

# Requirements Engineering

## Lecture 4

# Session Outcomes



- Why we need Requirements Engineering
- Requirement levels and types
- Requirements Engineering process
  - Requirements elicitation and analysis
  - Requirements Specification
  - Requirements Validation

# What and Why

- Requirements engineering is a process of establishing
  - the services that a customer requires from a system and
  - the constraints under which it operates and is developed.
- Why
  - Trouble in understanding what customer really wants
  - record requirements in a disorganized manner
  - spend far too little time verifying what we do record
  - fail to establish a solid foundation for the system or software that the user wants built

# Requirements Levels

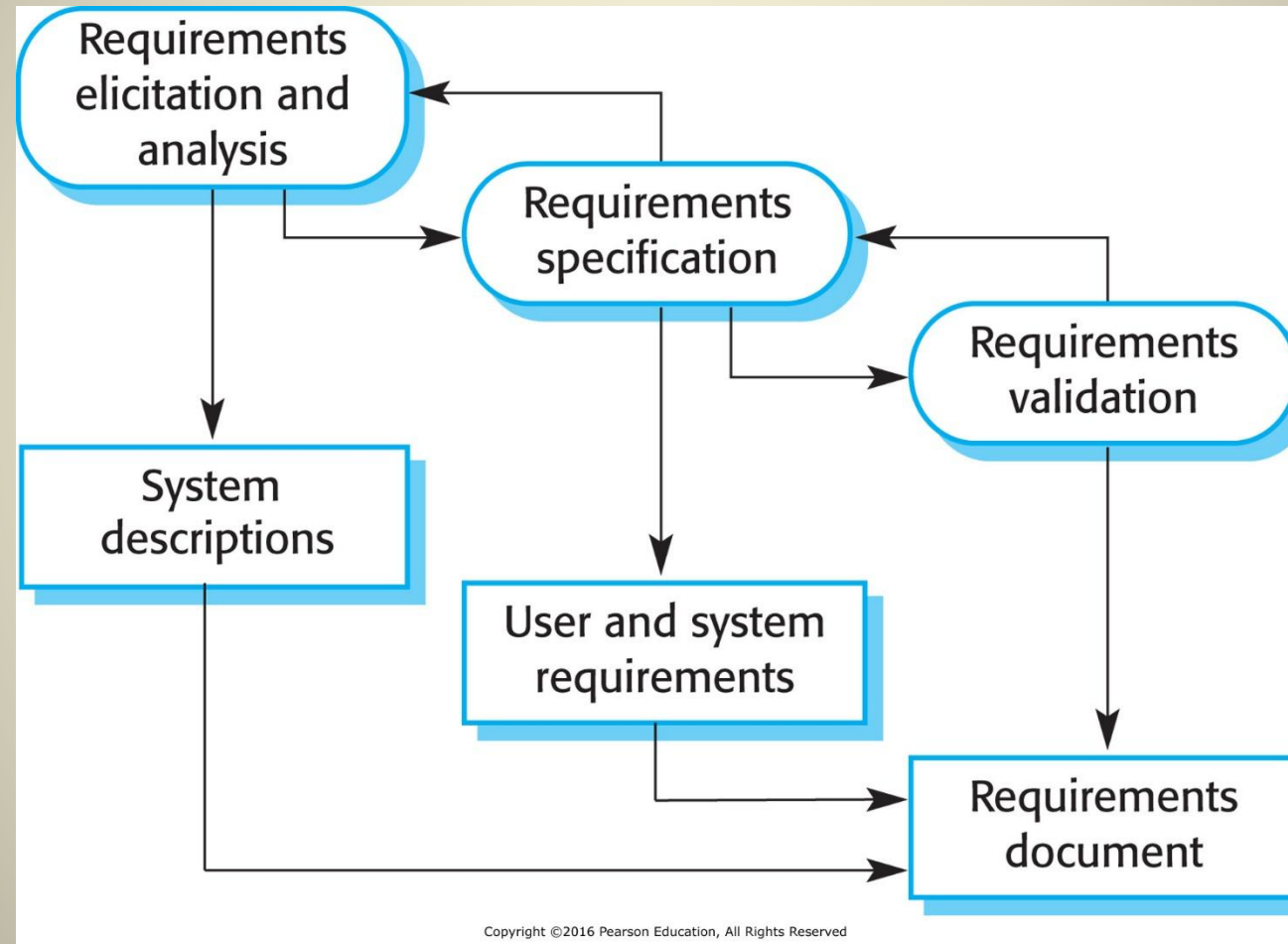
- User requirements
  - Statements in natural language plus diagrams of the services the system provides and its operational constraints.
- System requirements
  - A structured document setting out detailed descriptions of the system's functions, services and operational constraints.

