Process Improvement

- Understanding, Modelling and Improving the Software Process

Objectives

- To explain the principles of software process improvement
- To explain how software process factors influence software quality and productivity
- To introduce the SEI Capability Maturity Model and to explain why it is influential. To discuss the applicability of that model
- To explain why CMM-based improvement is not universally applicable

Topics covered

- Process and product quality
- Process analysis and modelling
- Process measurement
- The SEI process maturity model
- Process classification

Process improvement

- Understanding existing processes
- Introducing process changes to achieve organisational objectives which are usually focused on quality improvement, cost reduction and schedule acceleration
- Most process improvement work so far has focused on defect reduction. This reflects the increasing attention paid by industry to quality
- However, other process attributes can be the focus of improvement

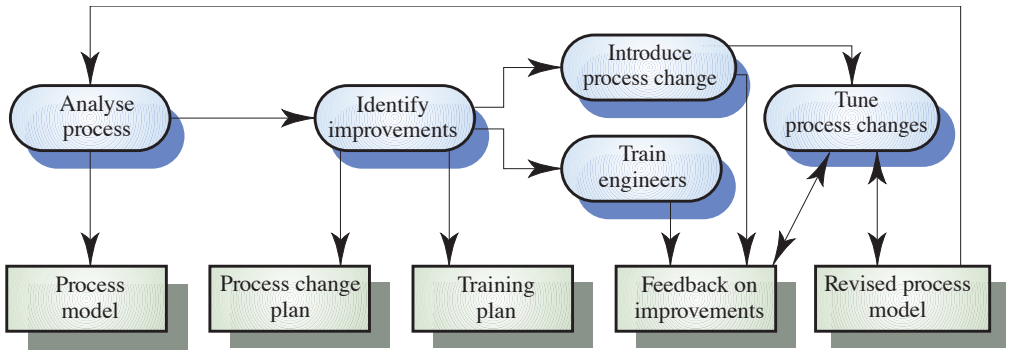
Process attributes

Process characteristic	Description
Understandability	To what extent is the process explicitly defined and how easy is it to understand the process definition?
Visibility	Do the process activities culminate in clear results so that the progress of the process is externally visible?
Supportability	To what extent can the process activities be supported by CASE tools?
Acceptability	Is the defined process acceptable to and usable by the engineers responsible for producing the software product?
Reliability	Is the process designed in such a way that process errors are avoided or trapped before they result in product errors?
Robustness	Can the process continue in spite of unexpected problems?
Maintainability	Can the process evolve to reflect changing organisational requirements or identified process improvements?
Rapidity	How fast can the process of delivering a system from a given specification be completed?

Process improvement stages

- Process analysis
  - Model and analyse (quantitatively if possible) existing processes
- Improvement identification
  - Identify quality, cost or schedule bottlenecks
- Process change introduction
  - Modify the process to remove identified bottlenecks
- Process change training
  - Train staff involved in new process proposals
- Change tuning
  - Evolve and improve process improvements

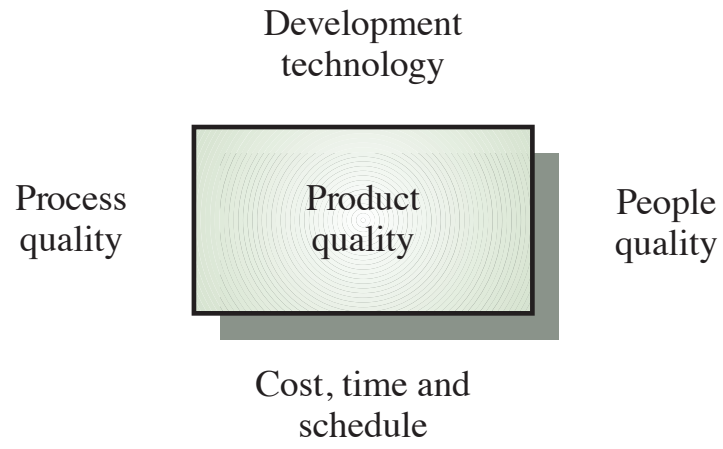
The process improvement process



Process and product quality

- Process quality and product quality are closely related
- A good process is usually required to produce a good product
- For manufactured goods, process is the principal quality determinant
- For design-based activity, other factors are also involved especially the capabilities of the designers

