

CPS 406 — Introduction to Software Engineering

Software Requirements Engineering and Requirements Elicitation
Summer 2020

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Outline

- Software Process Model Definition
- Requirements Engineering
- Requirements Elicitation & Analysis
- Requirements Elicitation Techniques
- Types of Requirements

Software Process Model

A model for the development of software

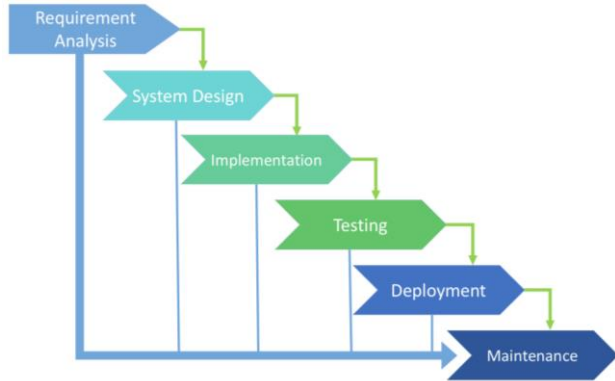
Software Process Model

A model for the development of software:

represents all the **activities** and **dependency relationships** necessary to develop a software system.

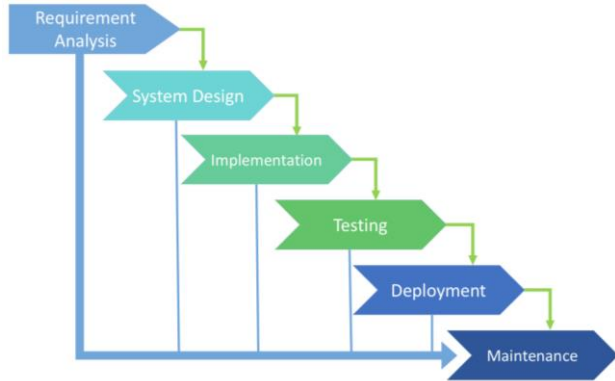
Software Process Models

Software Process Models

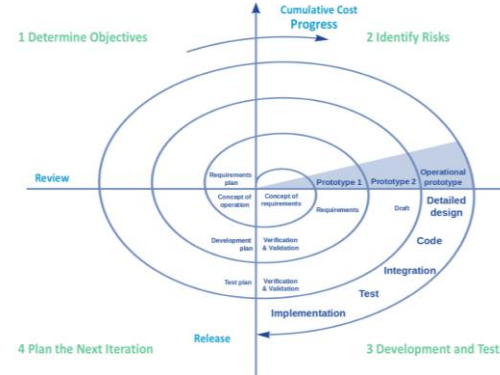


Waterfall Model

Software Process Models

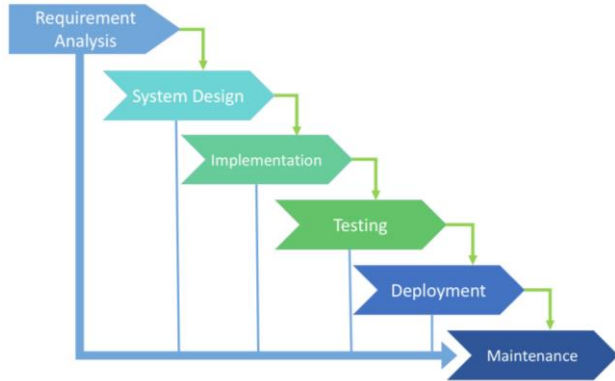


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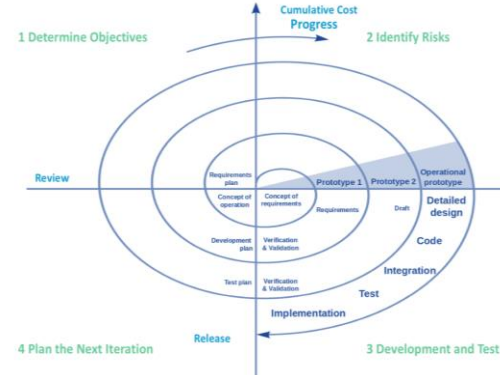


Spiral Model

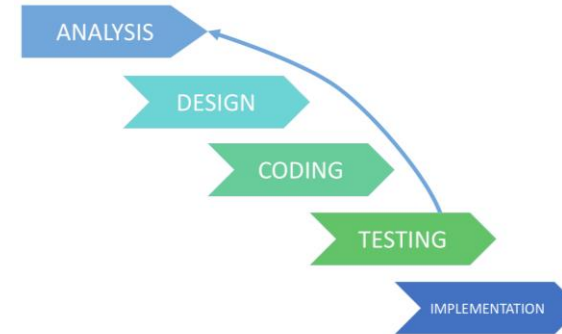
Software Process Models



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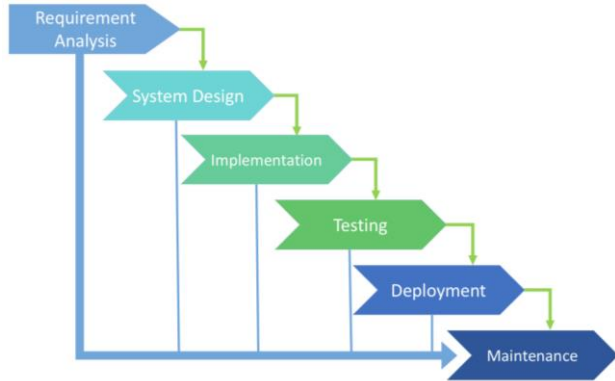


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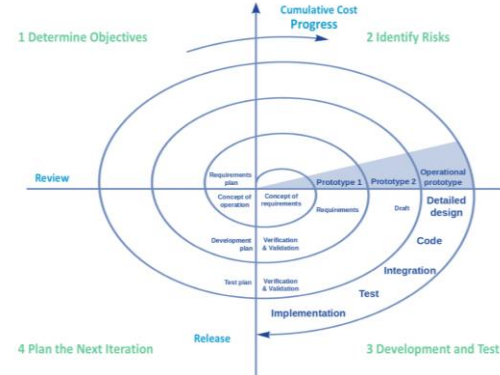