# System stakeholders

- Any person or organization who is affected by the system in some way and so who has a legitimate interest
- Stakeholder types
  - End users
  - System managers
  - System owners
  - External stakeholders



# Requirements Engineering process



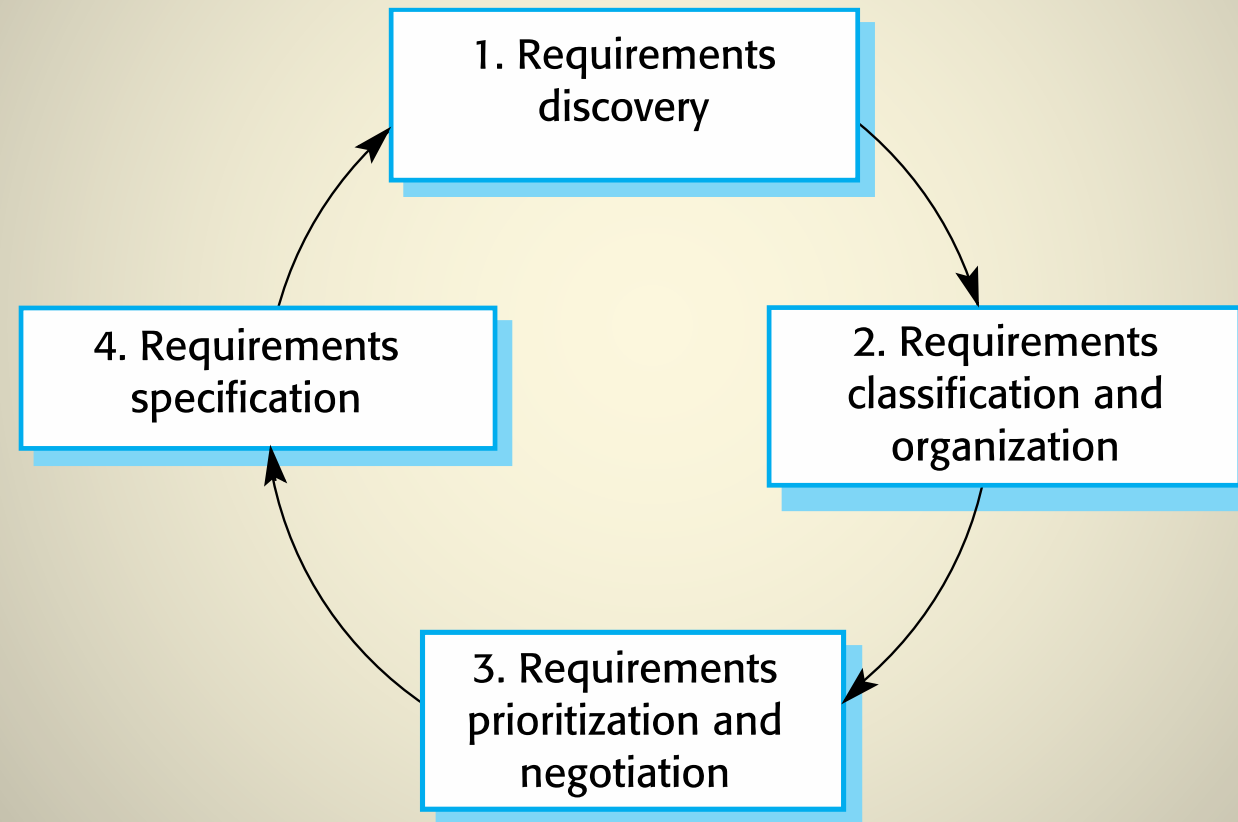
# Requirements elicitation and analysis

# Requirements elicitation

- Aim – Understand the work stakeholders do and how a new system would support that work.
- Software engineers work with a range of system stakeholders to find out about the application domain, the services that the system should provide, the required system performance, hardware constraints, other systems, etc.
- Stages include:
  - Requirements discovery,
  - Requirements classification and organization,
  - Requirements prioritization and negotiation,
  - Requirements specification.



# The requirements elicitation and analysis process



# Process activities

- Requirements discovery
  - Interacting with stakeholders to discover their requirements.
- Requirements classification and organisation
  - Groups related requirements and organises them into coherent clusters.
- Prioritisation and negotiation
  - Prioritising requirements and resolving requirements conflicts.
- Requirements specification
  - Requirements are documented and input into the next round of the spiral.

