ATME COLLEGE OF ENGINEERING

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A T M E

College of Engineering

Department of Master of Computer Applications

(ACADEMIC YEAR 2024-25)

Lesson Notes

SUBJECT: Software Engineering

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SEMESTER: II

SCHEME: 2024

UNIT-I
INTRODUCTION TO SOFTWARE ENGINEERING

Software: Software is

(1) Instructions (computer programs) that provide desired features, function, and performance,when executed
(2) Data structures that enable the programs to adequately manipulate information,
(3) Documents that describe the operation and use of the programs.

Characteristics of Software:

(1) Software is developed or engineered; it is not manufactured in the classical sense.
(2) Software does not "wear out"
(3) Although the industry is moving toward component-based construction, most software continues to be custom built.

Software Engineering:

(1) The systematic, disciplined quantifiable approach to the development, operation and maintenance of software; that is, the application of engineering to software.
(2) The study of approaches as in (1)

EVOLVING ROLE OF SOFTWARE:

Software takes dual role. It is both a **product** and a **vehicle** for delivering a product.

As a **product**: It delivers the computing potential embodied by computer Hardware or by a network of computers.

As a **vehicle**: Itis information transformer-producing, managing, acquiring, modifying, displaying, or transmitting information that can be as simple as single bit or as complex as a multimedia presentation. Software delivers the most important product of our time-information.

1. It transforms personal data
2. It manages business information to enhance competitiveness
3. It provides a gateway to worldwide information networks
4. It provides the means for acquiring information.
5. Dramatic Improvements in hardware performance
6. Vast increases in memory and storage capacity
7. A wide variety of exotic input and output options

THE CHANGING NATURE OF SOFTWARE:

The 7 broad categories of computer software present continuing challenges for software engineers:

1) System software
2) Application software
3) Engineering/scientific software
4) Embedded software
5) Product-line software
6) Web-applications
7) Artificial intelligence software.

- **System software:** System software is a collection of programs written to service other programs. The systems software is characterized by

  heavy interaction with computer hardware

  1. heavy usage by multiple users
  2. concurrent operation that requires scheduling, resource sharing, and sophisticated process management
  3. complex data structures
  4. multiple external interfaces

E.g. compilers, editors and file management utilities.

- **Application software:**
  Application software consists of standalone programs that solve a specific business need.
  It facilitates business operations or management/technical decision making.
  It is used to control business functions in real-time

E.g. point-of-sale transaction processing, real-time manufacturing process control.

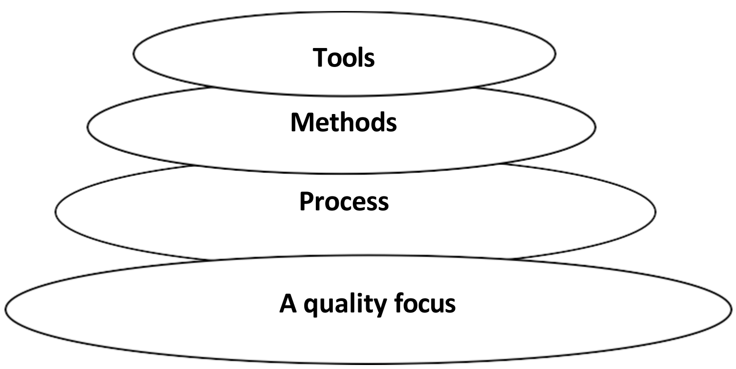
Engineering/Scientific software: Engineering and scientific applications range
from astronomy to volcanology
from automotive stress analysis to space shuttle orbital dynamics
from molecular biology to automated manufacturing
computer aided design, system simulation and other interactive applications.

Embedded software:
Embedded software resides within a product or system and is used to implement and control features and functions for the end-user and for the system itself.
It can perform limited and esoteric functions or provide significant function andcontrol capability.

E.g. Digital functions in automobile, dashboard displays, braking systems etc.

A GENERIC VIEW OF PROCESS

SOFTWARE ENGINEERING - A LAYERED TECHNOLOGY:



Software Engineering Layers

Software engineering is a layered technology. Any engineering approach must rest on an organizational commitment to quality. The bedrock that supports software engineering is a quality focus.

The foundation for software engineering is the process layer. Software engineering process is the glue that holds the technology layers. Process defines a framework that must be established for effective delivery of software engineering technology.

The software forms the basis for management control of software projects and establishes the context in which

1. technical methods are applied,
2. work products are produced,
3. milestones are established,
4. quality is ensured,

And change is properly managed.

A PROCESS FRAMEWORK:

- Software process must be established for effective delivery of software engineering technology.
- **A process framework** establishes the foundation for a complete software process by identifying a small number of framework activities that are applicable to all software projects, regardless of their size or complexity.
- The process framework encompasses a set of umbrella activities that are applicable across the entire software process.
- Each framework activity is populated by a set of software engineering actions
- Each software engineering action is represented by a number of different task sets- each a collection of software engineering work tasks, related work products, quality assurance points, and project milestones.

"A **process** defines who is doing what, when, and how to reach a certain goal."

THE CAPABILITY MATURITY MODEL INTEGRATION (CMMI):

The CMMI represents a process meta-model in two different ways:

- As a continuous model
- As a staged model.

Each process area is formally assessed against specific goals and practices and is rated according to the following capability levels.

Level 0: Incomplete. The process area is either not performed or does not achieve all goals and objectives defined by CMMI for level 1 capability.

Level 1: Performed. All of the specific goals of the process area have been satisfied. Work tasks required to produce defined work products are being conducted.

Level 2: Managed. All level 1 criteria have been 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;

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

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

Level 5: Optimized. All level 4 criteria have been achieved. In addition, the process area is adapted and optimized using quantitative means to meet changing customer needs and to continually improve the efficacy of the process area under consideration"

The CMMI defines each process area in terms of "specific goals" and the "specific practices" required to achieve these goals. Specific practices refine a goal into a set of process-related activities.

The specific goals (SG) and the associated specific practices(SP) defined for project planning are

SG 1 Establish estimates

SP 1.1 Estimate the scope of the project

SP 1.2 Establish estimates of work product and task attributes

SP 1.3 Define project life cycle

SP 1.4 Determine estimates of effort and cost

SG 2 Develop a Project Plan

SP 2.1 Establish the budget and schedule

SP 2.2 Identify project risks

SP 2.3 Plan for data management

SP 2.4 Plan for needed knowledge and skills

SP 2.5 Plan stakeholder involvement

SP 2.6 Establish the project plan

SG 3 Obtain commitment to the plan

SP 3.1 Review plans that affect the project

SP 3.2 Reconcile work and resource levels

SP 3.3 Obtain plan commitment

PERSONAL AND TEAM PROCESS MODELS:

The best software process is one that is close to the people who will be doing the work.Each software engineer would create a process that best fits his or her needs, and at the same time meets the broader needs of the team and the organization. Alternatively, the team itself would create its own process, and at the same time meet the narrower needs of individuals and the broader needs of the organization.