Iterative Model

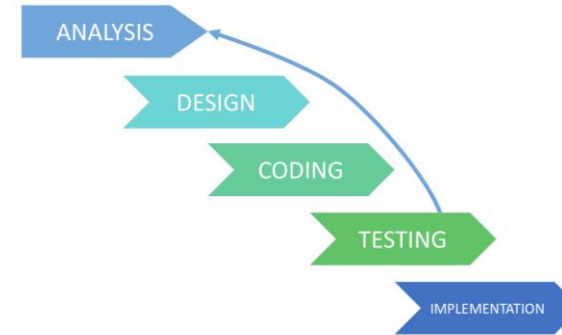
Software Process Models



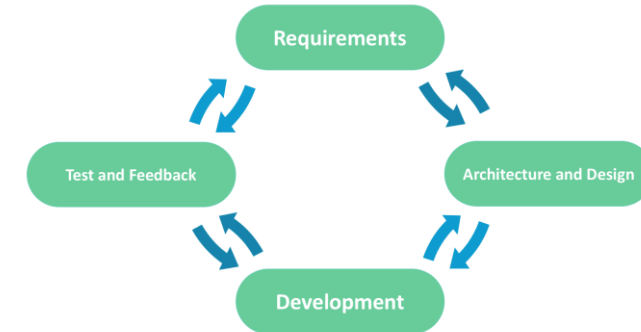
Waterfall Model



Spiral Model



Iterative Model



Agile Model

Software Development Activities

Four basic process activities of software development are:

- Specification
- Development
- Validation
- Evolution

Software Development Activities

Four basic process activities of software development are:

- **Specification = requirements engineering**
- Development
- Validation
- Evolution

Specification

Imagine that you want to build a house.

Be two-stored, have a red floor, and several windows.



<http://www.sweethome3d.com/>

Specification

The same applies to software development.

A **detailed vision** and **specifications** of the project is required to help software engineers, analysts and project managers create the system.

Requirements Engineering

The process of **defining the requirements** for the system under construction.

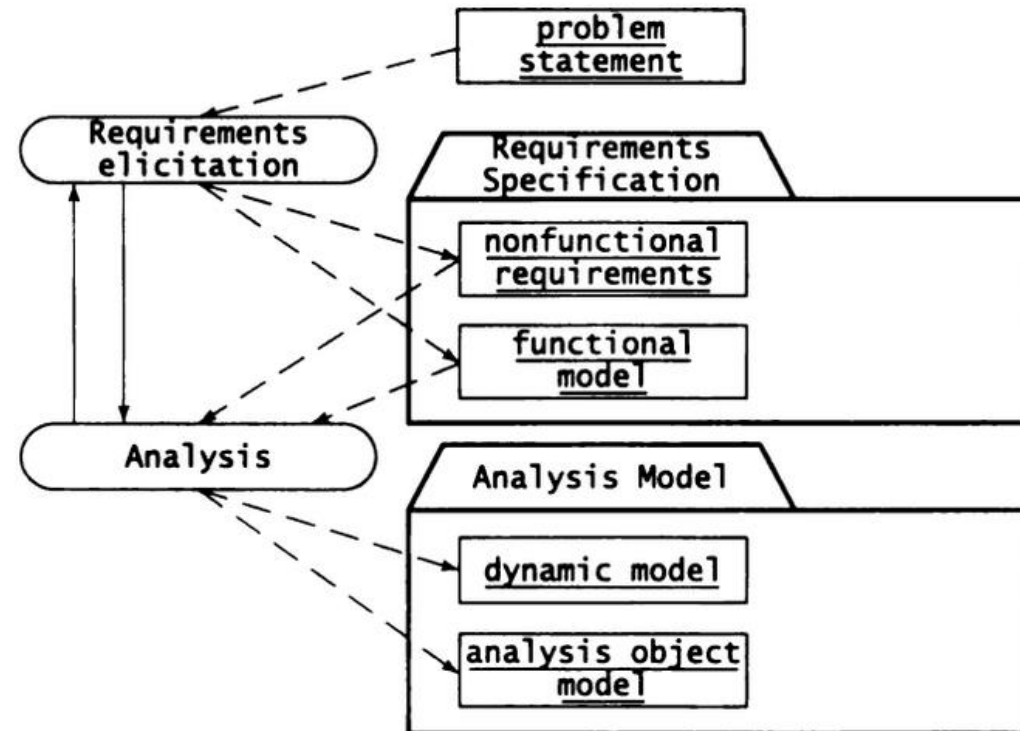
Requirements Engineering

Requirements engineering has **two main activities**:

