Chapter 26

SW Process Improvement is a way of enhancing the quality of their SW, reducing costs, or accelerating their development processes.

* Process Improvement = understanding existing processes and changing these processes to increase product quality and/or reduce costs and development time.

Two different approaches to process improvement and change are used:

* Process Maturity Approach
  + Focused on improving process and project management and introducing good software engineering practice into an organization
  + The level of process maturity reflects the extent to which good technical and management practice has been adopted in organizational SW development processes.
  + Primary goals of this approach are improved product quality and process predictability
  + Rooted in Plan-Driven approach and usually requires increased overhead
* Agile Approach
  + Focused on iterative development and the reduction of overheads in the SW process
  + Primary characteristics of Agile Methods are rapid delivery of functionality and responsiveness to changing customer requirements.

Statistical Quality Control = Based on measuring the number of product defects and relating these defects to the process. The aim is to reduce the number of product defects of analyzing and modifying the process so that the changes of introducing defects are reduced and defect detection is improved. Once a lower defect count has been achieved, the process is standardized and a further improvement cycle then begins.

The process quality/product quality relationship is less obvious when the product is intangible and dependent, to some extent, on intellectual processes that cannot be automated. SW quality is NOT influenced by its manufacturing process but by its design process.

* 4 Factors affecting SW products
  + Development Technology
  + People Quality
  + Cost, Time, and Schedule
  + Process Quality

**The Process Improvement Process (Section 26.1)**

* Process = a sequence of activities that lead to the production of a SW system.
* Each company has to develop its own process depending on its size, the background and skills of its staff, the type of SW being developed, customer and market requirements. And the company culture
* Process Attributes that may be the target for improvement
  + Understanbility
    - IS the process explicitly defined? How easy is it to understand the process definition?
  + Standardization
    - Is process based on standard generic process? This may be important for an industry that requires conformance to standards.
  + Visibility
    - Do the process activites culminate in clear results, so that the process of the process is externally visibile?
  + Measurability
    - Does the process include data collection that allows process/product characteristics to be measured?
  + Supportability
    - How helpful are SW tools to the process activites?
  + Acceptability
    - Is process accepted by engineers and used by them in producing the product?
  + Reliability
    - Does the process avoid errors or trap them before they result in product errors?
  + Robustness
    - Can the process continue in spite of unexpected problems?
  + Maintainability
    - Can the process evolve to reflect changing organizational requirements or identified process improvements?
  + Rapidity
    - How fast can the process of delivering a system from a given specification be completed?
  + \*\*\* IT IS IMPOSSIBLE TO MAKE PROCESS IMPROVEMENTS THAT OPTIMIZE ALL PROCESS ATTRIBUTES SIMULTANEOUSLY
* Process of Process Improvement
  + Is a cyclical process that has 3 stages
    - Process Measurement
      * Attributes of the current project or the product are measures. The aim is to improve the measures according to the goals of the organization involved in process improvement. This forms a baseline that helps you decide if process improvements have been effective
    - Process Analysis
      * Current process is assessed, and process weaknesses and bottlenecks are identified. Process models (aka Process Maps) that describe the process may be developed during this stage. The analysis may be focused by considering process characteristics such as rapidity and robustness.
    - Process Change
      * Process changes are proposed to address some of the identified process weaknesses. These are introduced and the cycle resumes to collect data about the effectiveness of the changes.

**Process Measurement (Section 26.2)**

* Process Measurements are quantitative data about the software process, such as the time taken to perform some process activity. They can be used to assess whether or not the efficiency of a process has been improved.
* 3 Types of process metrics can be collected:
  + The time taken for a particular process to be completed
    - Can be used to discover if process changes have improved the efficiency of a process
  + The resources required for a particular process
    - Resources could include days, travel costs, computer resources, etc.
    - Can be used to discover if process changes have improved the efficiency of a process
  + The number of occurrences of a particular
* Fundamental difficulty lies in knowing what information about the process should be collected to support process improvement
  + GQM (Goal-Question-Metric)
    - Answer 3 critical questions
      * Why are we introducing process improvement?
      * What info do we need to help identify and assess improvements?
      * What process and product measurements are required to provide this info?
    - 3 Abstractions
      * Goals
        + Is something that the organization is trying to achieve
        + Should be concerned with how the process affects products or the organization itself (Ex. Goal of improved level of process maturity)
      * Questions
        + Are refinements of goals where specific areas of uncertainty related to the goals are identified
        + A goals will have a number of associated questions
      * Metrics
        + Measurements that need to be collected to help answers the questions and to confirm whether or not process improvements have achieved the desired goal.
* AMI (Analyze, Measure, Improve)
  + A method of SW process improvement
  + Stage approach to process improvement, where measurement is started after an organization has introduced some standardization into its processes, as opposed to beginning measurement straight away.
* It is dangerous to make simplistic assumptions about improvements
  + Changes in a metric could be caused by something completely different, such as a change of the people in the project team, changes to the project schedule, etc.
  + Therefore, this info must be interpreted along with other information about the process before you can be sure that process changes are effective. This may reveal other factors that may have influenced the process, it reveals the extent to which the team has adopted the proposed changes and how these have affected actual development practice

