, designs, and implementations encompass products, product components, and product-related life-cycle processes either singly or in combination as appropriate.
  - Product Integration
    - assemble the product from the product components, ensure that the product, as integrated, functions properly, and deliver the product.

Adapted from https://www.tutorialspoint.com/cmmi/cmmi-process-areas.htm

CMM Process Areas (cont.)

- Engineering:
  - Verification
    - ensure that selected work products meet their specified requirements.
  - Validation
    - demonstrate that a product or product component fulfills its intended use when placed in its intended environment.
  - Requirements Management
    - manage the requirements of the project's products and product components and to identify inconsistencies between those requirements and the project's plans and work products.

Adapted from https://www.tutorialspoint.com/cmmi/cmmi-process-areas.htm

CMM Process Areas (cont.)

- Process management:
  - Organizational Innovation & Deployment
    - select and deploy incremental and innovative improvements that measurably improve the organization's processes and technologies. The improvements support the organization's quality and process-performance objectives as derived from the organization's business objectives.
  - Organizational Process Performance
    - establish and maintain a quantitative understanding of the performance of the organization's set of standard processes in support of quality and process-performance objectives, and to provide the process performance data, baselines, and models to quantitatively manage the organization's projects.

Adapted from https://www.tutorialspoint.com/cmmi/cmmi-process-areas.htm

CMM Process Areas (cont.)

- Process management:
  - Organizational Process Focus
    - plan and implement organizational process improvement based on a thorough understanding of the current strengths and weaknesses of the organization's processes and process assets.
  - Organizational Process Definition
    - establish and maintain a usable set of organizational process assets.
  - Organizational Training
    - develop the skills and knowledge of people so they can perform their roles effectively and efficiently.

Adapted from https://www.tutorialspoint.com/cmmi/cmmi-process-areas.htm

CMMI Process Areas

- For Maturity Level 2 there are 7 Process Areas that must be completely satisfied.
- For Maturity Level 3 there are 11 Process Areas that must be completely satisfied.
- Given the interactions and overlap, it becomes more efficient to work the Maturity Level 2 and 3 issues concurrently.

CMMI Process Areas

Maturity Level	Project Managment	Engineering	Process Management	Support
5 Optimizing			Organizational Innovation & Deployment	Causal Analysis & Resolution
4 Quantitatively Managed	Quantitative Project Mngt		Organizational Process Performance	
3 Defined	Integrated Project Mngt Risk Management	Requirements Development Technical Solution Product Integration Verification Validation	Organizational Process Focus Organizational Process Definition Organizational Training	Decision Analysis & Resolution
2 Managed	Project Planning Project Monitoring & Control Supplier Agreement Mngt	Requirements Mngt		Measurement & Analysis Process & Product Quality Assurance Configuration Mngt
1 Initial				

CMMI Process Areas - Exercises

- **Map the following statement to process areas**
  - *Whenever we conduct a detailed technical review of a work product, we record the item reviewed, the preparation time taken by each participant, the duration of the review, the types and numbers of defects found and fixed, and a list of all assigned action items.*

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5 Optimizing			Organizational Innovation & Deployment	Causal Analysis & Resolution
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CMMI Process Areas – Exercises (cont.)

- **Map the following statement to process areas**
  - *We have our own quality assurance people regularly check on the quality assurance activities performed by our key suppliers and suggest corrective actions as needed*

Maturity Level	Project Managment	Engineering	Process Management	Support
5 Optimizing			Organizational Innovation & Deployment	Causal Analysis & Resolution
4 Quantitatively Managed	Quantitative Project Mngt		Organizational Process Performance	
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CMMI Process Areas – Exercises (cont.)

- **Map the following statement to process areas**
  - *Preliminary versions of the user's manual and the maintenance manual are produced early in the project life cycle so that the operations and maintenance staff can give us some early feedback on the usability of these support documents.*

Maturity Level	Project Managment	Engineering	Process Management	Support
5 Optimizing			Organizational Innovation & Deployment	Causal Analysis & Resolution
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CMMI Process Areas – Exercises (cont.)