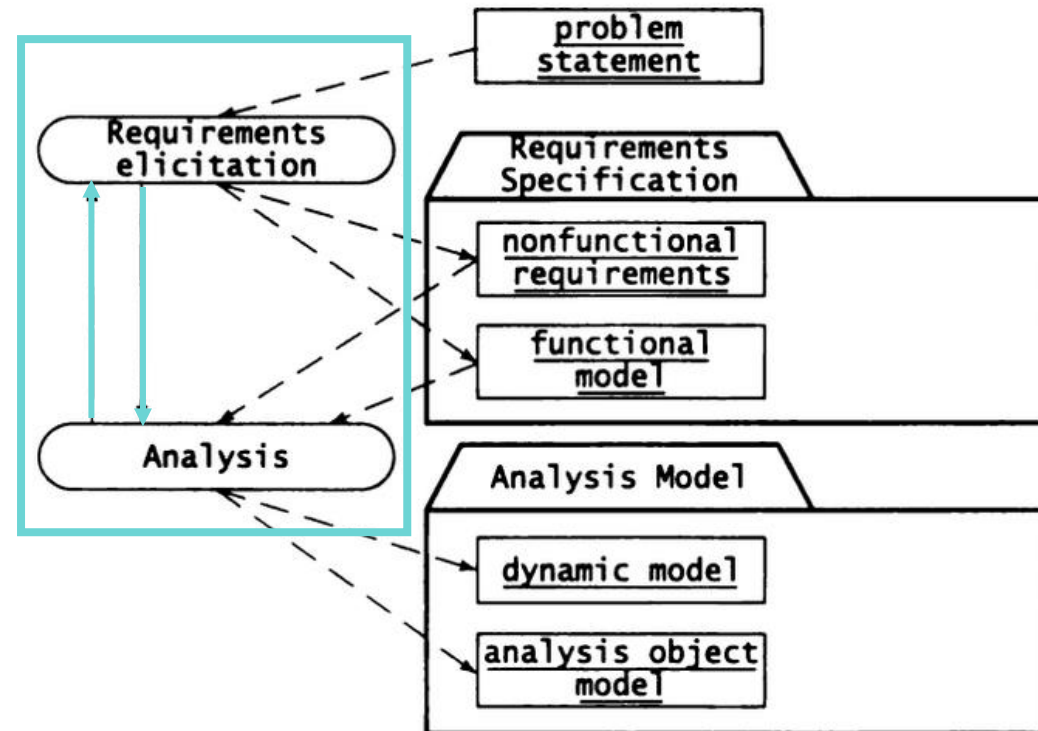
Elicitation: results in **requirements specification** that the customer understands.

Analysis: results in **analysis model** that developer can unambiguously understand.

Requirement Elicitation and Analysis



Requirement Elicitation and Analysis



Requirements Elicitation (What)

Focuses on describing the purpose of the system.

Determines the coverage and boundary of the system.

Separates requirements according to level of priority.

Requirements Elicitation is Hard

People with different backgrounds must collaborate to bridge the gap:

Client and end users who have
application domain knowledge.

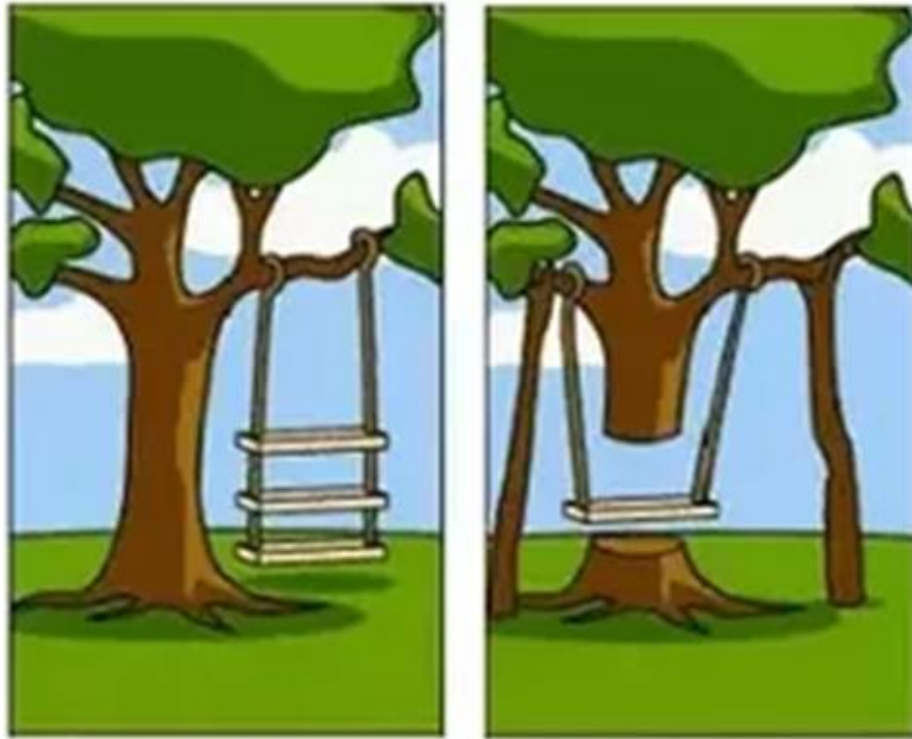
Software Engineers who have
solution domain knowledge.

Requirements Elicitation is Hard



How the customer
explained it.