Principal product quality factors



Quality factors

- For large projects with 'average' capabilities, the development process determines product quality
- For small projects, the capabilities of the developers is the main determinant
- The development technology is particularly significant for small projects
- In all cases, if an unrealistic schedule is imposed then product quality will suffer

Process analysis and modelling

- Process analysis
  - The study of existing processes to understand the relationships between parts of the process and to compare them with other processes
- Process modelling
  - The documentation of a process which records the tasks, the roles and the entities used
  - Process models may be presented from different perspectives

Process analysis and modelling

- Study an existing process to understand its activities
- Produce an abstract model of the process. You should normally represent this graphically. Several different views (e.g. activities, deliverables, etc.) may be required
- Analyse the model to discover process problems. Involves discussing activities with stakeholders

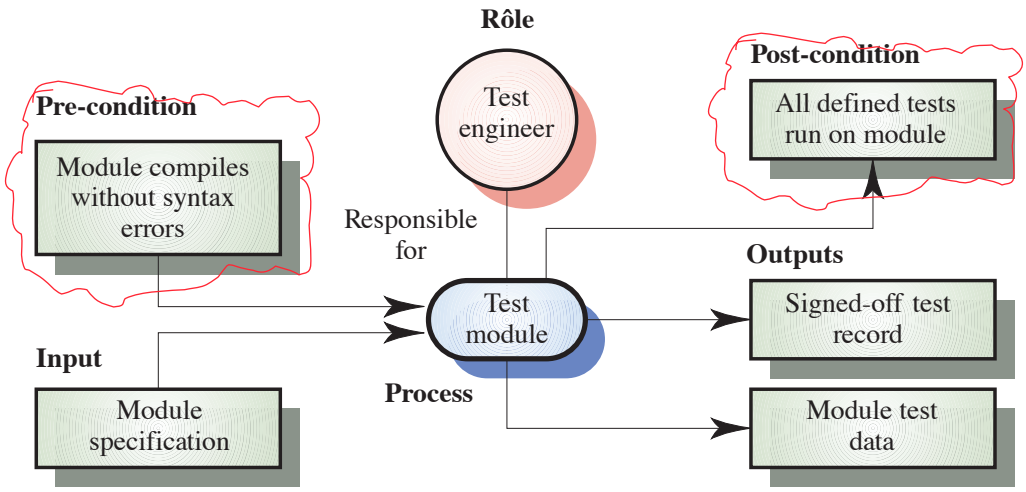
Process analysis techniques

- Published process models and process standards
  - It is always best to start process analysis with an existing model. People then may extend and change this.
- Questionnaires and interviews
  - Must be carefully designed. Participants may tell you what they think you want to hear
- Ethnographic analysis
  - Involves assimilating process knowledge by observation

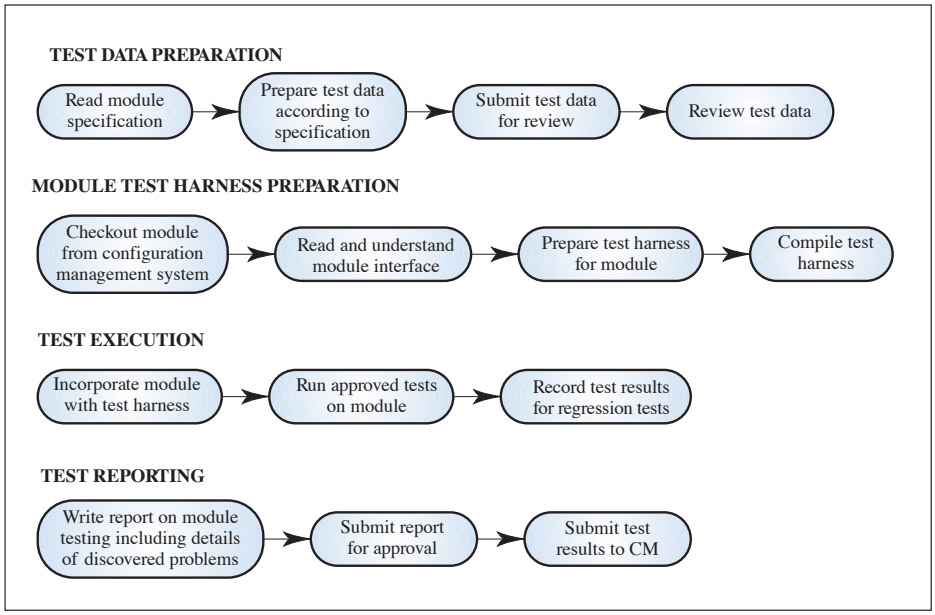
Process model element	Description
Activity (represented by a round-edged rectangle with no drop shadow)	An activity has a clearly defined objective, entry and exit conditions. Examples of activities are preparing a set of test data to test a module, coding a function or a module, proof-reading a document, etc. Generally, an activity is atomic i.e. it is the responsibility of one person or group. It is not decomposed into sub-activities.
Process (represented by a round-edged rectangle with drop shadow)	A process is a set of activities which have some coherence and whose objective is generally agreed within an organisation. Examples of processes are requirements analysis, architectural design, test planning, etc.
Deliverable (represented by a rectangle with drop shadow)	A deliverable is a tangible output of an activity which is predicted in a project plan.
Condition (represented by a parallelogram)	A condition is either a pre-condition which must hold before a process or activity can start or a post-condition which holds after a process or activity has finished.
Role (represented by a circle with drop shadow)	A role is a bounded area of responsibility. Examples of roles might be configuration manager, test engineer, software designer, etc. One person may have several different roles and a single role may be associated with several different people.
Exception (not shown in examples here but may be represented as a double edged box)	An exception is a description of how to modify the process if some anticipated or unanticipated event occurs. Exceptions are often undefined and it is left to the ingenuity of the project managers and engineers to handle the exception.
Communication (represented by an arrow)	An interchange of information between people or between people and supporting computer systems. Communications may be informal or formal. Formal communications might be the approval of a deliverable by a project manager; informal communications might be the interchange of electronic mail to resolve ambiguities in a document.