- **Map the following statement to process areas**
  - *We agree with the customer on the detailed acceptance testing procedures to be performed, trying to cover not only intended operational use scenarios, but also expected maintenance and training scenarios.*

Maturity Level	Project Managment	Engineering	Process Management	Support
5 Optimizing			Organizational Innovation & Deployment	Causal Analysis & Resolution
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CMMI Process Areas – Exercises (cont.)

- **Map the following statement to process areas**
  - *Our project identifies potential problems that we might encounter, estimates the likelihood and expected impact of each potential problem, and determines which ones have the highest priority for mitigation planning.*

Maturity Level	Project Managment	Engineering	Process Management	Support
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CMMI Process Areas – Exercises (cont.)

- **Map the following statement to process areas**
  - *Based upon historical data from many projects, we have calculated the expected range of product components that will normally be tested per day and the expected range of defects to be found in each test.*

Maturity Level	Project Managment	Engineering	Process Management	Support
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CMMI Process Areas – Exercises (cont.)

- **Map the following statement to process areas**
  - *We have a detailed plan for the order in which product components are to be assembled together into sub-systems and which sub-systems are to be integrated into the final product, and we measure and report the number of completed assemblies and integrations performed versus those planned*

Maturity Level	Project Managment	Engineering	Process Management	Support
5 Optimizing			Organizational Innovation & Deployment	Causal Analysis & Resolution
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CMMI Process Areas – Exercises (cont.)

- **Map the following statement to process areas**
  - *We have established a set of guidelines for determining which decisions require formal structured decision making, based largely on the decision process costs versus the decision's impact*

Maturity Level	Project Managment	Engineering	Process Management	Support
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CMMI Process Areas – Exercises (cont.)

- **Map the following statement to process areas**
  - *Our executives always review the records of which employees have successfully completed which relevant courses when they consider appointing a new task leader or project manager.*

Maturity Level	Project Managment	Engineering	Process Management	Support
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CMMI Process Areas – Exercises (cont.)

- **Map the following statement to process areas**
  - *We always place our project requirements document under configuration control and then make sure that our plans and work products can be traced to this document.*

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CMMI Process Areas – Exercises (cont.)

- **Map the following statement to process areas**
  - *We have a firm policy requiring that every project's process be a tailored version of the organization's standard process and that every project identify, negotiate, and track critical dependencies on groups outside of the project.*

Maturity Level	Project Managment	Engineering	Process Management	Support
5 Optimizing			Organizational Innovation & Deployment	Causal Analysis & Resolution
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CMMI Process Areas – Exercises (cont.)

- **Map the following statement to process areas**
  - *We routinely use a particular server as the repository for all of our controlled baseline product files, both current versions and archived copies of old versions.*