# Requirements discovery

- The process of gathering information about the required and existing systems and distilling the user and system requirements from this information.
- Interaction is with system stakeholders from managers to external regulators.
- Requirements elicitation techniques
  - Interviewing
  - Observation/Ethnography

# Interviewing

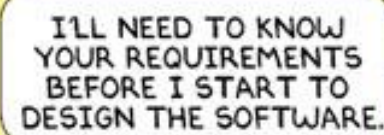
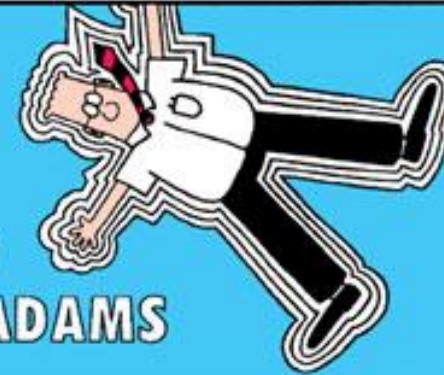
- Formal or informal interviews with stakeholders are part of most RE processes.
- Types of interview
  - Closed interviews based on pre-determined list of questions
  - Open interviews where various issues are explored with stakeholders.



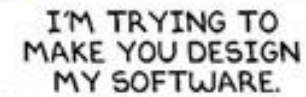
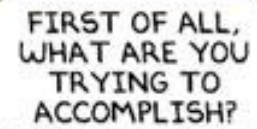


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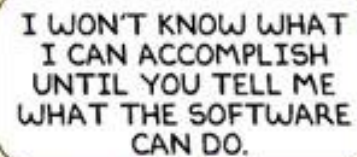
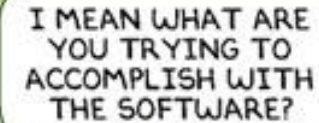
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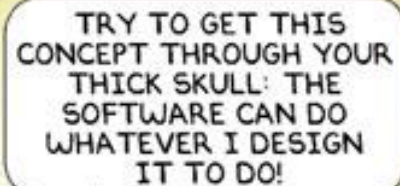
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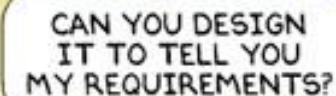
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# Ethnography

- Aim – try to understand the social and organizational issues that affect the use of the system.
- The development team watch people doing their job to see what artifacts they use, how they use them, ...
- Spends a considerable time observing and analysing how people actually work.
- People do not have to explain or articulate their work.
- Ethnographic studies have shown that work is usually richer and more complex than suggested by simple system models.

# Requirements classification and organisation

- User requirements
- System 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
    - Requirements that are not directly concerned with specific functionality

# Functional requirements

- Describe functionality or system services.
- Depend on the type of software, expected users and the type of system where the software is used.
- Functional user requirements may be high-level statements of what the system should do.
- Functional system requirements should describe the system services in detail.
- May state what the system should not do.

# Non-functional requirements

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- Constraints on the services or functions offered by the system.
- Often apply to the system as a whole rather than individual features or services.
- These define system properties and constraints.
- Non-functional requirements may be more critical than functional requirements. If these are not met, the system may be useless.



# Non-functional classifications

- Product requirements
  - Requirements which specify or constrain the runtime behaviour of software.
  - Response time, reliability, memory use, availability, security, usability.
- Organisational requirements
  - Requirements which are a consequence of organisational policies and procedures
  - process standards used, implementation requirements, programming language.
- External requirements
  - Requirements which arise from factors which are external to the system and its development process
  - legislative requirements, ethical requirements, regulator requirements.