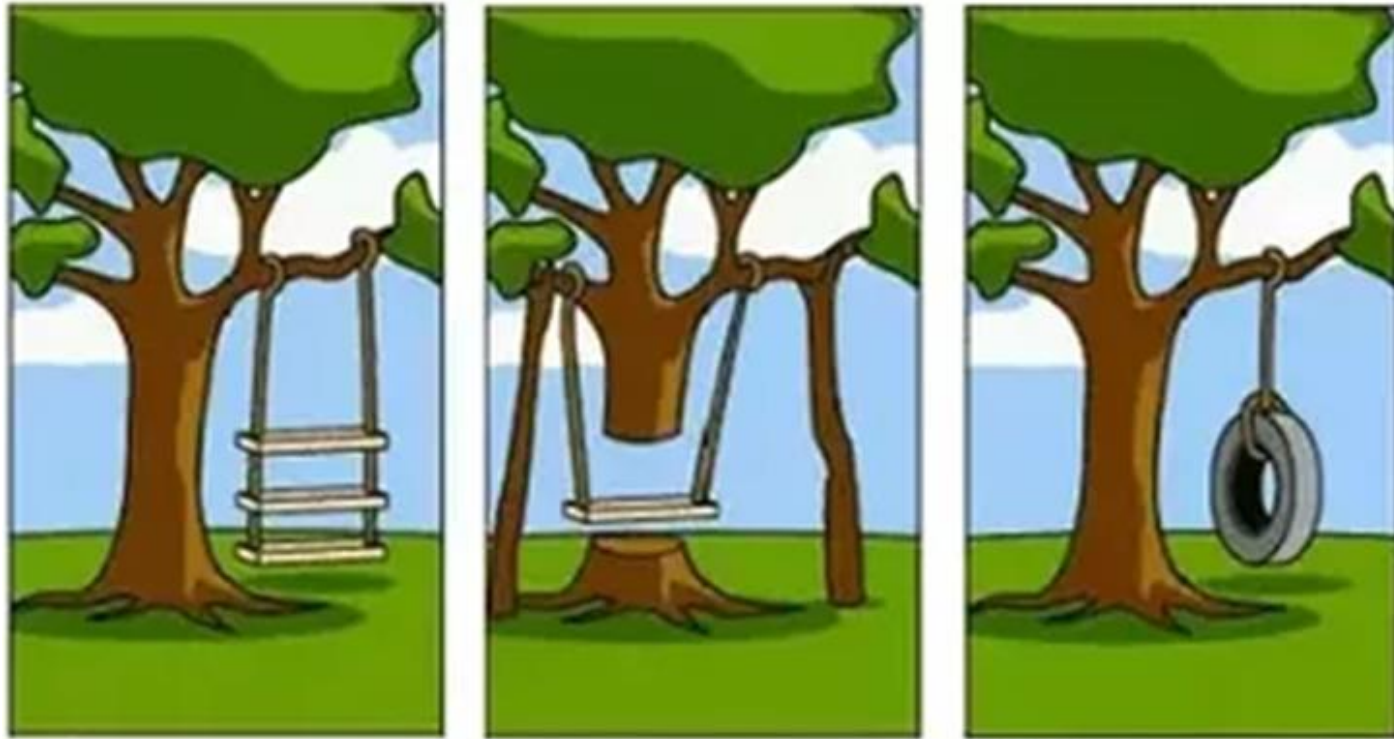
Requirements Elicitation is Hard



How the customer
explained it.

How the engineer
designed it.

Requirements Elicitation is Hard



How the customer explained it.

How the engineer designed it.

What the customer really needed.

Requirements Elicitation: Challenges

Requirements Elicitation: Challenges

Missing real-world scenarios



Requirements Elicitation: Challenges

Missing real-world scenarios



Leaving out unintended features



Requirements Elicitation: Challenges

Missing real-world scenarios



Leaving out unintended features



Setting ambiguous specifications



Ex. Heathrow Terminal 5 Opening 2008

Staff tested the brand new check-in baggage handling system.

Engineers tested the system with over 12,000 test pieces of luggage.

It worked flawlessly on all test runs.

Ex. Heathrow Terminal 5 Opening 2008

The following 10 days after opening, over 42,000 bags failed to travel with their owners, and over 500 flights were cancelled.



<https://www.dailymail.co.uk>

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Check-in staff were adding luggage to the system, which was designed to handle 12,000 bags an hour.

Baggage workers were not removing them quickly enough at the other end!

Ex. London Underground Train

London underground train leaves station without a driver!

What happened?

A passenger door was stuck and did not close.

The driver left his train to close the passenger door.

He left the driver door open!

Ex. London Underground Train

He relied on the specification that said the train does not move if at least one door is open.

When he shut the passenger door, the train left without him.



<https://www.independent.co.uk>

Ex. London Underground Train

He relied on the specification that said the train does not move if at least one door is open.

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<https://www.independent.co.uk>

The driver door was not treated as a door in the source code!

Requirements Elicitation (How)

Requirements Elicitation (How)



Interviews

Formal or informal interviews with stakeholders

Interviews

Formal or informal interviews with stakeholders:

Open-ended interviews

- Exploratory

Closed-ended interviews

- Prepare list of questions

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- Exploratory

Closed-ended interviews

- Prepare list of questions

In practice interviews are a mixed of these!

Interviews

It is hard to elicit domain knowledge during interviews:

- **Software engineering** requirement team use **domain terminology**.
- **Stakeholders** may find it **difficult to explain** or think it is not worth mentioning.

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Information from interviews can be used in supplement to other forms of requirement elicitations such as

Requirements Elicitation (How)



Interviews

Formal or informal interviews with stakeholders



Observation/Ethnography

Observing users and the environment

Ethnography

Observing end users in their **operational environment**.

Attempts to discover social, human, and political factors, which may also impact requirements.

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Observing end users in their operational environment.

Attempts to discover social, human, and political factors, which may also impact requirements.

Often reveal critical process details that are missed by other requirements elicitation techniques.

Requirements Elicitation (How)



Interviews

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Scenarios

Use of the system as a series of interactions

Scenarios

Describe the **use of the system** as a **series of interactions** between an end user and the system.

A synthetic description of an event or series of actions and events.

It usually also contains details about the work place, social situations and resource constraints.

A scenario can include text, video, pictures and story boards.

Types of Scenarios

As-is scenario

- Describes a current situation.

Visionary scenario

- Describes a future system.
- Often **cannot** be done by the user or developer alone.

Types of Scenarios

Evaluation scenario

- User tasks against which the system is to be evaluated.

Training scenario

- Step by step instructions that guide a novice user through a system elicitation.

How Should We Find Scenarios?

How Should We Find Scenarios?

If the **system exists**, don't wait for information!

- What is obvious does not need to be said.

If the **system does not exist**, don't expect the client to be verbal!

- Client understands problem domain, not the solution domain.

How Should We Find Scenarios?

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Engage in a conversation with the client!

How Should We Find Scenarios?

Engage in a dialectic approach!

- You help the client to formulate the requirements.
- The client helps you to understand the requirements.



Heuristics for Finding Scenarios

Ask yourself or the client the following questions:

- What are the primary tasks that the system needs to perform?
- What data will the user create, store, change, remove or add in the system?
- What external changes does the system need to know about?
- What changes or events will the users need to be informed about?

Heuristics for Finding Scenarios

Ask yourself or the client the following questions:

- What are the primary tasks that the system needs to perform?
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- What external changes does the system need to know about?
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Don't rely on questions *and* questionnaires alone!

Heuristics for Finding Scenarios

Insist on task observation if the system already exists.