Elements of a process model

The module testing activity



Activities in module testing



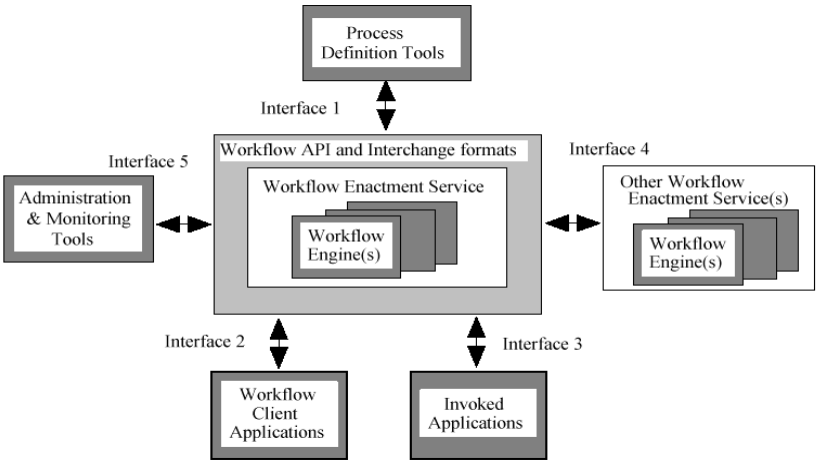
Process exceptions

- Software processes are complex and process models cannot effectively represent how to handle exceptions
  - Several key people becoming ill just before a critical review
  - A complete failure of a communication processor so that no e-mail is available for several days
  - Organisational reorganisation
  - A need to respond to an unanticipated request for new proposals
- Under these circumstances, the model is suspended and managers use their initiative to deal with the exception

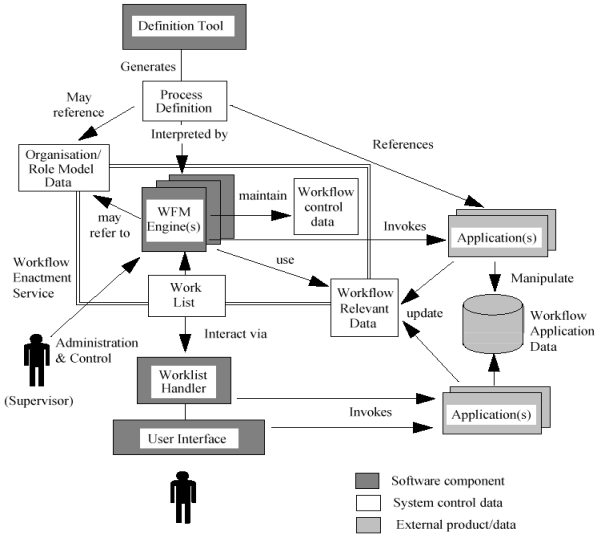
Process Management

- Includes modelling and enactment of processes
- Two main research areas with similar characterictics
  - Workflow Management Systems (WfMSs)
    - » From the Information Systems and Data Base area
  - Process-centred Software Engineering Environments (PSEEs)
    - » From the Software Engineering Area