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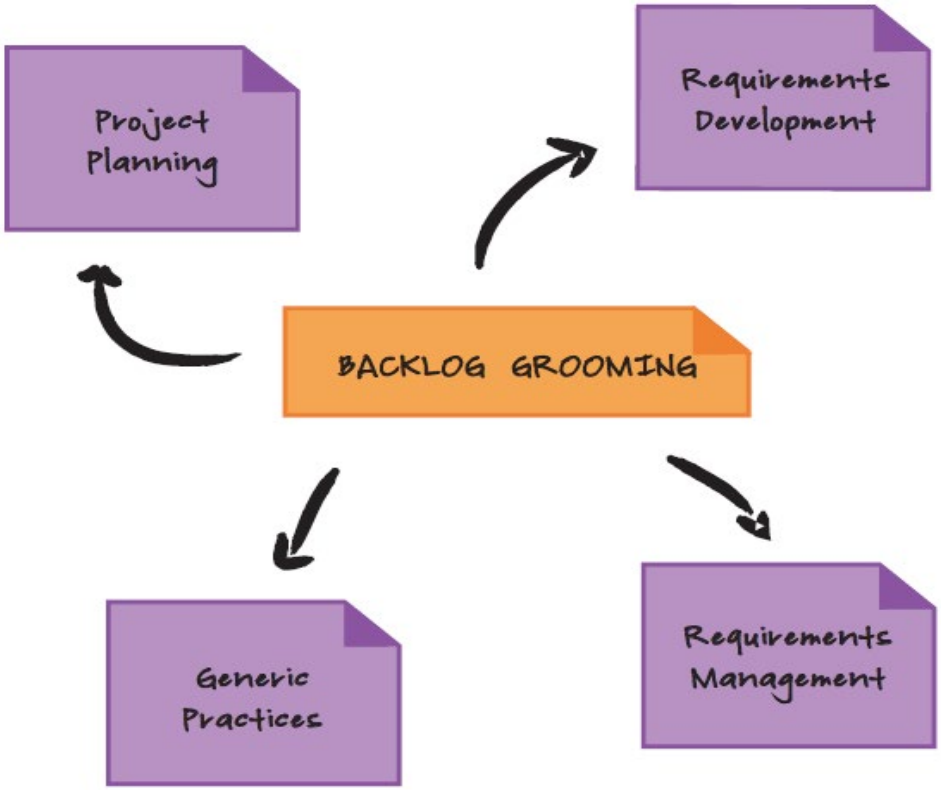
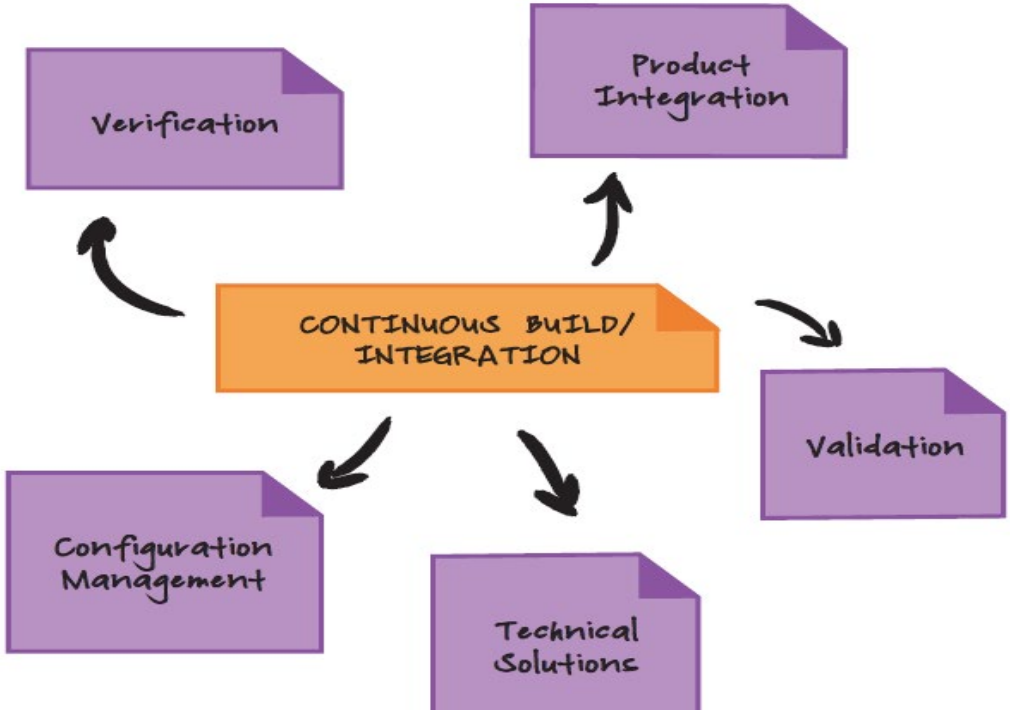
CMMI & Agile

- Backlog grooming: common agile technique used by Scrum teams to produce a prioritized backlog of epics and user stories before and during a sprint.