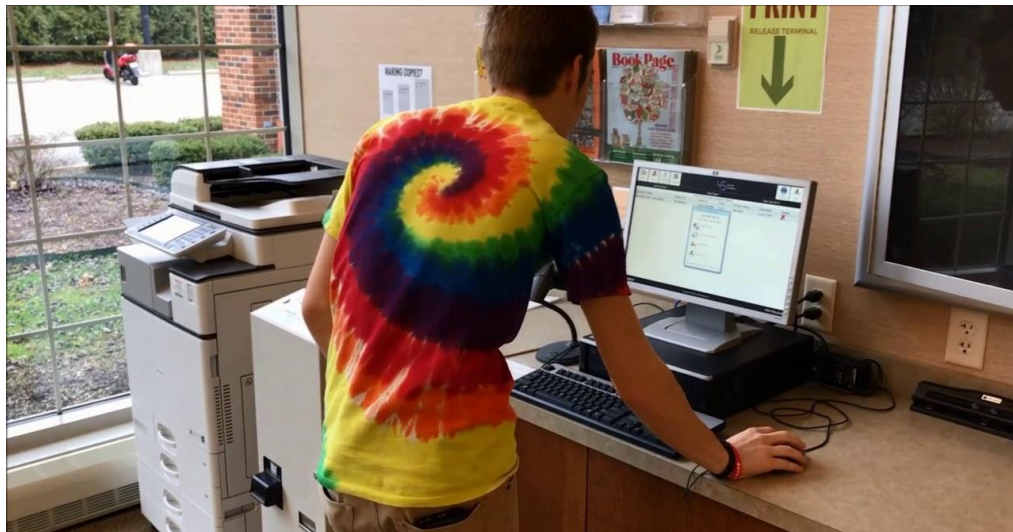
Ask to speak to the end user, **not just to the client**.

Expect resistance and try to overcome it.

Scenario Ex: Article Printing

Initial assumption:

The user has logged on to the online library system and has located the journal containing the copy of the article.



Scenario Ex: Article Printing

Scenario:

The user selects the article to be downloaded. The system prompts the user to provide subscription information for the journal or indicate method of payment for the article. Payment can be made by credit card or by quoting an organizational account number. The PDF version of the article is downloaded on the user's computer. The user is informed that it is available. The user is asked to select a printer and a copy of the article is printed.

Scenario Ex: Article Printing

What can go wrong:

The user subscription information is entered incorrectly.

The payment may be rejected by the system.

The printer may not be disconnected from the system.

....

Requirements Elicitation (How)



Interviews

Formal or informal interviews with stakeholders



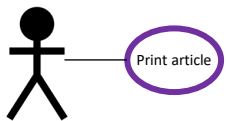
Observation/Ethnography

Observing users and the environment



Scenarios

Use of the system as a series of interactions



Use cases

Abstractions that describe a class of scenarios

Use Cases

Description of a **sequence of interactions** between a system and external **actors** to complete a given task.

Actors – any agent that interact with the system to achieve a useful goal (e.g., people, other software systems, hardware).

Use Cases

In general, a use case should cover the full sequence of steps from the beginning of a task until the end.

A use case should describe the user's interaction with the system, **not the computations** the system performs.

Heuristics for Finding Use Cases

Select a narrow **vertical slice** of the system (i.e., one scenario)

- Discuss it in detail with the user to understand the user's style of interaction.
- Discuss the chosen scenario with many users.

Select a **horizontal slice** of the system (i.e., many scenarios)

- Discuss the scope of the system with the user.

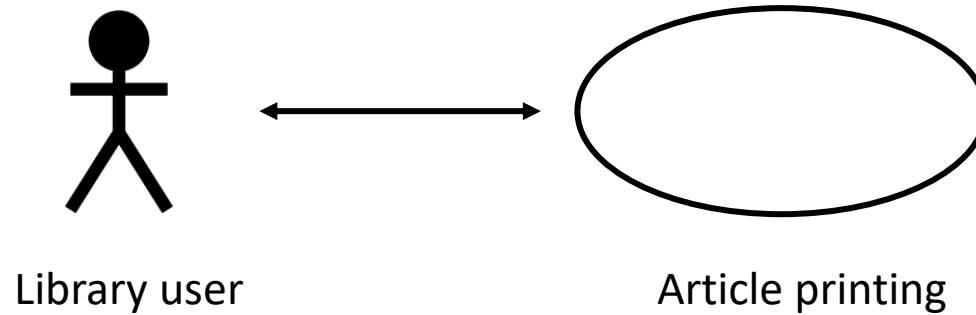
Heuristics for Finding Use Cases

Use illustrative prototypes (e.g., mock-ups) as visual support.