Workflow reference model



Workflow reference model



Process measurement

- Wherever possible, quantitative process data should be collected
  - However, where organisations do not have clearly defined process standards this is very difficult as you don't know what to measure. A process may have to be defined before any measurement is possible
- Process measurements should be used to assess process improvements
  - But this does not mean that measurements should drive the improvements. The improvement driver should be the organizational objectives

Classes of process measurement

- Time taken for process activities to be completed
  - E.g. Calendar time or effort to complete an activity or process
- Resources required for processes or activities
  - E.g. Total effort in person-days
- Number of occurrences of a particular event
  - E.g. Number of defects discovered

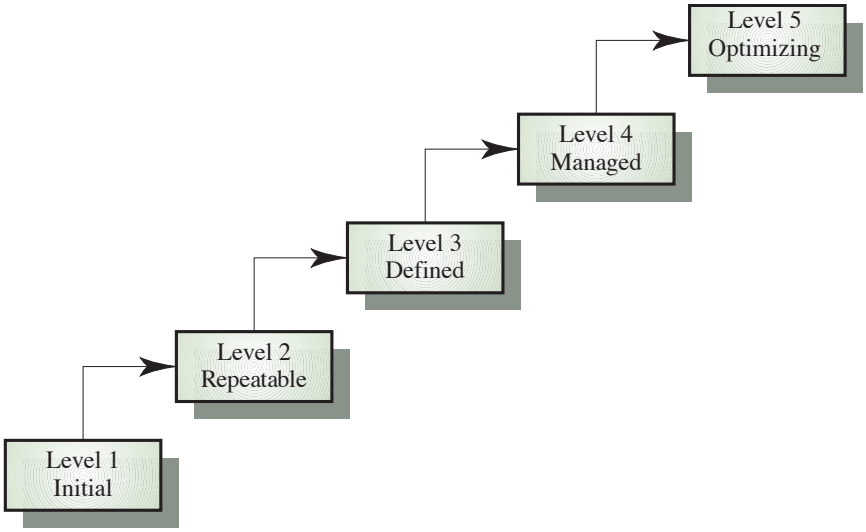
Goal-Question-Metric Paradigm

- Goals
  - What is the organisation trying to achieve? The objective of process improvement is to satisfy these goals
- Questions
  - Questions about areas of uncertainty related to the goals. You need process knowledge to derive these
- Metrics
  - Measurements to be collected to answer the questions

The Software Engineering Institute

- US Defense Dept. funded institute associated with Carnegie Mellon
- Mission is to promote software technology transfer particularly to defense contractors
- Maturity model proposed in mid-1980s, refined in early 1990s.
- Work has been very influential in process improvement