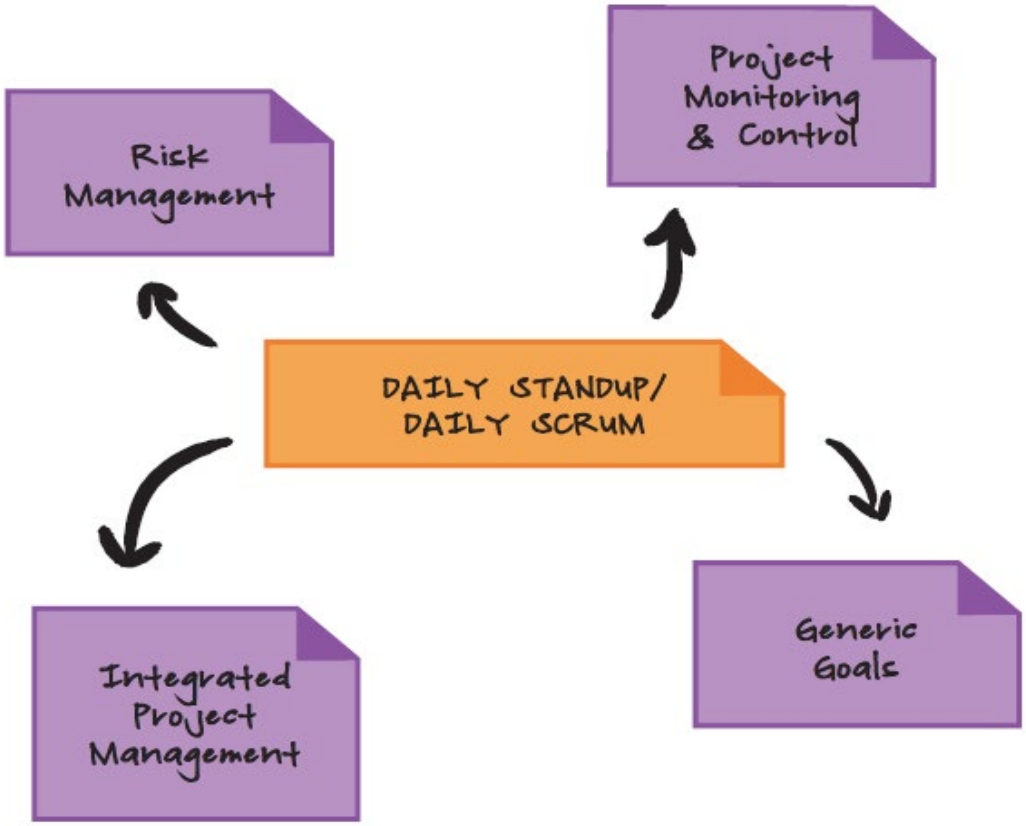
CMMI & Agile (cont.)

- Continuous integration: an approach to continuous testing and product integration popular with agile teams that was first introduced in Extreme Programming (XP).