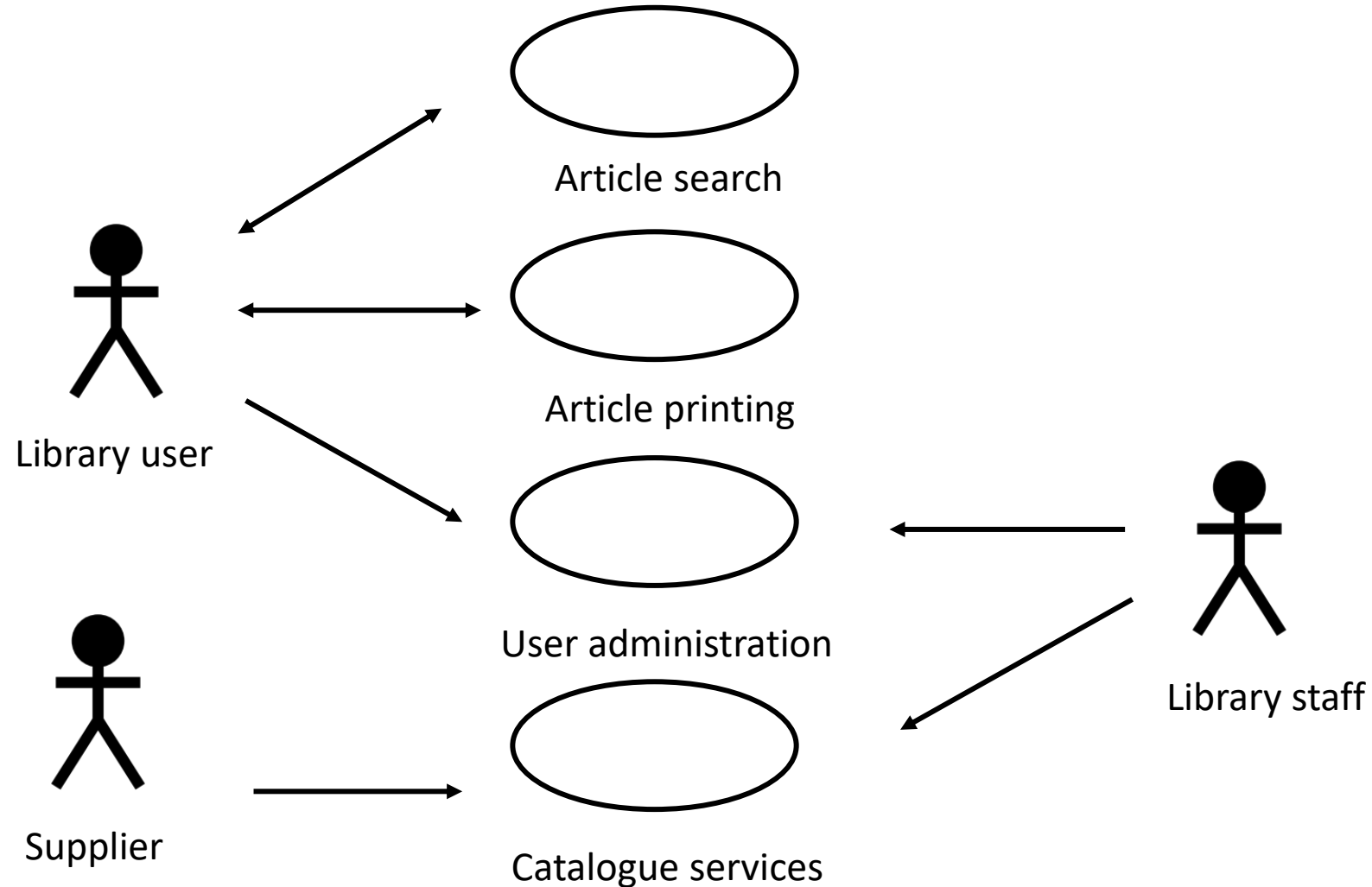
Find out what the user does via:

- Task observation
- Questionnaires

Use Case Ex: Article Printing



Use Case Ex: Library System



Requirements Elicitation (How)



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Formal or informal interviews with stakeholders



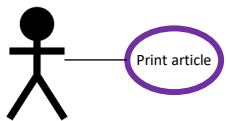
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Scenarios

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Use cases

Abstractions that describe a class of scenarios

Types of Requirements

- **Functional requirements**
- **Non-Functional requirements**
- **Domain requirements**

Types of Requirements

- **Functional requirements**

Interactions between the system & its environment independent from the implementation.

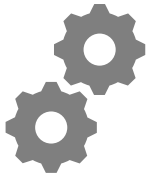
- **Non-Functional requirements**

Aspects not directly related to functional behavior of the system.

- **Domain requirements**

Characteristics and constraints of the domain.

Functional vs. Non-Functional



Functional requirements (What)

- Have to do with the functionality of the system, what the system does with the computation.
- Ex. Elevator shall take ppl to the floor they select.



Non-Functional requirements (How)

- Refer to system non-functional properties; system qualities, they must be objective and quantifiable.
- Ex. Elevator must take 10 floors in less than one minute!

Qualities of Requirements

- Clear, Unambiguous, Understandable
- Realistic
- Valid
- Verifiable
- Consistent
- Complete

Activity

Let's look at a few non-functional requirement examples!

Cast your vote:

Good! Unclear! Not measurable!

Activity

Link: www.PollEv.com

Enter this: **fatemerajabi419**

When poll is active, respond at **PollEv.com/fatemerajabi419**

Text **FATEMERAJABI419** to **37607** once to join

The iOS application must support iPhone devices.

Good

Unclear

Not measurable

Total Results: 0

🖱️ When poll is active, respond at **PollEv.com/fatemerajabi419**

💬 Text **FATEMERAJABI419** to **37607** once to join

The website must process a customer order in <100 ms.

Good

Unclear

Not measurable

Total Results: 0

When poll is active, respond at **PollEv.com/fatemerajabi419**

Text **FATEMERAJABI419** to **37607** once to join

The system will crash no more than once per 10000 transactions.

Good

Unclear

Not measurable

Total Results: 0

When poll is active, respond at **PollEv.com/fatemerajabi419**

Text **FATEMERAJABI419** to **37607** once to join

All text must be pink.

Good

Unclear

Not measurable

Total Results: 0

NF Requirements Specifying Metrics

Property	Measure
Speed	
Size	
Ease of use	
Reliability	
Robustness	
Portability	

NF Requirements Specifying Metrics

Property	Measure
Speed	Process transactions per second/Event response time/Screen refresh time
Size	
Ease of use	
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NF Requirements Specifying Metrics

Property	Measure
Speed	Process transactions per second/Event response time/Screen refresh time
Size	K Bytes/Number of RAM chips
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NF Requirements Specifying Metrics

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NF Requirements Specifying Metrics