Personal software process (PSP)

The personal software process (PSP) emphasizes personal measurement of both the work product that is produced and the resultant quality of the work product.

The PSP process model defines five framework activities: planning, high-level design, high level design review, development, and postmortem.

Planning: This activity isolates requirements and, base on these develops both size and resource estimates. In addition, a defect estimate is made. All metrics are recorded on worksheets or templates. Finally, development tasks are identified and a project schedule is created.

High level design: External specifications for each component to be constructed are developed and a component design is created. Prototypes are built when uncertainty exists. All issues are recorded and tracked.

High level design review: Formal verification methods are applied to uncover errors in the design. Metrics are maintained for all important tasks and work results.

Development: The component level design is refined and reviewed. Code is generated, reviewed, compiled, and tested. Metrics are maintained for all important task and work results.

Postmortem: Using the measures and metrics collected the effectiveness of the process is determined. Measures and metrics should provide guidance for modifying the process to improve its effectiveness.

PSP stresses the need for each software engineer to identify errors early and, as important, to understand the types of errors that he is likely to make.

PSP represents a disciplined, metrics-based approach to software engineering.

Team software process (TSP): The goal of TSP is to build a "self-directed project team that organizes itself to produce high-quality software. The following are the objectives for TSP:

- Build self-directed teams that plan and track their work, establish goals, and own their processes and plans. These can be pure software teams or integrated product teams(IPT) of 3 to about 20 engineers.
- Show managers how to coach and motivate their teams and how to help them sustain peak performance.
- Accelerate software process improvement by making CMM level 5 behavior normal andexpected.
- Provide improvement guidance to high-maturity organizations.
- Facilitate university teaching of industrial-grade teamskills.

A self-directed team defines

- roles and responsibilities for each team member
- tracks quantitative project data
- identifies a team process that is appropriate for the project
- a strategy for implementing the process
- defines local standards that are applicable to the teams software engineering work;
- continually assesses risk and reacts to it
- Tracks, manages, and reports project status.
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TSP defines the following framework activities: launch, high-level design, implementation, integration and test, and postmortem.
TSP makes use of a wide variety of scripts, forms, and standards that serve to guide team members in their work.
Scripts define specific process activities and other more detailed work functions that are part of the team process.
Each project is "launched" using a sequence of tasks.

The following launch script is recommended

- Review project objectives with management and agree on and document team goals
- Establish team roles
- Define the teams development process
- Make a quality plan and set quality targets
- Plan for the needed support facilities

PROCESS MODELS

Prescriptive process models define a set of activities, actions, tasks, milestones, and work products that are required to engineer high-quality software. These process models are not perfect, but they do provide a useful roadmap for software engineering work.

A prescriptive process model populates a process framework with explicit task sets for software engineering actions.

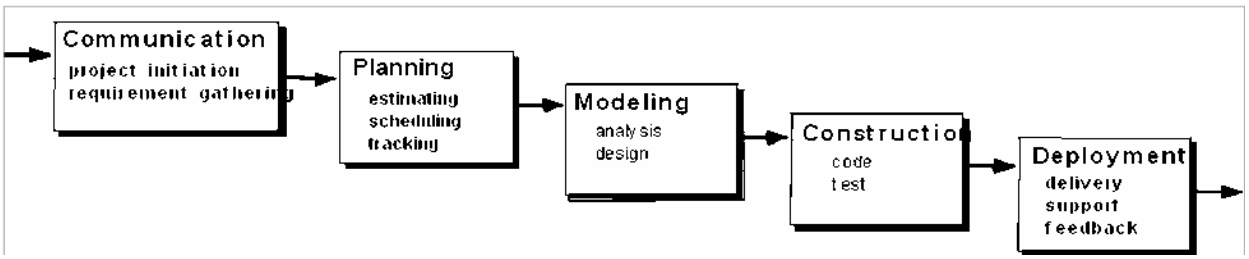
THE WATERFALL MODEL:

The waterfall model, sometimes called the *classic life cycle*, suggests a systematic sequential approach to software development that begins with customer specification of requirements and progresses through planning, modeling, construction, and deployment.

Context: Used when requirements are reasonably well understood.

Advantage:

It can serve as a useful process model in situations where requirements are fixed and work is to proceed to complete in a linear manner.



The **problems** that are sometimes encountered when the waterfall model is applied are:

1. Real projects rarely follow the sequential flow that the model proposes. Although the linear model can accommodate iteration, it does so indirectly. As a result, changes can cause confusion as the project team proceeds.
2. It is often difficult for the customer to state all requirements explicitly. The waterfall model requires this and has difficulty accommodating the natural uncertainty that exist at the beginning of many projects.
3. The customer must have patience. A working version of the programs will not be available until late in the project time-span. If a major blunder is undetected then it can be disastrous until the program is reviewed.

INCREMENTAL PROCESS MODELS:

1) The incremental model
2) The RAD model

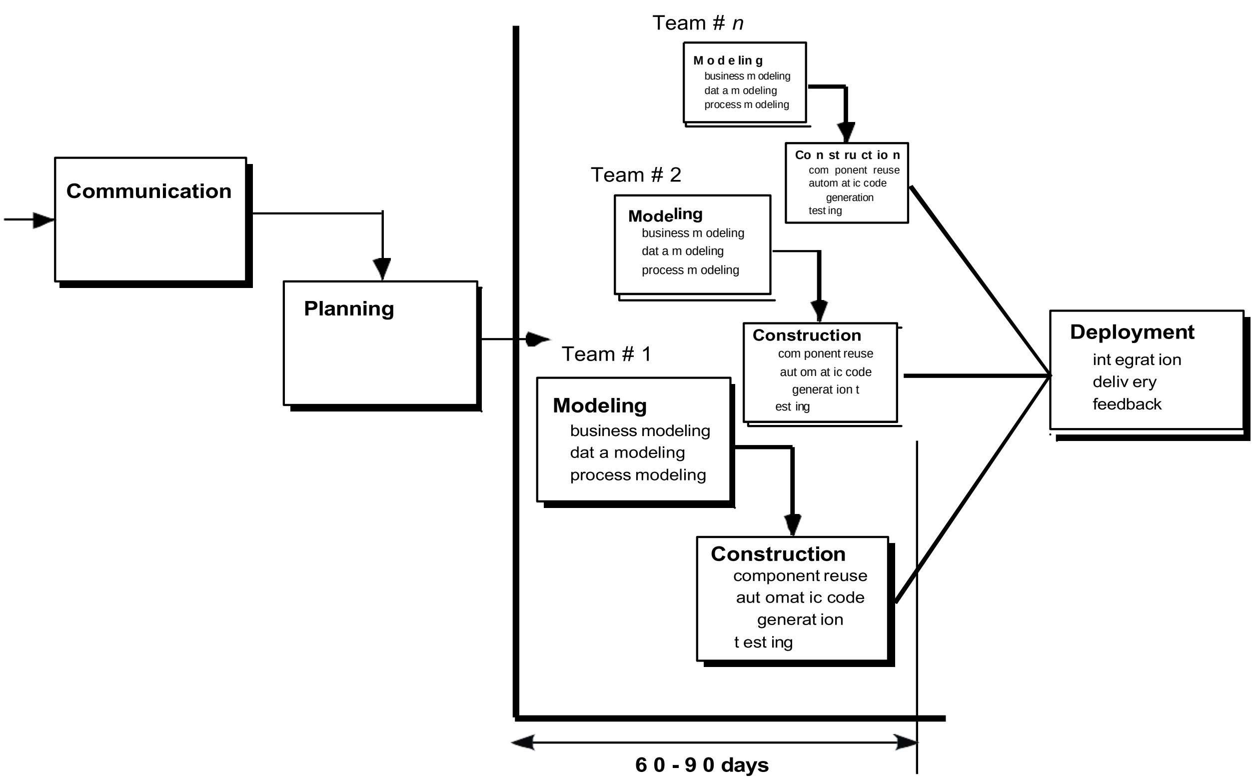
THE INCREMENTAL MODEL:

Context: Incremental development is particularly useful when staffing is unavailable for a complete implementation by the business deadline that has been established for the project. Early increments can be implemented with fewer people. If the core product is well received, additional staff can be added to implement the next increment. In addition, increments can be planned to manage technical

THE RAD MODEL:

Rapid Application Development (RAD) is an incremental software process model that emphasizes a short development cycle. The RAD model is a “high-speed” adaption of the waterfall model, in which rapid development is achieved by using a component base construction approach.

Context: If requirements are well understood and project scope is constrained, the RAD process enables a development team to create a “fully functional system” within a very short time period.



The RAD approach maps into the generic framework activities.
Communication works to understand the business problem and the information characteristics that the software must accommodate.

Planning is essential because multiple software teams works in parallel on different system functions.

Modeling encompasses three major phases- business modeling, data modeling and process modeling- and establishes design representation that serve existing software components and the application of automatic code generation.

Deployment establishes a basis for subsequent iterations.

The RAD approach has **drawbacks**:

For large, but scalable projects, RAD requires sufficient human resources to create the right number of RAD teams.

If developers and customers are not committed to the rapid-fire activities necessary to complete the system in a much abbreviated time frame, RAD projects will fail

If a system cannot be properly modularized, building the components necessary for RAD will be problematic

If high performance is an issue, and performance is to be achieved through tuning the interfaces to system components, the RAD approach may not work; and

RAD may not be appropriate when technical risks are high.

EVOLUTIONARY PROCESS MODELS:

Evolutionary process models produce with each iteration produce an increasingly more complete version of the software with every iteration.

Evolutionary models are iterative. They are characterized in a manner that enables software engineers to develop increasingly more complete versions of the software.

PROTOTYPING:

Prototyping is more commonly used as a technique that can be implemented within the context of anyone of the process model.

The prototyping paradigm begins with communication. The software engineer and customer meet and define the overall objectives for the software, identify whatever requirements are known, and outline areas where further definition is mandatory.

Prototyping iteration is planned quickly and modeling occurs. The quick design leads to the construction of a prototype. The prototype is deployed and then evaluated by the customer/user.

Iteration occurs as the prototype is tuned to satisfy the needs of the customer, while at the same time enabling the developer to better understand what needs to be done.

Advantages:

The prototyping paradigm assists the software engineer and the customer to better understand what is to be built when requirements are fuzzy.

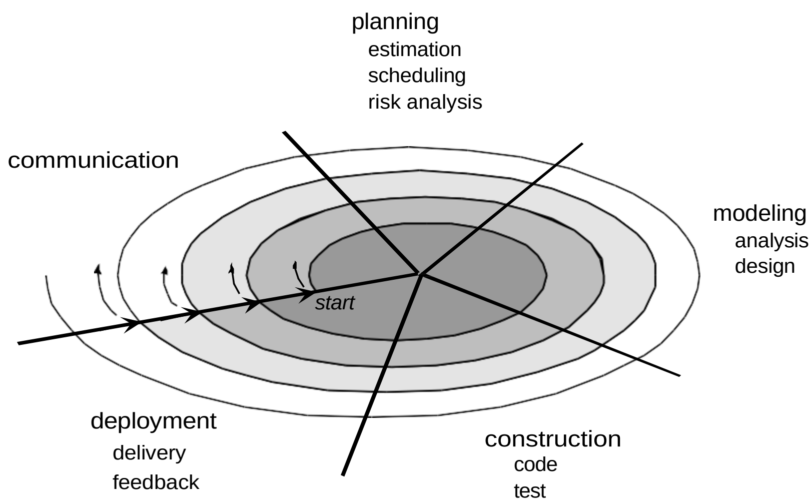
The prototype serves as a mechanism for identifying software requirements. If a working prototype is built, the developer attempts to make use of existing program fragments or applies tools.

Prototyping can be **problematic** for the following reasons:

1. The customer sees what appears to be a working version of the software, unaware that the prototype is held together “with chewing gum and baling wire”, unaware that in the rush to get it working we haven’t considered overall software quality or long-term maintainability. When informed that the product must be rebuilt so that high-levels of quality can be maintained, the customer cries foul and demands that “a few fixes” be applied to make the prototype a working product. Too often, software development relents.
2. The developer often makes implementation compromises in order to get a prototype working quickly. An inappropriate operating system or programming language may be used simply because it is available and known; an inefficient algorithm may be implemented simply to demonstrate capability. After a time, the developer may become comfortable with these choices and forget all the reasons why they were inappropriate. The less-than-ideal choice has now become an integral part of the system.

THE SPIRAL MODEL

- The spiral model, originally proposed by Boehm, is an evolutionary software process model that couples the iterative nature of prototyping with the controlled and systematic aspects of the waterfall model.
- The spiral model can be adapted to apply throughout the entire life cycle of an application, from concept development to maintenance.
- Using the spiral model, software is developed in a series of evolutionary releases. During early iterations, the release might be a paper model or prototype. During later iterations, increasingly morecomplete versions of the engineered system are produced


planning
estimation
scheduling
risk analysis
communication
modeling
analysis
design
start
deployment
delivery
feedback
construction
code
test

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- **Anchor point milestones**- a combination of work products and conditions that are attained along the path of the spiral- are noted for each evolutionary pass.
- The first circuit around the spiral might result in the development of product specification; subsequent passes around the spiral might be used to develop a prototype and then progressively more sophisticated versions of the software.
- Each pass through the planning region results in adjustments to the project plan. Cost and schedule are adjusted based on feedback derived from the customer after delivery. In addition, the project manager adjusts the planned number of iterations required to complete the software.
- It maintains the systematic stepwise approach suggested by the classic life cycle but incorporates it into an iterative framework that more realistically reflects the real world.

- ➢ The first circuit around the spiral might represent a "**concept development project**" which starts at the core of the spiral and continues for multiple iterations until concept development is complete.
- ➢ If the concept is to be developed into an actual product, the process proceeds outward on the spiral and a "**new product development project**" commences.
- ➢ Later, a circuit around the spiral might be used to represent a "**product enhancement project**." In essence, the spiral, when characterized in this way, remains operative until the software is retired.