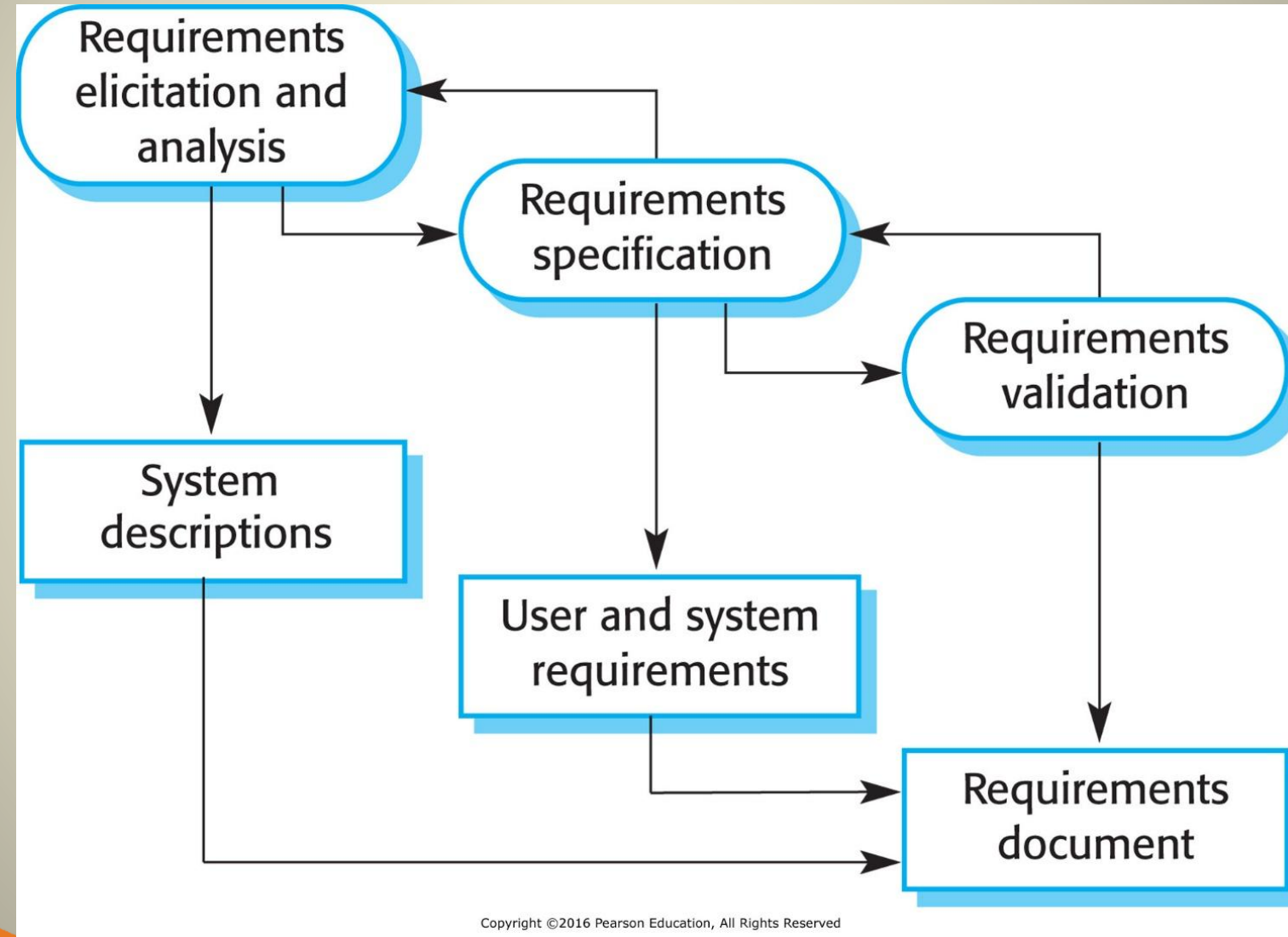
# Requirements imprecision

- Problems arise when requirements are not precisely stated.
  - **inconsistent Requirements** -the customer cannot decide what problem they really want solved.
  - **ambiguous Requirements** -it is not possible to determine what the requirements mean.
    - The system should display a warning when the user enters invalid data.
  - **Incomplete Requirements** -there is insufficient information to allow a system to be built.

# Metrics for specifying non-functional requirements

Property	Measure
Speed	Processed transactions/second User/event response time Screen refresh time
Size	Mbytes Number of ROM chips
Ease of use	Training time Number of help frames
Reliability	Mean time to failure Probability of unavailability Rate of failure occurrence Availability
Robustness	Time to restart after failure Percentage of events causing failure Probability of data corruption on failure
Portability	Percentage of target dependent statements Number of target systems

# Requirements Engineering process



# Requirements Specification

# System requirements specification notations

Notation	Description
<b>Natural language</b>	The requirements are written using numbered sentences in natural language. Each sentence should express one requirement.
Structured natural language	The requirements are written in natural language on a standard form or template. Each field provides information about an aspect of the requirement.
Design description languages	This approach uses a language like a programming language, but with more abstract features to specify the requirements by defining an operational model of the system. This approach is now rarely used although it can be useful for interface specifications.
Graphical notations	Graphical models, supplemented by text annotations, are used to define the functional requirements for the system; UML use case and sequence diagrams are commonly used.
Mathematical specifications	These notations are based on mathematical concepts such as finite-state machines or sets. Although these unambiguous specifications can reduce the ambiguity in a requirements document, most customers don't understand a formal specification. They cannot check that it represents what they want and are reluctant to accept it as a system contract



# 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 be mixed-up.
- Requirements amalgamation
  - Several different requirements may be expressed together.

# Structured specifications

- An approach to writing requirements where the requirements are written in a standard way.
- Define a template.
- Template Example
  - Function
  - Description
  - Inputs, Outputs
  - Pre-conditions, post-conditions

# Graphical Notations

- UML
  - Use case Diagrams
  - Activity Diagrams
- Storyboards
  - <https://www.youtube.com/watch?v=LGeDZmrWwsw> (Agile)
  - <https://www.youtube.com/watch?v=6q5-cVeNjCE> (Agile)
  - <https://youtu.be/502ILHjX9EE>(\*Agile)
  - <http://www.agileacademy.com.au/agile/knowledgehub>

# User Stories

- Three Cs
  - Card
  - Conversation – with the product owner
  - Confirmation – Acceptance tests on the back of the card (conditions of satisfaction)

- Template

User Story Template  
As a [user role]  
I want to [desired feature]  
so that [value/benefit]

– As a ..... I want to ..... so that .....