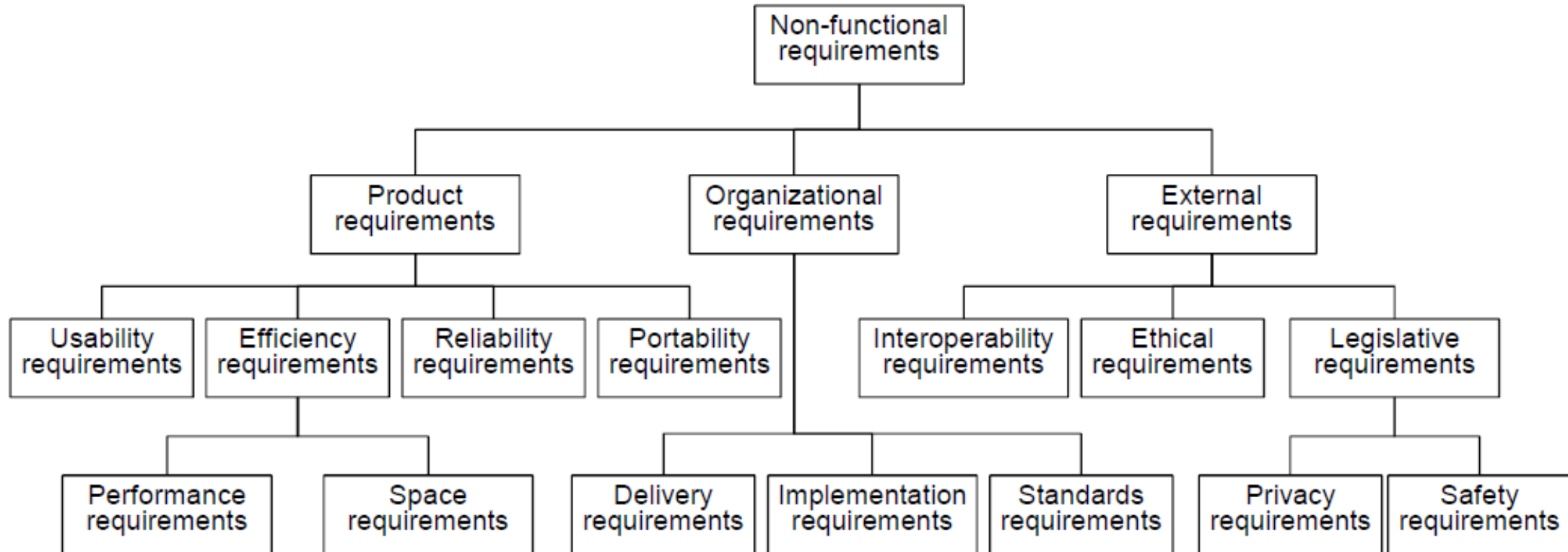
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NF Requirements Specifying Metrics

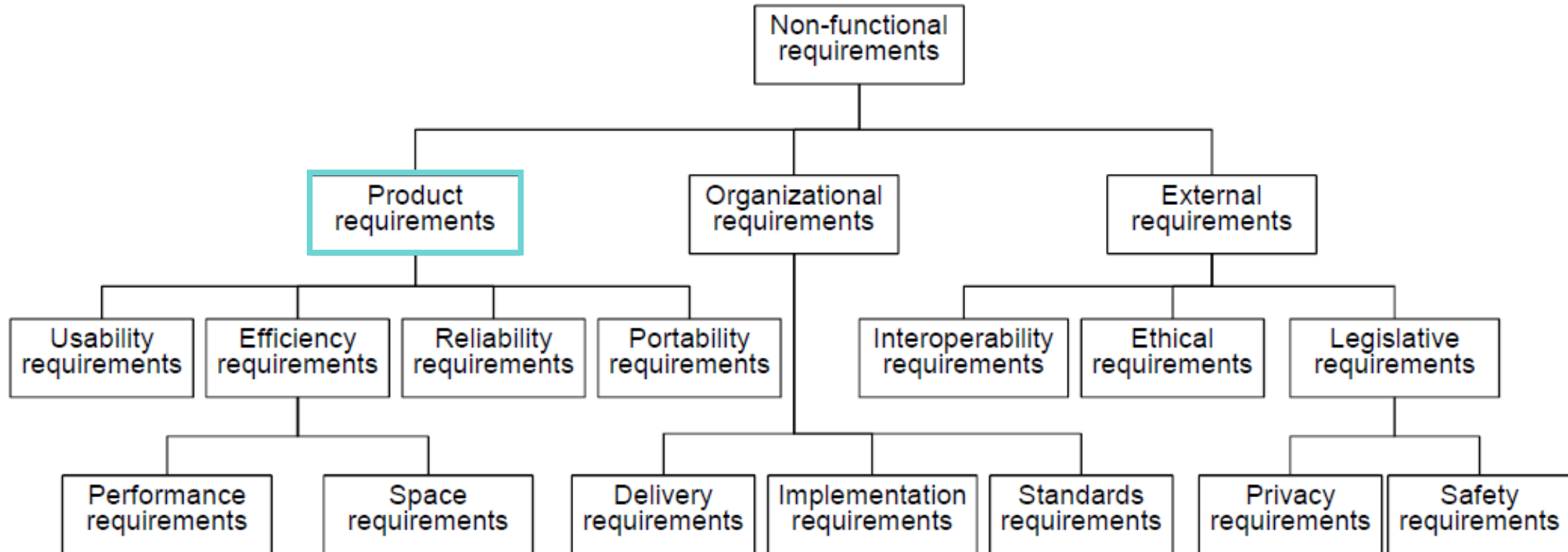
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Portability	Percentage of target dependent statements/Number of target systems

Notice how each metric is a quantifiable amount, a number to be verified!