Advantages:
It provides the potential for rapid development of increasingly more complete versions of the software.

The spiral model is a realistic approach to the development of large-scale systems and software. The spiral model uses prototyping as a risk reduction mechanism but, more importantly enables the developer to apply the prototyping approach at any stage in the evolution of the product.

Draw Backs:
The spiral model is not a panacea. It may be difficult to convince customers that the evolutionary approach is controllable. It demands considerable risk assessment expertise and relies on this expertise for success. If a major risk is not uncovered and managed, problems will undoubtedly occur.

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UNIT-II

SOFTWARE REQUIREMENTS

Software requirements are necessary

- To introduce the concepts of user and system requirements
- To describe functional and non-functional requirements
- To explain how software requirements may be organised in a requirements document

What is a requirement?

- The requirements for the system are the description of the services provided by the system and its operational constraints
- It may range from a high-level abstract statement of a service or of a system constraint to a detailed mathematical functional specification.
- This is inevitable as requirements may serve a dual function
    - May be the basis for a bid for a contract - therefore must be open to interpretation;
    - May be the basis for the contract itself - therefore must be defined in detail;

Both these statements may be called requirements

Requirements engineering:

- The process of finding out, analysing documenting and checking these services and constraints is called requirement engineering.
- The process of establishing the services that the customer requires from a system and the constraints under which it operates and is developed.
- The requirements themselves are the descriptions ofthe system services and constraints that are generated during the requirements engineering process.

Requirements abstraction (Davis):

If a company wishes to let a contract for a large software development project, it must define its needs in a sufficiently abstract way that a solution is not pre-defined. The requirements must be written so that several contractors can bid for the contract, offering, perhaps, different ways of meeting the client organisation's needs. Once a contract has been awarded, the contractor must write a system definition for the client in more detail so that the client understands and can validate what the software will do. Both of these documents may be called the requirements ***document*** *for the system."*

Types of requirement:

- **User requirements**
    - Statements in natural language plus diagrams ofthe services the system provides and its operational constraints. Written for customers.
- **System requirements**
    - A structured document setting out detailed descriptions of the system's functions, services and operational constraints. Defines what should be implemented so may be part of a contract between client and contractor.

Definitions and specifications:

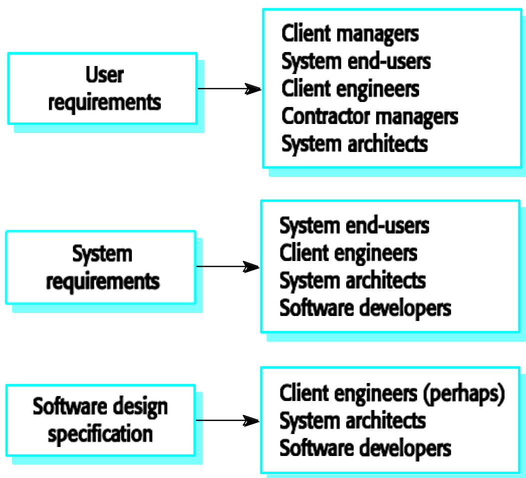
User Requirement Definition:

The software must provide the means of representing and accessing external files created by other tools.

System Requirement specification:

- The user should be provided with facilities to define the type of external files.
- Each external file type may have an associated tool which may be applied to the file.
- Each external file type may be represented as a specific icon on the user's display.
- Facilities should be provided for the icon representing an external file type to be defined bythe user.
- When an user selects an icon representing an external file, the effect of that selection is to apply the tool associated with the type of the external file to the file represented by the selected icon.

Requirements readers:



1) **Functional and non-functional requirements:**

Functional requirements

- Statements of services the system should provide how the system should react to particular inputs and how the system should behave in particular situations.

Non-functional requirements

- Constraints on the services or functions offered by the system such as timing constraints, constraints on the development process, standards, etc.

Domain requirements

- Requirements that come from the application domain of the system and that reflect characteristics of that domain.

FUNCTIONAL REQUIREMENTS:

- Describe functionality or system services.
- Depend on the type of software, expected users and the type of system where the softwareis used.
- Functional user requirements may be high-level statements of what the system should do but functional system requirements should describe the system services in detail.

The functional requirements for **The LIBSYS system:**

- A library system that provides a single interface to a number of databases of articles in different libraries.
- Users can search for, download and print these articles for personal study.

Examples of functional requirements

- The user shall be able to search either all ofthe initial set of databases or select a subset from it.
- The system shall provide appropriate viewers for the user to read documents in thedocument store.

- Every order shall be allocated a unique identifier (ORDER_ID) which the user shall be able to copy to the account's permanent storage area.

Requirements imprecision

- Problems arise when requirements are not precisely stated.
- Ambiguous requirements may be interpreted in different ways by developers and users.
- Consider the term 'appropriate viewers'
    - User intention - special purpose viewer for each different document type;
    - Developer interpretation - Provide a text viewer that shows the contents of the document.

Requirements completeness and consistency:

In principle, requirements should be both complete and consistent.

Complete

- They should include descriptions of all facilities required.

Consistent

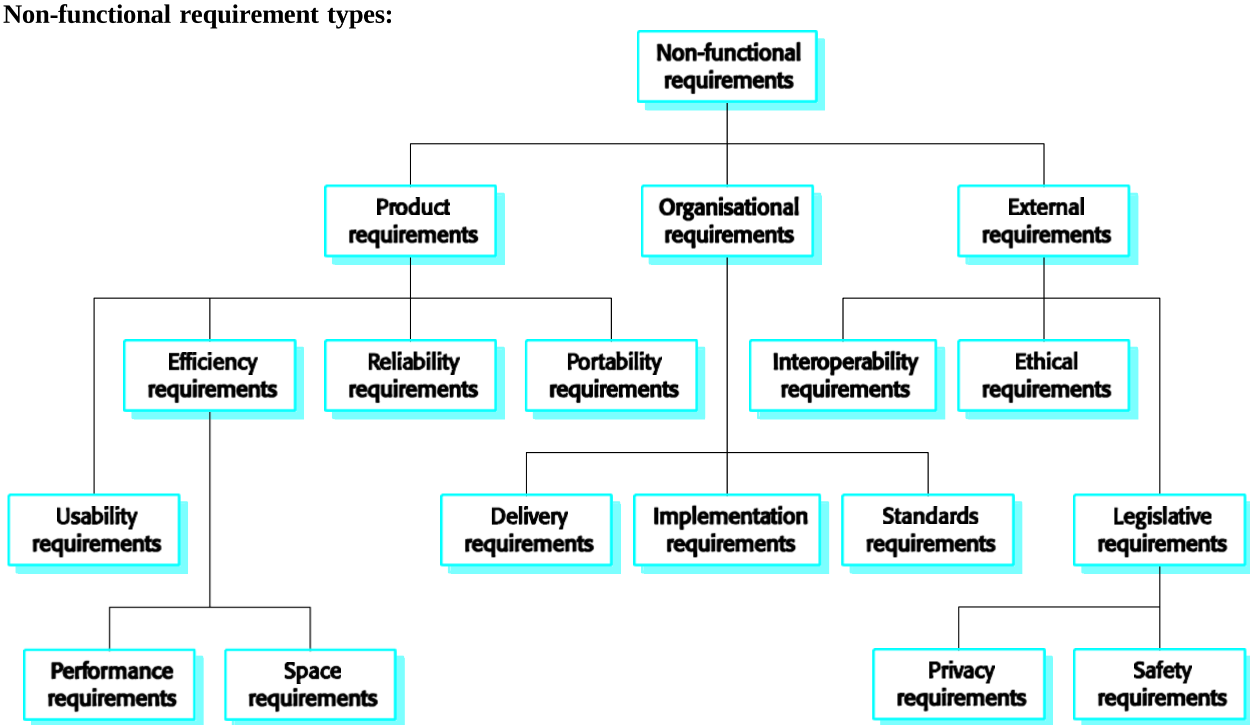
- There should be no conflicts or contradictions in the descriptions of the system facilities.