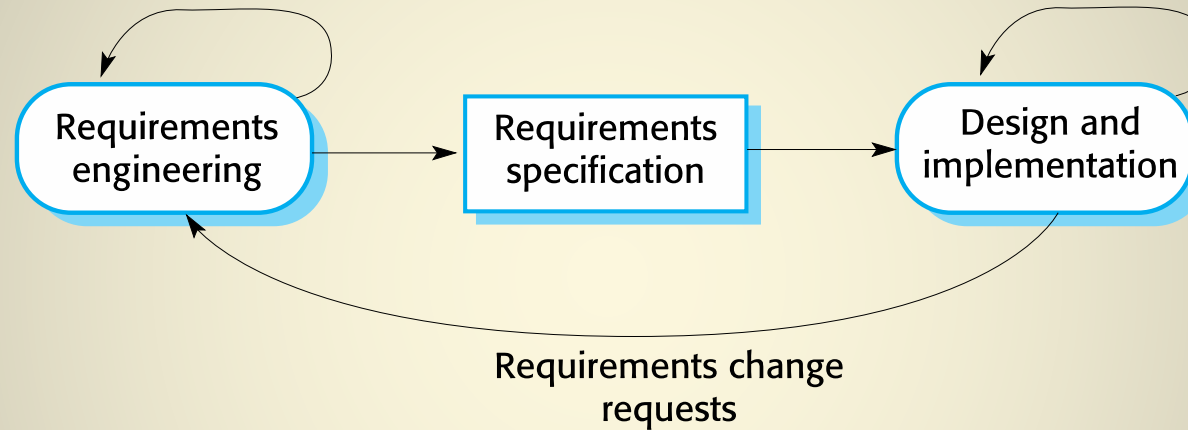
# User Stories

- Writing User Stories
  - Users and their roles
  - What they want from the system
  - Sub user stories
- Examples
  - **As a** member **I want to** login to the system **so that** I can reserve books
  - **As a** forgetful member, **I want to** have a password reminder **so that** I can login if I forget mine.
  - **As the** admin **I want to** ensure that all passwords have eight characters with one Capital and one number.