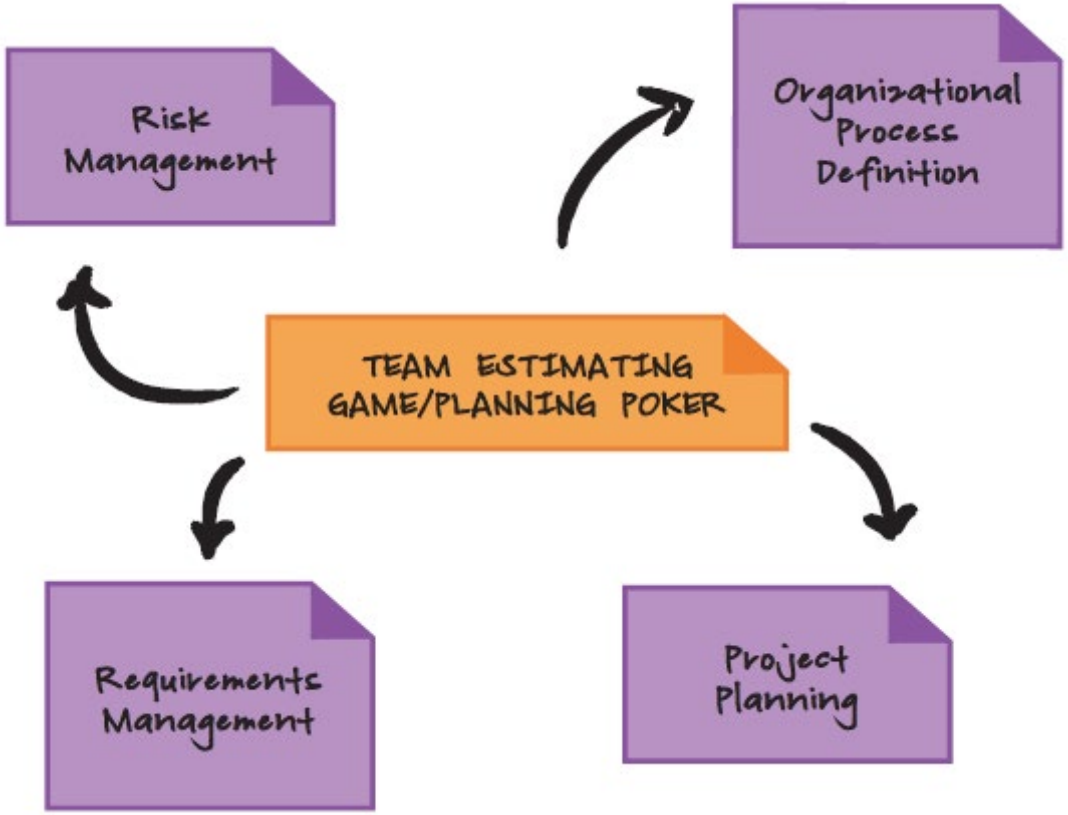
CMMI & Agile (cont.)

- Daily standup/Daily Scrum: Daily Standup Meeting is used as a way to identify issues and risks earlier than a traditional project ("fail fast"), and to increase collaboration between agile team members.



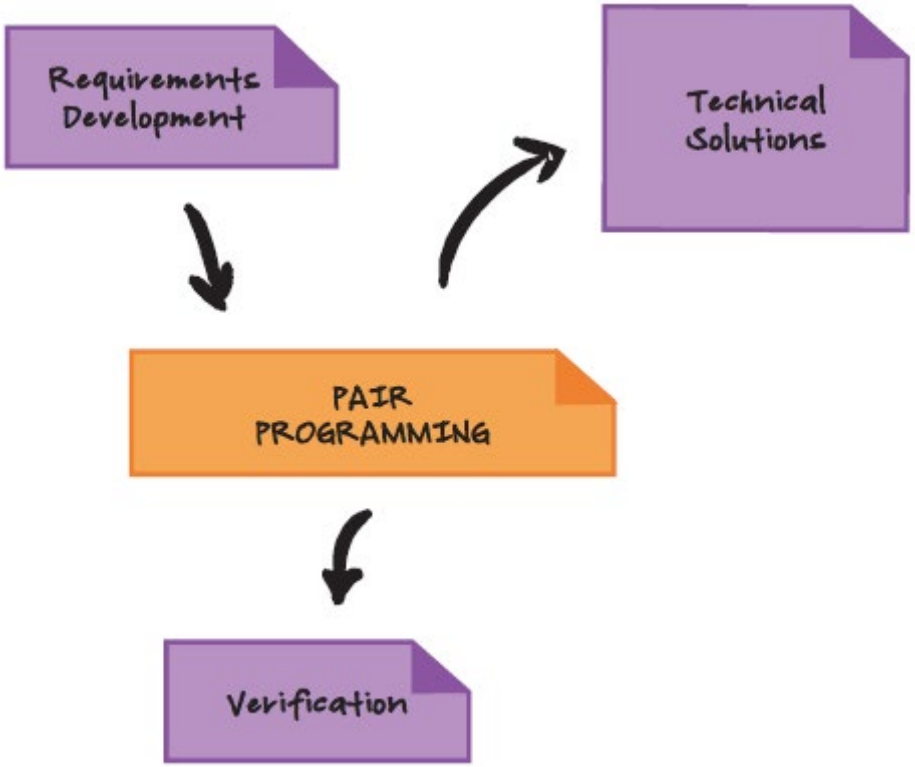
CMMI & Agile (cont.)