In practice, it is impossible to produce a complete and consistent requirementsdocument.

NON-FUNCTIONAL REQUIREMENTS

- These define system properties and constraints e.g. reliability, response time and storage requirements. Constraints are I/O device capability, system representations, etc.
- Process requirements may also be specified mandating a particular CASE system, programming language or development method.
- Non-functional requirements may be more critical than functional requirements. If these are not met, the system is useless.

Non-functional requirement types:



Non-functional requirements :

Product requirements

Requirements which specify that the delivered product must behave in a particular way e.g. execution speed, reliability, etc.

- *Eg:* The user interface for LIBSYS shall be implemented as simple HTML without frames or Java applets.

Goals and requirements:

- Non-functional requirements may be very difficult to state precisely and imprecise requirements may be difficult to verify.
- Goal
  - A general intention of the user such as ease of use.
  - The system should be easy to use by experienced controllers and should be organised in such a way that user errors are minimised.
- Verifiable non-functional requirement
  - A statement using some measure that can be objectively tested.
  - Experienced controllers shall be able to use all the system functions after a total of two hours training. After this training, the average number of errors made by experienced users shall not exceed two per day.
- Goals are helpful to developers as they convey the intentions of the system users.

Handle request

USER REQUIREMENTS

- Should describe functional and non-functional requirements in such a way that they are understandable by system users who don't have detailed technicalknowledge.
- User requirements are defined using natural language, tables and diagrams as these can be understood by all users.

Complete transaction

Problems with natural language

Lack of clarity

- Precision is difficult without making the document difficult to read.

Requirements confusion

- Functional and non-functional requirements tend to bemixed-up.

Requirements amalgamation

- Several different requirements may be expressed together

SYSTEM REQUIREMENTS

- More detailed specifications of system functions, services and constraints than userrequirements.
- They are intended to be a basis for designing the system.
- They may be incorporated into the system contract.
- System requirements may be defined or illustrated using system models

System requirement specification using a standard form:

1. Function
2. Description
3. Inputs
4. Source
5. Outputs
6. Destination
7. Action
8. Requires
9. Pre-condition

10. Post-condition
11. Side-effects

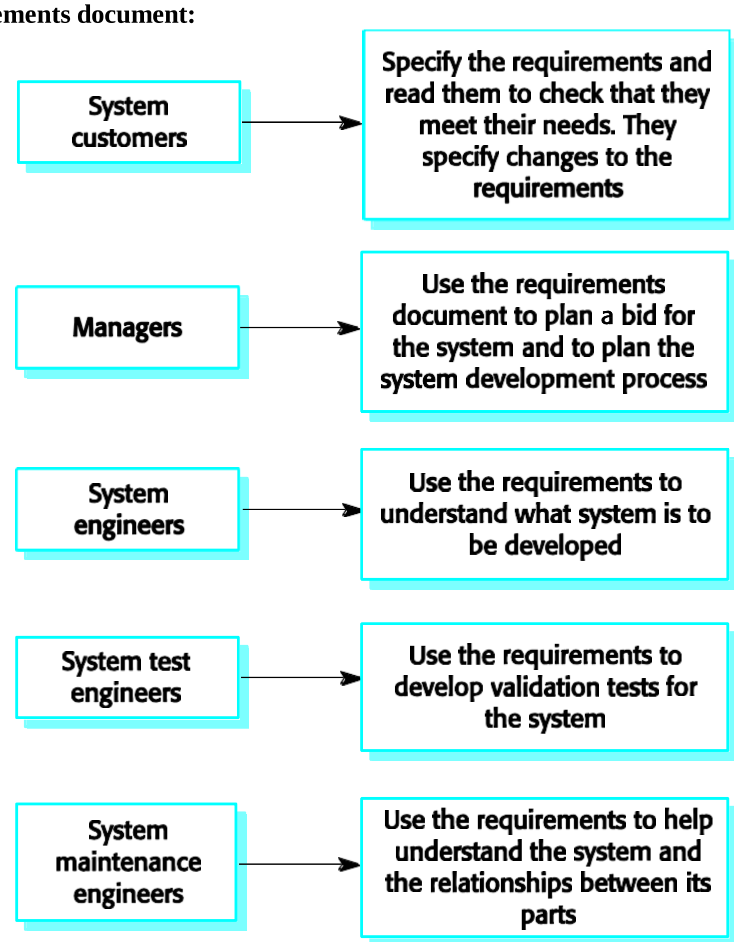
2) INTERFACE SPECIFICATION

- Most systems must operate with other systems and the operating interfaces must be specified as part of the requirements.
- Three types of interface may have to be defined
  - ***Procedural interfaces*** where existing programs or sub-systems offer a range of services that are accessed by calling interface procedures. These interfaces are sometimes called Applicatin Programming Interfaces (APIs)
  - ***Data structures that are exchanged*** **t**hat are passed from one sub-system to another. Graphical data models are the best notations for this type of description
  - ***Data representations*** that have been established for an existing sub-system
- Formal notations are an effective technique for interface specification.

3) THE SOFTWARE REQUIREMENTS DOCUMENT:

- The requirements document is the official statement of what is required of the system developers.
- Should include both a definition of user requirements and a specification of the system requirements.
- It is NOT a design document. As far as possible, it should set of WHAT the system shoulddo rather than HOW it should do it

Users of a requirements document:



IEEE requirements standard defines a generic structure for a requirements document that must be instantiated for each specific system.

1. Introduction.
   i) Purpose of the requirements document
   ii) Scope of the project
   iii) Definitions, acronyms and abbreviations
   iv) References
   v) Overview of the remainder of the document
2. General description.
   i) Product perspective
   ii) Product functions
   iii) User characteristics
   iv) General constraints
   v) Assumptions and dependencies
3. Specific requirements cover functional, non-functional and interface requirements. The requirements may document external interfaces, describe system functionality and performance, specify logical database requirements, design constraints, emergent system properties and quality characteristics.
4. Appendices.
5. Index.