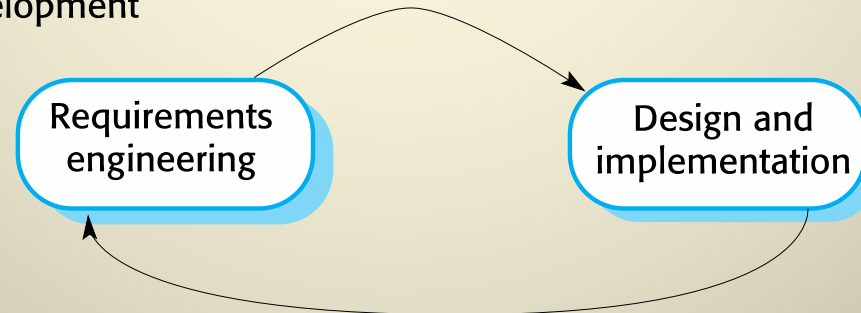


# Plan-driven and Agile development

Plan-based development



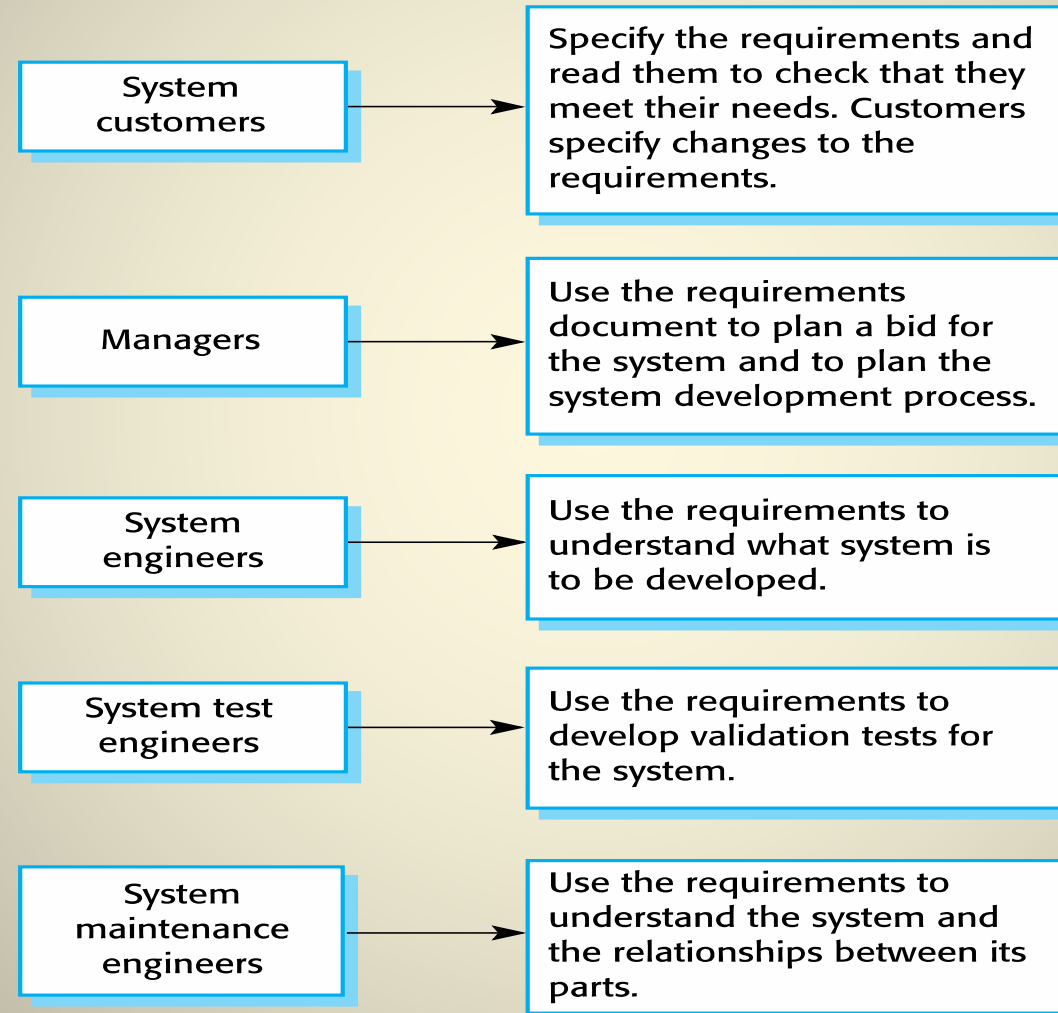
Agile development



# SRS

- Software Requirements Specification
- The software 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 should do rather than **HOW** it should do it.

# Users of SRS



# IEEE 830

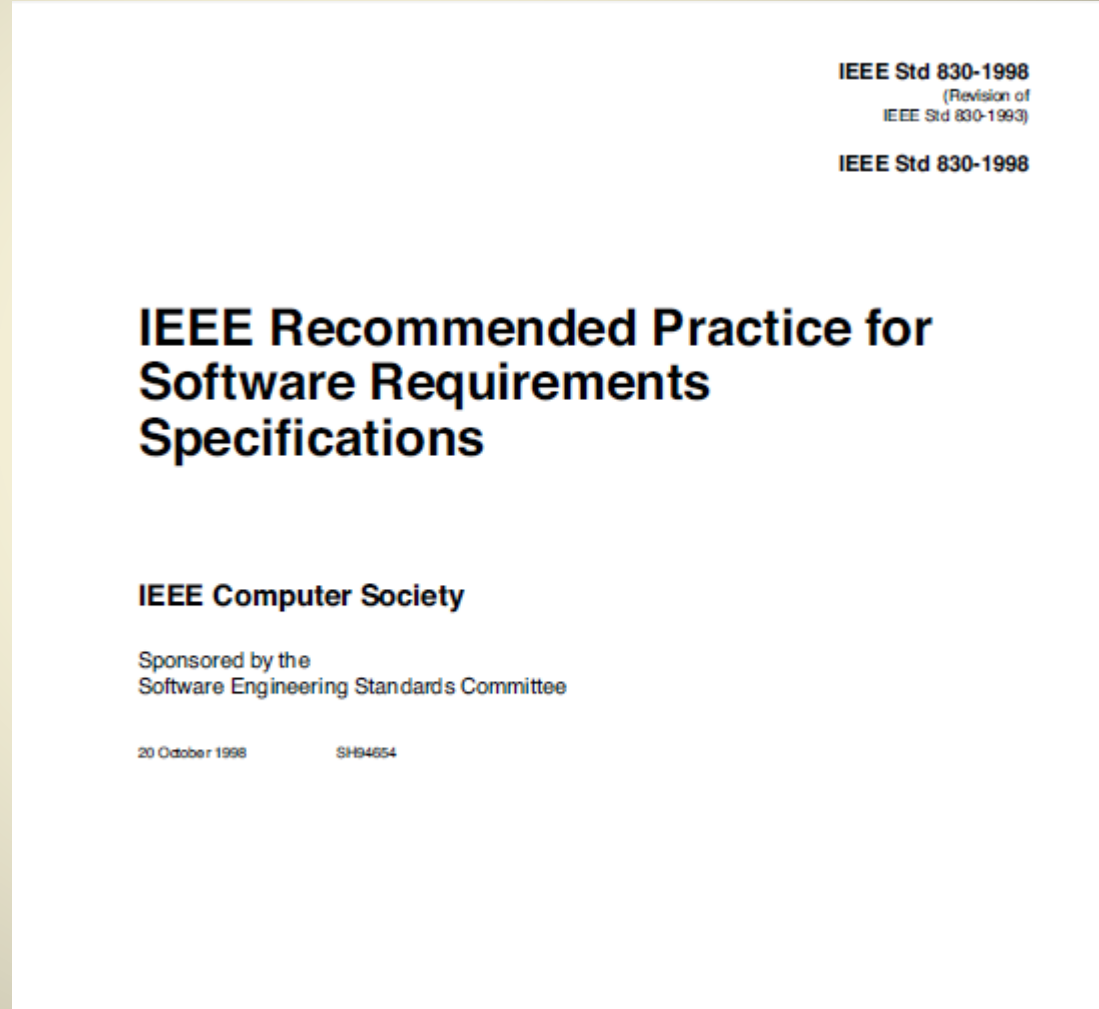
[IEEE SRS Template.pdf](#)