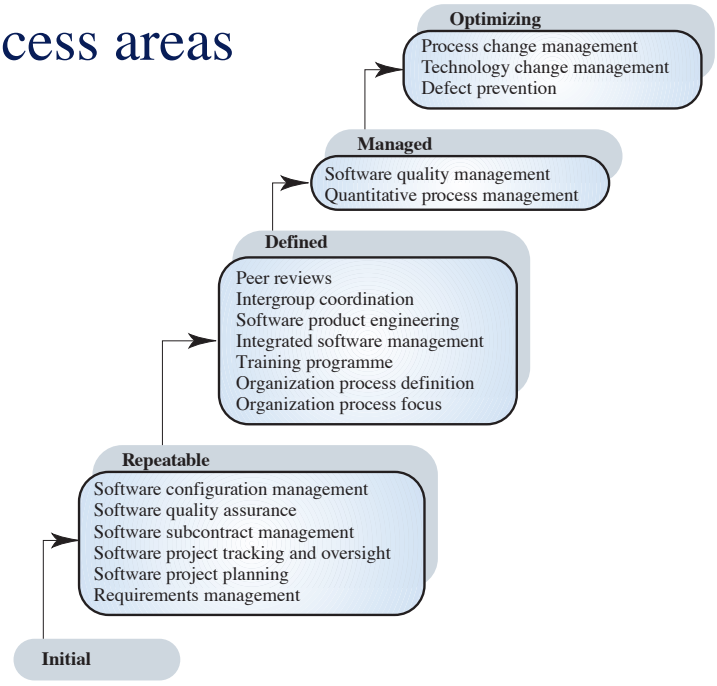
The SEI process maturity model



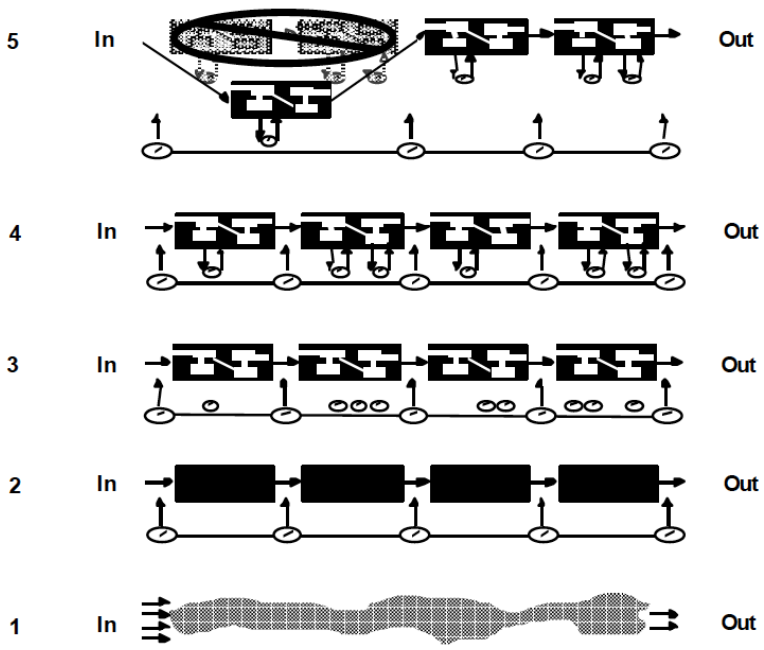
Maturity model levels

- Initial
  - Essentially uncontrolled
- Repeatable
  - Product management procedures defined and used
- Defined
  - Process management procedures and strategies defined and used
- Managed
  - Quality management strategies defined and used
- Optimising
  - Process improvement strategies defined and used

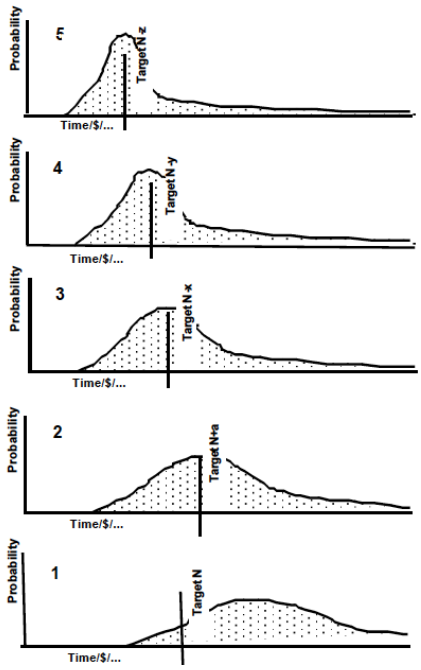
Key process areas



Model Visibility



Predictive performances



Performance continuously improves in Level 5 organizations

Based on quantitative understanding of process and product, performance continues to improve in Level 4 organizations

With well-defined processes, performance improves in Level 3 organizations

Plans based on past performance are more realistic in Level 2 organizations

Schedule and cost targets are typically overrun by Level 1 organizations.

SEI model problems

- It focuses on project management rather than product development.
- It ignores the use of technologies such as rapid prototyping.
- It does not incorporate risk analysis as a key process area
- It does not define its domain of applicability