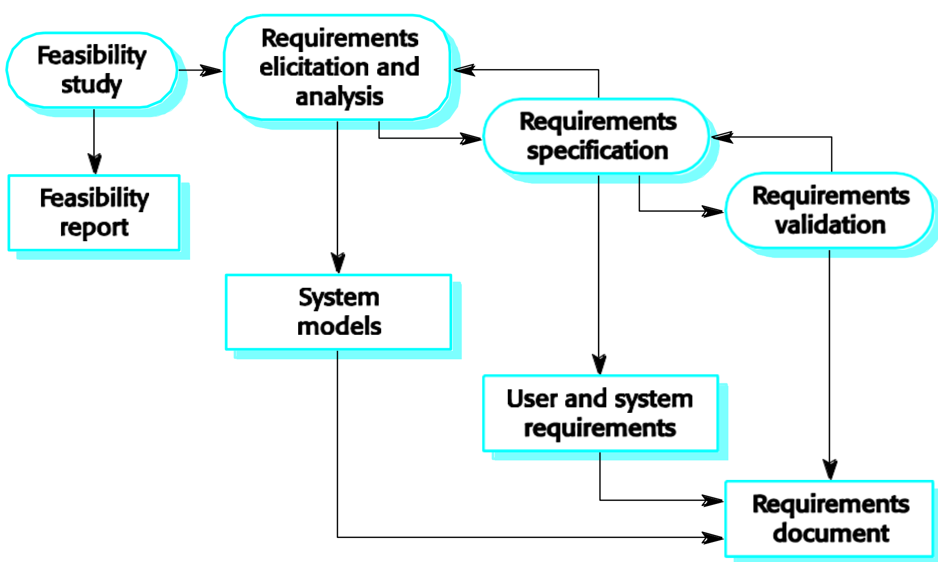
REQUIREMENTS ENGINEERING PROCESSES

The **goal** of requirements engineering process is to create and maintain a system requirements document. The overall process includes four high-level requirement engineering sub-processes. These are concerned with

- ✓ Assessing whether the system is useful to the business(feasibility study)
- ✓ Discovering requirements(elicitation and analysis)
- ✓ Converting these requirements into some standard form(specification)
- ✓ Checking that the requirements actually define the system that the customerwants(validation)

The process of managing the changes in the requirements is called **requirementmanagement**.

The requirements engineering process

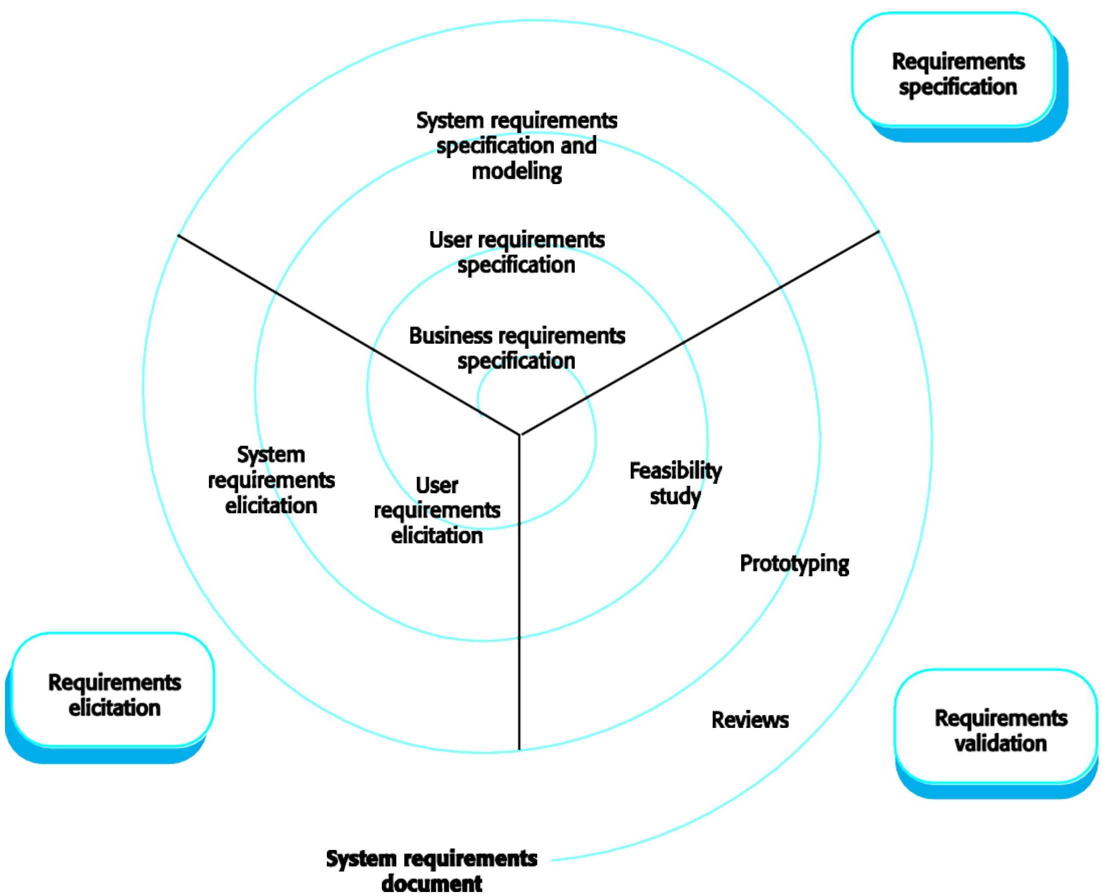


Requirements Engineering: The alternative perspective on the requirements engineering process presents the process as a **three-stage activity** where the activities are organized as an iterative process around a spiral. The amount of time and effort devoted to each activity in iteration depends on the stage of the overall process and the type of system being developed. Early in the process, most effort will be spent on understanding high-level business and non-functional requirements and the user requirements. Later in the process, in the outer rings of the spiral, more effort will be devoted to system requirements engineering and systemmodeling.

This spiral model accommodates approaches to development in which the requirements are developed to different levels of detail. The number of iterations around the spiral can vary, so the spiral can be exited after some or all of the user requirements have been elicited.

Some people consider requirements engineering to be the process of applying a structured analysis method such as object-oriented analysis. This involves analyzing the system and developing a set of graphical system models, such as use-case models, that then serve as a system specification. The set of models describes the behavior of the system and are annotated with additional information describing, for example, its required performance or reliability.

Spiral model of requirements engineering processes



1) FEASIBILITY STUDIES

A feasibility study decides whether or not the proposed system is worthwhile. The input to the feasibility study is a set of preliminary business requirements, an outline description of the system and how the system is intended to support business processes. The results of the feasibility study should be a report that recommends whether or not it worth carrying on with the requirements engineering and system development process.

- A short focused study that checks
  - If the system contributes to organisational objectives;
  - If the system can be engineered using current technology and within budget;

- If the system can be integrated with other systems that are used.