## **Role of SRS**

1. Should correctly define all of the software requirements.
2. Should not describe any design or implementation details.
3. Should not impose additional constraints on the software.

# Characteristics of a Good SRS

1. Correct
2. Unambiguous
3. Complete
4. Consistent
5. Verifiable
6. Modifiable
7. Traceable



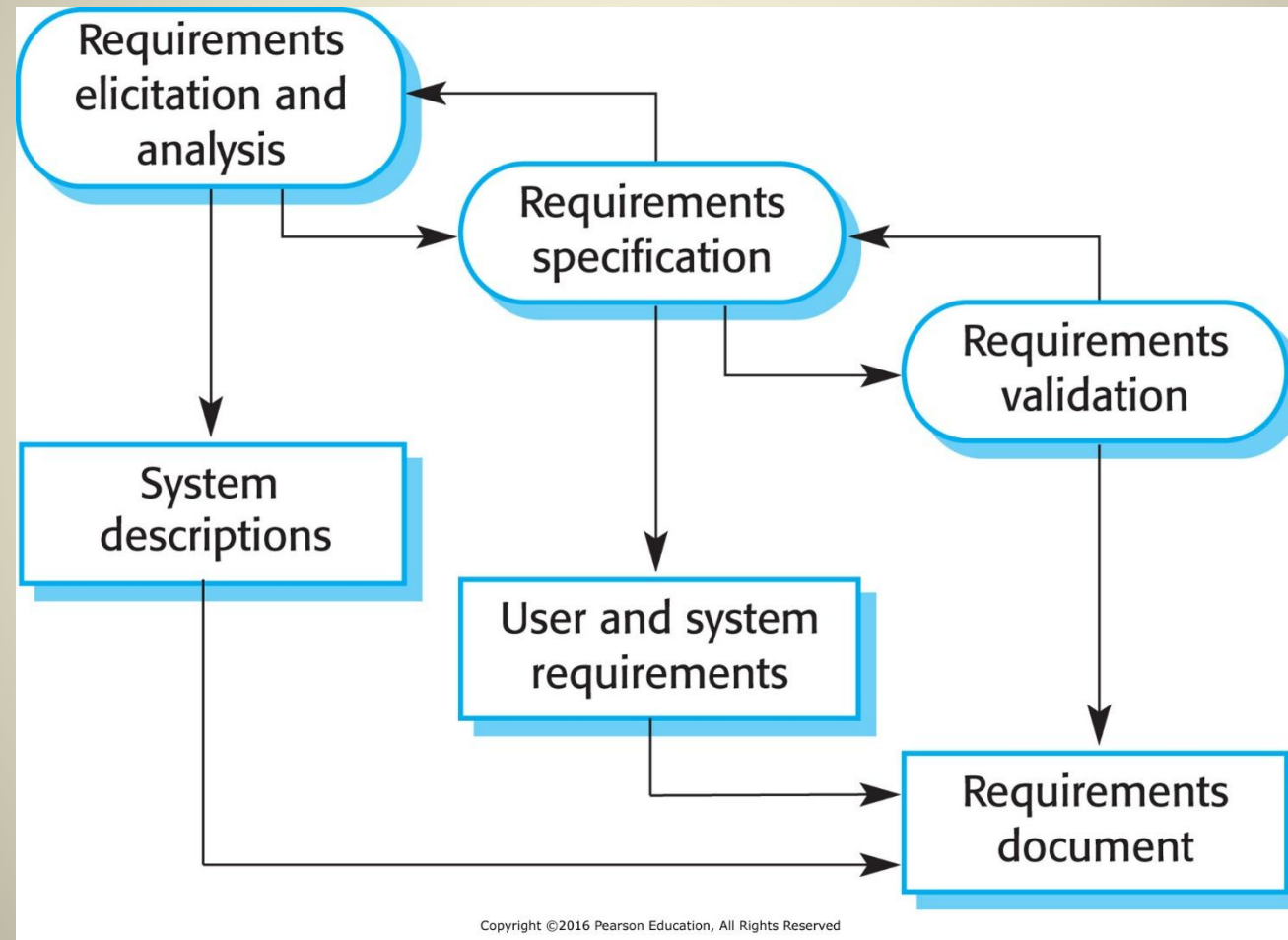


# SRS Template



- Introduction
  - Purpose, Scope , Overview
- The General Description
  - Product Perspective, User Characteristics, Assumptions and Dependencies
- The Specific Requirements
  - Functional Requirements, Performance Requirements, Design Constraints, Attributes, External Interface Requirements