**Process Analysis (Section 26.3)**

* Is the study of processes to help understand their key characteristics and how such processes are performed in practice by the people involved. This maybe be intertwined with Process Measurement.
* Has closely related objectives
  + To understand the activities involved in the process and the relationships between them
  + To understand the relationships between the process activities and the measurements that have been made
  + To relate the specific process or processes that you are analyzing to comparable processes elsewhere in the organization, or to idealized processes of the same type.
* In this stage, you are trying to understand what is going on in a process. You are looking for info about that process’ problems and inefficiencies.
* Aspects of a process that may be investigated:
  + Adoption and Standardization
    - Is the process documented and standardized across the organization?
  + SW Engineering Practice
    - Are there known, good SWE practices that are not included in the process? Why are they not included?
  + Organizational Constraints
    - What are the organizational constraints that affect the process design and the ways that the process is performed?
  + Communications
    - How are communications managed in the process?
  + Introspection
    - Is the process reflective (i.e., do the actors involved in the process explicitly think about and discuss the process and how it might be improved?)?
  + Learning
    - How do people joining a development team learn about the software processes used?
  + Tool Support
    - What aspects of the processes are and aren’t supported by software tools?
* Techniques of Process Analysis:
  + Questionnaires and Interviews
    - Engineers and managers in a project are questioned about what actually goes on.
    - Pros
      * Can be done quickly
    - Cons
      * Questions can be badly worded or inappropriate
      * Employees may see questionnaires as a form of assessment or appraisals
        + They may give you the answers you want to hear instead of the true answers
  + Ethnographic Studies
    - Process participants are observed as they work
    - These are used to understand the nature of SW development as a human activity.
    - Pros
      * More likely to find out how a process is really used
    - Cons
      * Must start doing this at the beginning of a project. Impractical for large projects
* When analyzing a process, it is useful to start with a Process Model that defines the activities in the process and the inputs and outputs of these activities. The purpose of these models is to provoke discussion rather than document the process in detail. Discussion and observations of a process are often structured around a set of question about he Process Model. Examples of question are:
  + What activities take place in practice but are not shown in the model?
  + Are there process activities, shown in the model, that you (the employee) think are inefficient?
  + What happens when things go wrong? Does the team continue to follow the process defined in the model?
  + Who are the actors involved at different stages in the process and how do they communicate?
  + What tool support is used for the activities shown in the model?
* **Process Exceptions (Section 26.3.1)**
  + Exceptions (unanticipated problems) will affect and usually alter the resources, budgets, or schedules of a project. It is difficult to predict all exceptions in advance and to incorporate them into a formal process model. You therefore often have to work out how to handle exceptions and then dynamically change the ‘standard’ process to cope with these unexpected circumstances.

**Process Change (Section 26.4)**

* Involves making modifications to the existing process. You may do this by introducing new practices, methods, or tools; changing the ordering of process activities; introducing or removing deliverables from the process; improving communications; or by introducing new roles and responsibilities.
* Changes should be driven by improvement goals such as “reduce the number of defects discovered during integration by 25%”.
* 5 Stages in Process Change Process
  + Improvement Identification
    - Using the results of the process analysis to identify ways to tackle quality problems, schedule bottlenecks, or cost inefficiencies that have been identified during process analysis.
  + Improvement Prioritization
    - Assessing possible changes to the process, and prioritizing them for implementation.
  + Process Change Introduction
    - Putting new procedures, methods, and tools into place and integrating them with other process activities.
  + Process Training
    - Engineers involved need to understand the changes that have been proposed and how to perform the new and changed processes.
  + Change Tuning
    - You need a tuning phase where minor problems can be discovered, and modifications to the process can be proposed and introduced.
* Difficulties with Change Processes
  + Difficulty with assessing the effectiveness of changed processes
  + Resistance to Change
    - Team members or project managers may resist the introduction of process changes and propose reasons why changes will not work, or delay the introduction of changes.
  + Change Persistence
    - Although it may be possible to introduce process changes initially, it is common for process innovations to be discarded after a short time and for the processes to revert to their previous state.