Feasibility study implementation:

- A feasibility study involves information assessment, information collection and report writing.
- Questions for people in the organisation
  - What if the system wasn't implemented?
  - What are current process problems?
  - How will the proposed system help?
  - What will be the integration problems?
  - Is new technology needed? What skills?
  - What facilities must be supported by the proposed system?

In a feasibility study, you may consult information sources such as the managers of the departments where the system will be used, software engineers who are familiar with the type of system that is proposed, technology experts and end-users of the system. They should try to complete a feasibility study in two or three weeks.

Once you have the information, you write the feasibility study report. You should make a recommendation about whether or not the system development should continue. In the report, you may propose changes to the scope, budget and schedule of the system and suggest further high-level requirements for the system.

2) REQUIREMENT ELICITATION AND ANALYSIS:

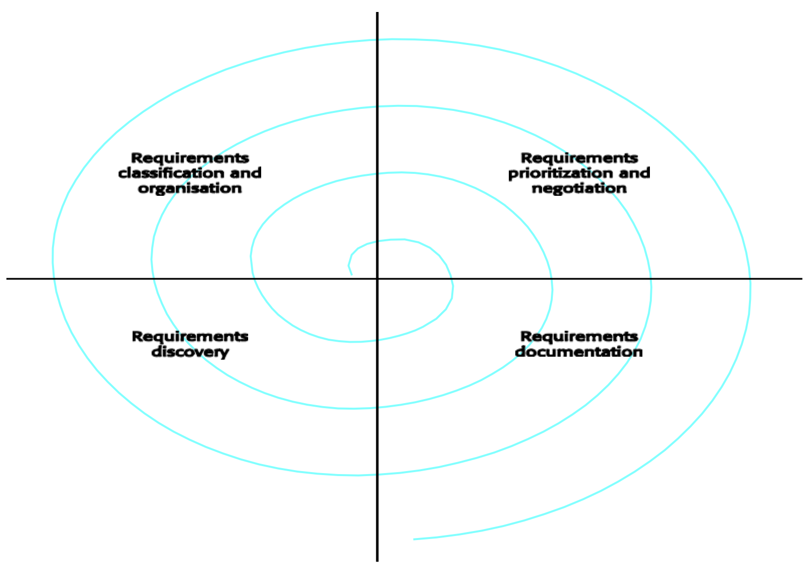
The requirement engineering process is requirements elicitation and analysis.

- Sometimes called requirements elicitation or requirements discovery.
- Involves technical staff working with customers to find out about the application domain, the services that the system should provide and the system's operational constraints.
- May involve end-users, managers, engineers involved in maintenance, domainexperts, trade unions, etc. These are called *stakeholders.*
-

Problems of requirements analysis

- Stakeholders don't know what they really want.
- Stakeholders express requirements in their own terms.
- Different stakeholders may have conflicting requirements.
- Organisational and political factors may influence the system requirements.
- The requirements change during the analysis process. New stakeholders mayemerge and the business environment change.

The requirements spiral



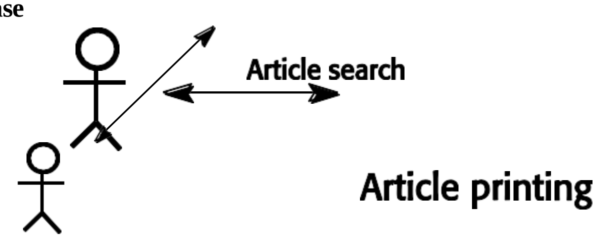
Process activities

1. Requirements discovery
   – Interacting with stakeholders to discover their requirements. Domain requirements are also discovered at this stage.
2. Requirements classification and organisation
   – Groups related requirements and organises them into coherent clusters.
3. Prioritisation and negotiation
   – Prioritising requirements and resolving requirements conflicts.
4. Requirements documentation
   – Requirements are documented and input into the next round of the spiral.

Use cases

- Use-cases are a scenario based technique in the UML which identify the actors in an interaction and which describe the interaction itself.
- A set of use cases should describe all possible interactions with the system.
- Sequence diagrams may be used to add detail to use-cases by showing the sequence ofevent processing in the system.
-

Article printing use-case



REQUIREMENTS VALIDATION

- Concerned with demonstrating that the requirements define the system that the customer really wants.

  User
- Requirements error costs are high so validation is very important
  – Fixing a requirements error after delivery may cost up to 100 times the cost of fixing an implementation error.

Requirements checking:

- ***Validity***: Does the system provide the functions which best support the customer's needs?
- ***Consistency***: Are there any requirements conflicts?
- ***Completeness***: Are all functions required by the customer included?
- ***Realism***: Can the requirements be implemented given available budget and technology
- ***Verifiability***: Can the requirements be checked?

Requirements validation techniques

- Requirements reviews
  – Systematic manual analysis of the requirements.
- Prototyping
  – Using an executable model of the system to check requirement.
- Test-case generation
  – Developing tests for requirements to check testability.

Requirements reviews:

- Regular reviews should be held while the requirements definition is being formulated.
- Both client and contractor staff should be involved in reviews.
- Reviews may be formal (with completed documents) or informal. Good communications between developers, customers and users can resolve problems at an early stage.

Review checks:

- ***Verifiability*:** Is the requirement realistically testable?

- ***Comprehensibility*****:** Is the requirement properlyunderstood?
- ***Traceability*****:** Is the origin of the requirement clearlystated?
- ***Adaptability*****:** Can the requirement be changed without a large impact on other requirements?

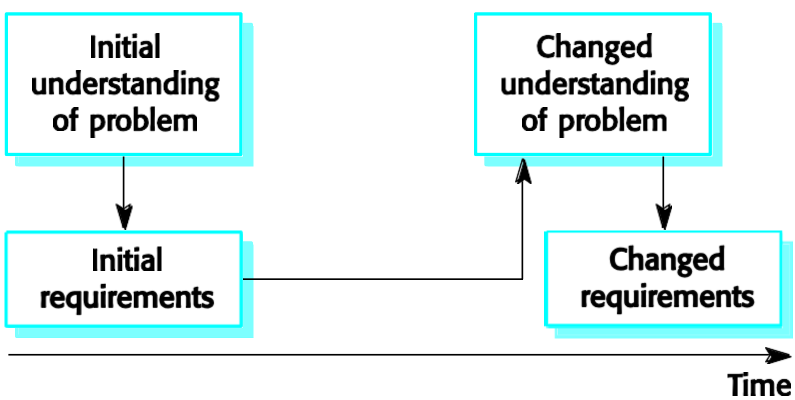
3) REQUIREMENTS MANAGEMENT

- Requirements management is the process of managing changing requirements during the requirements engineering process and system development.
- Requirements are inevitably incomplete and inconsistent
  - New requirements emerge during the process as business needs change and a better understanding of the system is developed;
  - Different viewpoints have different requirements and these are oftencontradictory.

Requirements change

- The priority of requirements from different viewpoints changes during the developmentprocess.
- System customers may specify requirements from a business perspective that conflict withend-user requirements.
- The business and technical environment of the system changes during its development.

