CS 451
Software Engineering

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SOFTWARE ENGINEERING – A LAYERED TECHNOLOGY

- Software engineering is the establishment and use of sound engineering principles in order to economically obtain software that is reliable and works efficiently on real machines.

- I would add to this definition, “obtain software that is reliable, easily maintained, and works efficiently on real machines.

- The software process forms the basis for management control of software projects and establishes the context in which technical methods are applied, work products are produced, milestones established, quality assured, and change properly managed.
SOFTWARE ENGINEERING

- Processes
- Methods
- Tools
Why processes?

- Which one is more important? Processes or Products?

- Software Engineering Focus shift:
  - Structured programming (product)
  - Structured analysis methods (process)
  - Data encapsulation (product)
  - CMMI (process)
  - OO (products)
  - Agile (process)

- The duality between product and process
SOFTWARE PROCESS

- Process is distinct from product – products are outcomes of executing a process on a project
- SW Engg. focuses on process
- Premise: Proper processes will help achieve project objectives of high QP
SOFTWARE PROCESS

- Process: A particular method, generally involving a number of steps
- Software Process: A set of steps, along with ordering constraints on execution, to produce software with desired outcome
- Many types of activities performed by diff people in a software project
- Better to view software process as comprising of many component processes
COMPONENT SOFTWARE PROCESSES

- Two major processes
  - Development – focuses on development and quality steps needed to engineer the software
  - Project management – focuses on planning and controlling the development process

- Development process is the heart of software process; other processes revolve around it

- These are executed by different people
  - developers execute engg. Process
  - project manager executes the mgmt process
COMPONENT SOFTWARE PROCESSES

- Other processes
  - Configuration management process: manages the evolution of artifacts
  - Change management process: how changes are incorporated
  - Inspection process: How inspections are conducted on artifacts
  - Process management process: management of processes themselves
Development Process Framework

- A generic framework is as follows:
  - Communication
  - Planning – Risks, resources, work schedule
  - Modeling
  - Construction
  - Deployment
Development Process Framework

- Umbrella Activities within the generic framework include:
  - Software project tracking and control
  - Risk Management
  - Software quality assurance
  - Formal technical reviews
  - Measurement
  - Software configuration management – manage the effect of change
DESired process properties

- Provide high Q&P
  - Support testability as testing is the most expensive task; testing can consume 30 to 50% of total development effort
  - Support maintainability as maintenance can be more expensive than development; over life up to 80% of total cost
  - Remove defects early, as cost of removing defects increases with latency
HIGH Q&P: EARLY DEFECT REMOVAL

- Cost of a defect increases with latency

- I.e. fixing a req defect in operation can cost a 100 times the cost of fixing it in requirements itself

- Hence, for high Q&P, the process must support early defect removal
EARLY DEFECT REMOVAL

![Graph showing the relative cost to fix errors in different phases.](image)

- **Y-axis**: Relative Cost to Fix Error
- **X-axis**: Phase in Which Error Was Detected
  - Requirements
  - Design
  - Code
  - Development Test
  - Acceptance Test
  - Operation

The graph illustrates that the relative cost to fix errors increases as errors are detected later in the development cycle.
DESIRED PROCESS PROPERTIES

- Predictability and repeatability
  - Process should repeat its performance when used on different projects
  - I.e. outcome of using a process should be predictable
  - Without predictability, cannot estimate, or say anything about quality or productivity
  - With predictability, past performance can be used to predict future performance
PREDICTABILITY
SUPPORT CHANGE

- Software changes for various reasons
- Requirements change is a key reason
- Requirement changes cannot be wished away or treated as “bad”
- They must be accommodated in the process for sw development
How mature is your organization?

- CMMI is a process defined in a 700 page manual documenting process characteristics that should exist if an organization wants to establish a software process that is complete.

- The larger the organization and projects the more important the spirit of CMMI becomes.
  - Level 0: Incomplete. The process area (requirements management) is either not performed or does not achieve the goals set forth by CMMI for level 1 capability.
  - Level 1: Performed. All the specific goals of the process area (as defined by CMMI) have been satisfied. Work takes required to produce defined work products are being conducted.
How mature is your organization?

- Level 2: Managed. All level 1 criteria are satisfied. In addition, all work associated with the process area conforms to an organizationally defined policy; all people doing the work have access to adequate resources to get the job done.

  - Stakeholders are actively involved in the process area as required.

  - All work tasks and work products are “monitored, controlled, and reviewed; and are evaluated for adherence to the process description.”
How mature is your organization?

- Level 3: Defined. All level 2 criteria are achieved. In addition, the process is tailored from the organization’s set of standard processes according to the organization’s tailoring guidelines, and contributes work products, measures, and other process-improvement information to the organizational process assets.”

- Level 4: Quantitatively managed. All level 3 criteria are achieved. In addition, the process area is controlled and improved using measurements and quantitative assessment. “Quantitative objectives for quality and process performance are established and used as criteria in managing the process.”

- Level 5: Optimized. All capability in level 4 criteria are achieved. In addition, the process area is adapted and optimized using quantitative (statistical) means to meet changing customer needs and to continually improve the efficacy of the process area under consideration.
How mature is your organization?

- Level 0: Chaos
- Level 1: Attempting to document and plan
- Level 2: The process is managed
- Level 3: The process is standardized
- Level 4: The process is measured
- Level 5: The process is improved
How mature is your organization?

- There are eight process areas defined. One example is project planning, the specific goals follow:

  - SG 1 Establish estimates
    - Estimate the scope of the project
    - Establish estimates of work product and task attributes
    - Define project life cycle
    - Determine estimates of effort and cost
How mature is your organization?

- SG 2 Develop a Project Plan
  - Establish the budget and schedule
  - Identify project risks
  - Plan for data management
  - Plan for project resources
  - Plan for needed knowledge and skills
  - Plan stakeholder involvement
  - Establish the project plan
CAPABILITY MATURITY MODEL INTEGRATION (CMMI)

How mature is your organization?

- SG 3 Obtain commitment to the plan
  - Review plans that affect the project
  - Reconcile work and resource levels
  - Obtain plan commitment
CAPABILITY MATUREITY MODEL INTEGRATION (CMMI)

**Characteristics of the Maturity levels**

- **Level 1** “Initial”
  - Processes unpredictable, poorly controlled and reactive

- **Level 2** “Managed”
  - Process characterized for projects and is often reactive.

- **Level 3** “Defined”
  - Process characterized for the organization and is proactive. (Projects tailor their process from the organization’s standard)

- **Level 4** “Quantitatively Managed”
  - Process measured and controlled.

- **Level 5** “Optimizing”
  - Focus on process improvement.

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