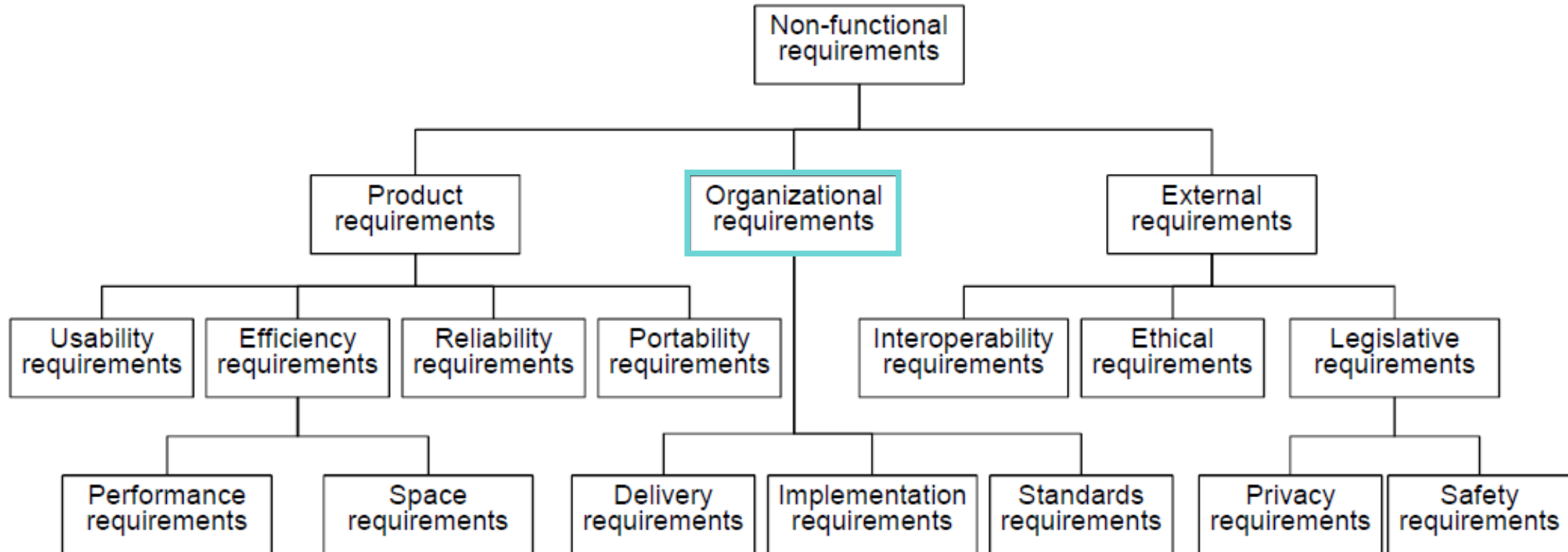
Classification of NF Requirements



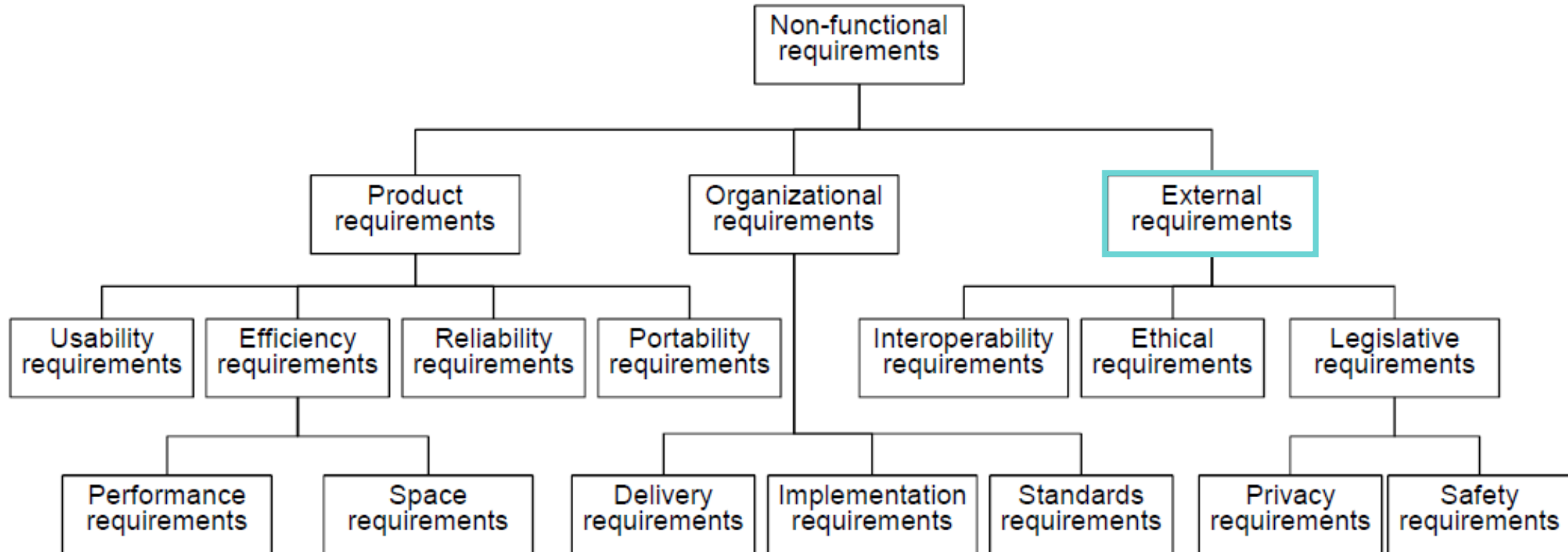
Classification of NF Requirements



Classification of NF Requirements



Classification of NF Requirements



Summary

Software process model represents all the activities and dependency relationships necessary to develop a software system.

Requirements engineering is the process of defining the system requirements.

Requirements elicitation and analysis are two main activities of requirement engineering.

Requirements elicitation techniques include interviews, observations, scenarios, and use cases.

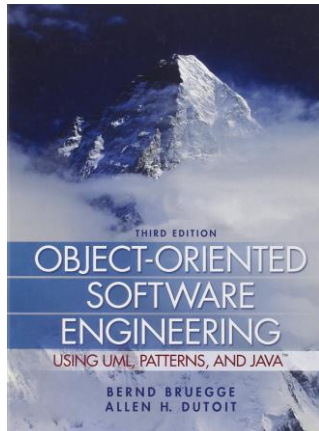
Types of requirements are functional, non-functional, and domain requirements.

Further Readings



Software engineering. Ian Sommerville. 2015

- Chapter 4. Software Processes
- Chapter 6. Software Requirements
- Chapter 7. Requirement Engineering Processes



Object-oriented software engineering: using UML, Patterns and Java. Bruegge, Bernd & Allen H Dutoit. 2009

- Chapter 4. Requirements Elicitation

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