**The CMMI Process Improvement Framework (Section 26.5)**

* Intended to be a framework for process improvements that has broad applicability across a range of companies. It allows an organization’s system development and management processes to be assessed and assigned a maturity level from 1 to 5. It provides a way of rating 22 process areas on a scale from 0 to 5.
  + Categories (bullets are Process Areas)
    - Process Management
      * Organizational Process Definition
      * Organizational Process Focues
      * Organizational Training
      * Organizational Process Performance
      * Organizatioanl Innovation and Deployment
    - Project Management
      * Project Planning
      * Project Monitoring and Control
      * Supplier Agreement Management
      * Integrated Project Management
      * Risk Management
      * Quantitative Project Management
    - Engineering
      * Requirements Management
      * Requirements Development
      * Technical Solution
      * Product Integration
      * Verification
      * Validation
    - Support
      * Configuration Management
      * Process and Product Quality Management
      * Measurement and Analysis
      * Decision Analysis and Resolution
      * Causal Analysis and Resolution
* Principal Model Components
  + A set of process areas that are related to SW process activites. There are 22 of these which are mapped to 4 groups in the CMMI
  + A number of goals, which are abstract descriptions of a desirable state that should be attained by an organization. There are specific goals (that target a single process area) and generic goals
  + A set of good practices, which are descriptions of ways of achieving a goal. More than one specific and generic practices may be associated with each goal within a process area.
* CMMI assessment involves examining the processes in an organization and rating these processes or process areas on a 6-point scale that relates to the level of maturity in each process area. The 6-point scale assigns a level of maturity to a process area as follows:
  + Incomplete
    - At least one of the specific goals associated with the process area is not satisfied
  + Performed
    - The goals associated with the process area are satisfied, and for all processes the scope of the work to be performed is explicitly set out and communicated to the team members
  + Managed
    - Goals associated with the process area are met and organizational policies are in place that define when each process should be used. There must be documented project plans that define the project goals.
  + Defined
    - Focuses on organizational standardization and deployment of processes. Each project has a managed process that is adapted to the project requirements from a defined set of organizational processes.
  + Quantitatively Managed
    - There is an organizational responsibility to use statistical and other quantitative methods to control subprocesses; that is, collected process and product measurements must be used in process management
  + Optimizing
    - Organization must use the process and product measurements to drive process improvement. Tends must be analyzed and the processes adapted to changing business needs
* **The Staged CMMI Model (Section 26.5.1)**
  + Is comparable with the CMMI in that it provides a means to assess an organization’s process capability at one of five levels, and prescribes the goals that should be achieved at each of these levels. Process improvement is achieved by implementing practices at each level, moving from the lower to the higher levels in the model
  + The five levels of Stage CMMI are:
    - Initial
    - Managed
    - Defined
    - Quantitatively Managed
    - Optimizing
    - \*\*\*Differences with this and the CMMI model
      * Stage Model
        + Used to assess the capability of the organization as a while
      * CMMI measures the maturity of specific process areas within the organization
  + Each maturity level has an associated set of process areas and generic goals. These reflect food SWE and management practice and the institutionalization of process improvement. The lower maturity levels may be achieved by introducing good practice; however, higher levels require a commitment to process measurement and improvement
  + Advantages
    - It is compatible with the SW capability maturity model that was proposed in the late 80s. Many companies understand and are committed to using this model for process improvement -> easy for them to transition to the Stage CMMI
  + Disadvantages
    - Each maturity level has its own goals and practices.
      * The Stage model assumes that all of the goals and practices at one level are implemented before the transition to the next level -> but it may be better to implement goals at later levels
* **The Continuous CMMI Model (Section 26.5.2)**
  + Do NOT classify an organization according to discrete levels. They are finer-grained models that consider individual or groups of practices and assess the use of good practice within each process group.
  + The maturity assessment is a set of values showing the organization’s maturity for each process or process group.
  + The Continuous CMMI uses the same process areas as above and assigns a capability assessment level from 0 to 5 to each process area.
  + Normally, organizations operate at different maturity levels for different process areas. Consequently, the result of a Continuous CMMI assessment is a capability profile showing each process area and its associated capability assessment.
  + Advantages
    - Companies can pick and choose processes for improvement according to their own needs and requirements.
    - Permits discretion and flexibility, while still allowing companies to work within the CMMI improvement framework