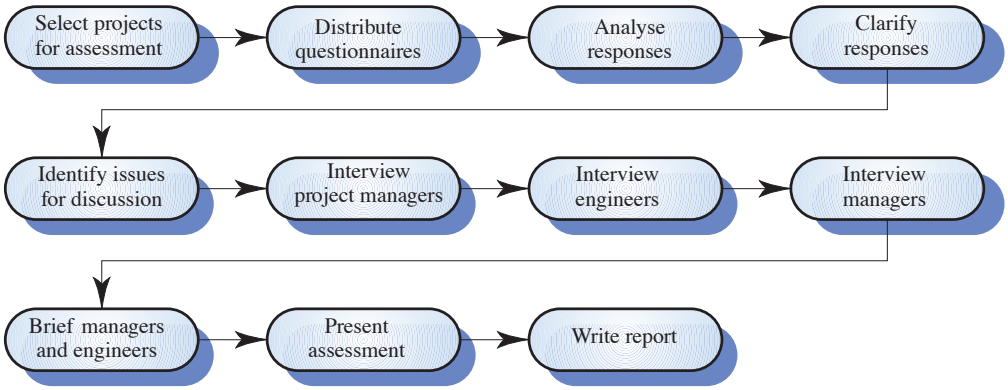
The CMM and ISO 9000

- There is a clear correlation between the key processes in the CMM and the quality management processes in ISO 9000
- The CMM is more detailed and prescriptive and includes a framework for improvement
- Organisations rated as level 2 in the CMM are likely to be ISO 9000 compliant

Capability assessment

- An important role of the SEI is to use the CMM to assess the capabilities of contractors bidding for US government defence contracts
- The model is intended to represent organisational capability not the practices used in particular projects
- Within the same organisation, there are often wide variations in processes used
- Capability assessment is questionnaire-based

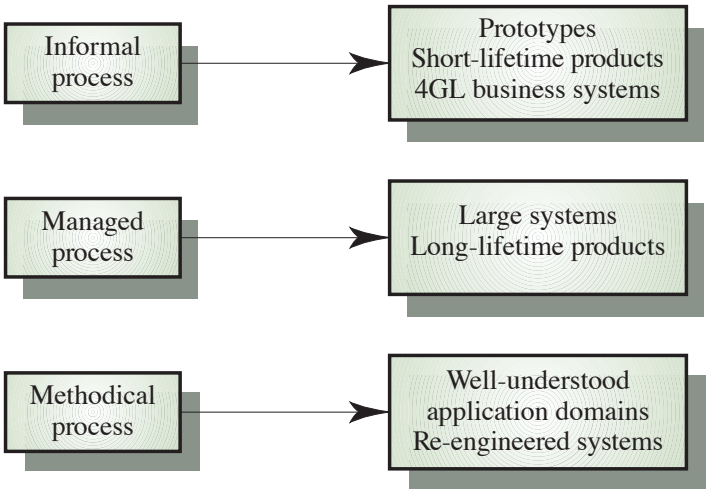
The capability assessment process



Process classification

- Informal
  - No detailed process model. Development team chose their own way of working
- Managed
  - Defined process model which drives the development process
- Methodical
  - Processes supported by some development method such as HOOD
- Supported
  - Processes supported by automated CASE tools

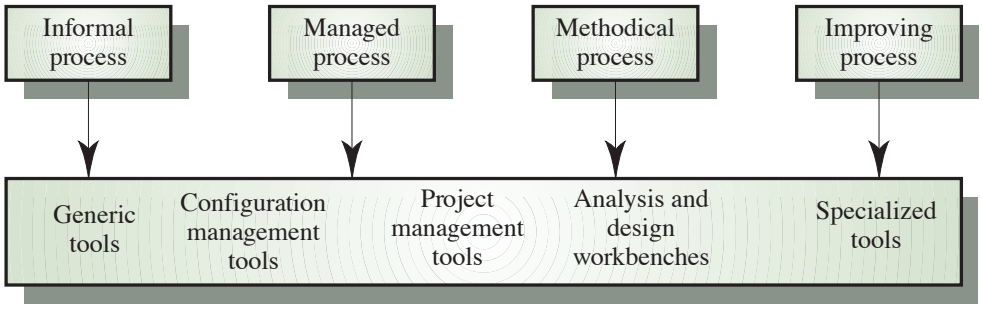
Process applicability



Process choice

- Process used should depend on type of product which is being developed
  - For large systems, management is usually the principal problem so you need a strictly managed process. For smaller systems, more informality is possible.
- There is no uniformly applicable process which should be standardised within an organisation
  - High costs may be incurred if you force an inappropriate process on a development team

Process tool support



Key points

- Process improvement involves process analysis, standardisation, measurement and change
- Process models include descriptions of tasks, activities, roles, exceptions, communications, deliverables and other processes
- Measurement should be used to answer specific questions about the software process used
- The three types of process metrics which can be collected are time metrics, resource utilisation metrics and event metrics

Key points

- The SEI model classifies software processes as initial, repeatable, defined, managed and optimising. It identifies key processes which should be used at each of these levels
- The SEI model is appropriate for large systems developed by large teams of engineers. It cannot be applied without modification in other situations
- Processes can be classified as informal, managed, methodical and improving. This classification can be used to identify process tool support