- Team estimating/Planning poker: an agile estimation technique that establishes relative sizing using story points and rough order of magnitude estimation.



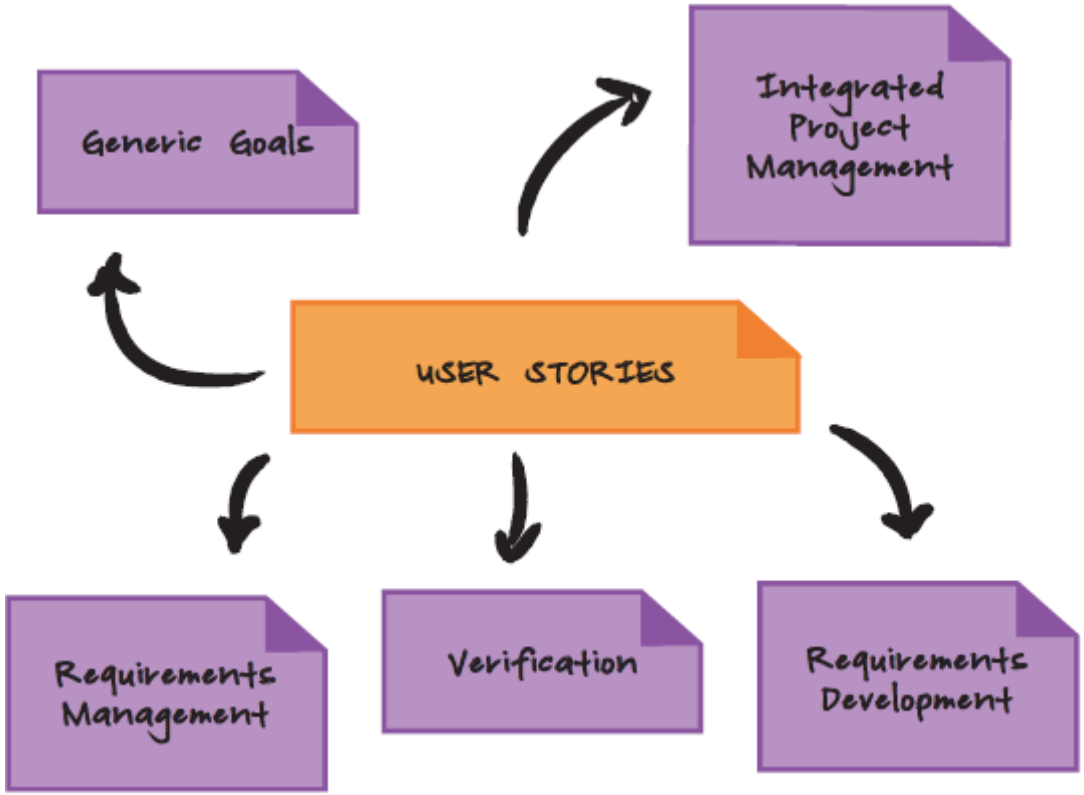
CMMI & Agile (cont.)

- Pair programming: usually increases the initial cost of programing, but it more than pays for itself in increased code quality.



CMMI & Agile (cont.)

- User stories



CMMI & Agile (cont.)

- Test-driven development: powerful technique that can improve the quality of code and requirements, so therefore has a strong relationship to Validation, Verification, and Requirements Development.