Requirements evolution:



Requirements management planning:

- During the requirements engineering process, you have to plan:
  - Requirements identification
    - How requirements are individually identified;
  - A change management process
    - The process followed when analysing a requirements change;
  - Traceability policies
    - The amount of information about requirements relationships that is maintained;
  - CASE tool support
    - The tool support required to help manage requirements change;

Traceability:

Traceability is concerned with the relationships between requirements, their sources and the system design

- Source traceability
  - Links from requirements to stakeholders who proposed these requirements;
- Requirements traceability
  - Links between dependent requirements;
- Design traceability - Links from the requirements to the design;

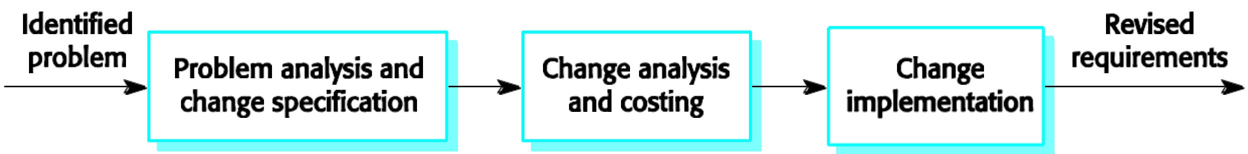
CASE tool support:

- Requirements storage
  - Requirements should be managed in a secure, managed data store.
- Change management
  - The process of change management is a workflow process whose stages can bedefined and information flow between these stages partially automated.
- Traceability management
  - Automated retrieval of the links between requirements.

Requirements change management:

- Should apply to all proposed changes to the requirements.
- Principal stages
  - Problem analysis. Discuss requirements problem and propose change;
  - Change analysis and costing. Assess effects of change on other requirements;
  - Change implementation. Modify requirements document and other documents to reflect change.

Change management:



SYSTEM MODELLING

- System modelling helps the analyst to understand the functionality of the system and models are used to communicate with customers.
- Different models present the system from different perspectives
  - Behavioural perspective showing the behaviour of the system;
  - Structural perspective showing the system or data architecture.

Model types

- Data processing model showing how the data is processed at different stages.
- Composition model showing how entities are composed of other entities.
- Architectural model showing principal sub-systems.
- Classification model showing how entities have common characteristics.
- Stimulus/response model showing the system's reaction to events.

1) CONTEXT MODELS:

- Context models are used to illustrate the operational context of a system - they show what lies outside the system boundaries.
- Social and organisational concerns may affect the decision on where to position system boundaries.
- Architectural models show the system and its relationship with other systems.

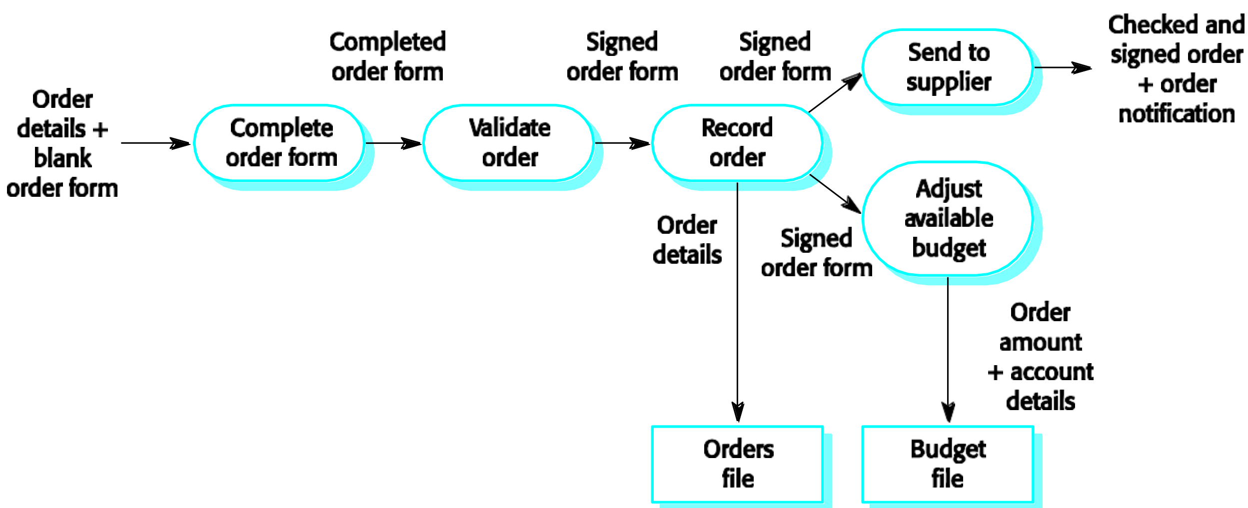
2) BEHAVIOURAL MODELS:

- Behavioural models are used to describe the overall behaviour of a system.
- Two types of behavioural model are:
  - Data processing models that show how data is processed as it moves through the system;
  - State machine models that show the systems response to events.
- These models show different perspectives so both of them are required to describe the system's behaviour.

Data-processing models:

- Data flow diagrams (DFDs) may be used to model the system's data processing.
- These show the processing steps as data flows through a system.
- DFDs are an intrinsic part of many analysis methods.
- Simple and intuitive notation that customers can understand.
- Show end-to-end processing of data.

Order processing DFD:



Data flow diagrams:

- DFDs model the system from a functional perspective.
- Tracking and documenting how the data associated with a process is helpful to develop an overall understanding of the system.
- Data flow diagrams may also be used in showing the data exchange between a system and other systems in its environment.

Data dictionaries

- Data dictionaries are lists of all of the names used in the system models. Descriptions of the entities, relationships and attributes are also included.
- Advantages
  - Support name management and avoid duplication;
  - Store of organisational knowledge linking analysis, design and implementation;
- Many CASE workbenches support data dictionaries.

3) OBJECT MODELS:

- Object models describe the system in terms of object classes and their associations.
- An object class is an abstraction over a set of objects with common attributes and theservices (operations) provided by each object.
- Various object models may be produced

  - Inheritance models;
  - Aggregation models;
  - Interaction models.
- Natural ways of reflecting the real-world entities manipulated by the system
- More abstract entities are more difficult to model using this approach
- Object class identification is recognised as a difficult process requiring a deep understanding of the application domain
- Object classes reflecting domain entities are reusable across systems

Inheritance models:

- Organise the domain object classes into a hierarchy.
- Classes at the top of the hierarchy reflect the common features of all classes.
- Object classes inherit their attributes and services from one or more super-classes. these may then be specialised as necessary.

Class hierarchy design can be a difficult process if duplication in different branches is to be avoided.

Object models and the UML:

- The UML is a standard representation devised by the developers of widely used object-oriented analysis and design methods.
- It has become an effective standard for object-oriented modelling.
- Notation
  - Object classes are rectangles with the name at the top, attributes in the middle sectionand operations in the bottom section;
  - Relationships between object classes (known as associations) are shown as lines linking objects;
  - Inheritance is referred to as generalisation and is shown‘upwards’ rather than ‘downwards’ in a hierarchy.