# Requirements Engineering process



# Requirements Validation

# Requirements validation

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- Validate whether the elicited requirements define the system that the customer really wants.
- Requirements error costs are high so validation is very important.
- Requirements checking
  - Validity
  - Precise requirements
  - Realism
  - Verifiability

# Requirements validation techniques

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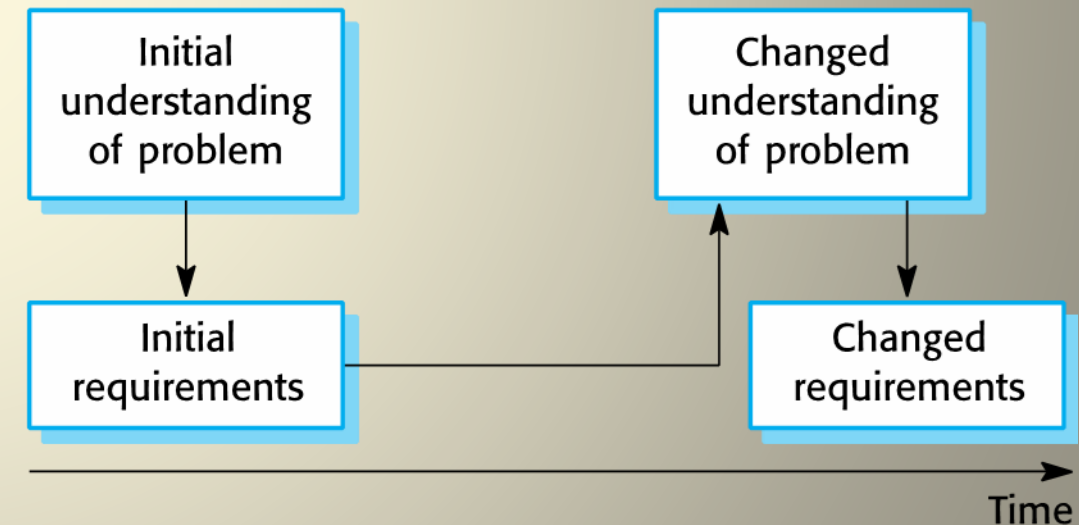
- Requirements reviews
  - Systematic manual analysis of the requirements.
- Prototyping
  - Using an executable model of the system to check requirements.
- Test-case generation
  - Developing tests for requirements to check testability.
  - Will be discussed later



# Requirements change

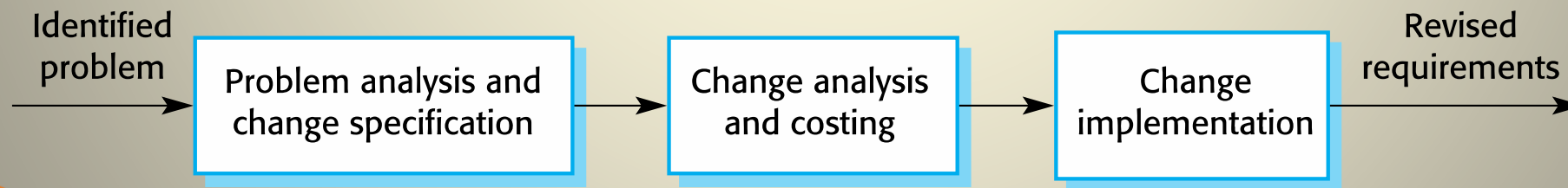
# Change is inevitable

- Causes of change
  - Problem is not fully defined
  - Changes in hardware and other support systems
  - New legislation and regulations
  - Change of business priorities
  - Change of users



# Requirement Change Management

- *Problem analysis and change specification*
  - This analysis can be used to get more details of the change.
- *Change analysis and costing*
  - The effect is assessed with regard to the cost and other impacts and then decide to proceed or not.
- Change implementation
  - The documents are changed to reflect the changes.



# References

- Software Engineering – 10<sup>th</sup> Edition by Ian Sommerville, Chapter 4
- <http://iansommerville.com/systems-software-and-technology/>
- <http://iansommerville.com/software-engineering-book/>
- IEEE Recommended Practice for Software Requirements Specifications - IEEE Std 830-1998