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# Introduction to Requirements Engineering

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University of Seville  
February 2016*

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Introduction to Requirements Engineering

- Learning objectives
  - Understand the concept of **requirement** and its related terminology.
  - Know the different **types of requirements**.
  - Understand the requirements engineering **process** and its relationship with the rest of the development processes.

1. The concept of requirement


2. Types of requirements

3. Classic view of requirements

4. Requirements Engineering definition

5. Requirements Engineering process

6. Requirements Management



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Introduction to Requirements Engineering

• Requirements terminology

– There is no sound consensus on requirements terminology.

– We shall use the CMMI-DEV\* terminology.

Stakeholder needs

Customer Requirements

Product Requirements

\* See the Introduction to Software Engineering lesson of the IISII subject.

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Introduction to Requirements Engineering

• Requirements terminology

– Stakeholder needs

• Stakeholder: customers, end users, IT managers,... anyone with some **interest** in the system to be developed (or maintained).

• Stakeholders needs are all the needs, expectations, constraints, etc. the stakeholders have with respect to (the **business processes** of) their organization.

• Some needs may be written in internal reports, audits, etc., but most of them remain **implicit** in stakeholders' minds or they are not even aware of them.

• Also known as *business needs*, *user needs*, *client needs*, etc.

Stakeholder needs


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Introduction to Requirements Engineering

• Requirements terminology

– Customer Requirements




Customer Requirements

- Are stakeholder needs once **elicited** and specified in any type of document.
- Must be expressed in stakeholders **language**, using their vocabulary.
- They are usually related to the **business processes** that are going to be supported by the system to be developed.
- Must be **prioritized** in order to manage **iterations** during development.
- Also known as *client requirements, user requirements, business goals, etc..*

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Introduction to Requirements Engineering

• Requirements terminology

– Product Requirements



Product Requirements

- Describe a system that must satisfy customer requirements, to which they must be **traced**.
- A more technical vocabulary than in customer requirements can be used.
- The process usually starts with the **general requirements or objectives** of the system to be developed; then, detailed requirements are specified
- Detailed requirements are often classified into **functional requirements** and **nonfunctional requirements**.
- Also known as *system requirements\*, software requirements, or simply requirements*.

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\* Usually, *system* refers to both *hardware* and *software*.

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## Introduction to Requirements Engineering

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- Requirements terminology
  - Product Requirements
    - Very **complex** systems can be divided into different **components** or **subsystems**, each with its product component requirements or subsystem requirements.
    - In these cases, requirements are often very technical.



***Product Requirements***


The diagram illustrates the relationship between different types of requirements in Requirements Engineering. It is structured as follows:

- Stakeholder Needs:** Represented by a cloud icon. The text inside is "Avoid losses for having to throw away expired food".
- Customer Requirements:** Represented by a document icon. The text inside is "As a manager, I want to be notified when there were products expiring in less than 48 hours, so I can do something about it".
- Product Requirements:** Represented by a document icon. The text inside is "The system shall keep track of food expiration dates.".
- Product Requirements (continued):** Below the first product requirement, there are two more requirements: "The system shall notify managers about close expiration dates." and "The system shall provide managers with sales forecasts."

Arrows indicate the flow and relationship between these requirements:

- A curved arrow points from **Stakeholder Needs** to **Customer Requirements**.
- A curved arrow points from **Customer Requirements** to **Product Requirements**.
- A curved arrow points from the first **Product Requirement** to the second **Product Requirement**.

The text "Why?" is placed near the arrows, indicating the rationale or justification for the requirements.



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• Requirement definitions (I)

– Glossary IEEE 610.12

a) A condition or capability needed by a user to solve a problem or achieve an objective.

b) A condition or capability that must be met or possessed by a system or system component to satisfy a contract, standard, specification, or other formally imposed documents.


c) A documented representation of a condition or capability as in a) or b).



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• Requirement definitions (II)

– MIL-STD-498

• A characteristic that a system or system component must possess in order to be acceptable to the acquirer.

– Goguen

• A property that a system should have to succeed in the environment in which they will be used.



Joseph Goguen (1941-2006), Computer Science professor at the universities of California and Oxford.

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• Requirement definitions

– Glossary IEEE 610.12

a) A condition or capability that a user or customer desires that a system or system component possess in order to solve a problem or perform a function.

b) A characteristic that a system or system component must possess in order to be acceptable to the acquirer, as in a contract, imposed by a contract, or imposed by a contract.

c) A condition or capability that a system or system component must possess in order to be acceptable to the acquirer, as in a contract, imposed by a contract, or imposed by a contract.

– MIL-STD-498

• A characteristic that a system or system component must possess in order to be acceptable to the acquirer, as in a contract, imposed by a contract, or imposed by a contract.

– Goguen

• A property that a system should have to succeed in the environment in which they will be used.

What type of CMMI requirement match each definition?

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• Types of (product) requirements

Requirement

General requirement (goal/objective)

Requirement (detailed)

Functional Requirement

Nonfunctional requirement

Information requirement

Business rule

Interface requirement

Use Case

Usability requirement

Safety requirement

Technical constraint

Reliability requirement


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Introduction to Requirements Engineering


- Objectives [REM icon] ← REM\* icon
  - General, high-level requirements, also known as **features** when the product is market-oriented.
  - They express a condition on the system to be developed but at a level of **detail** which is not usually enough to implement a solution.
  - Examples:
    - The system shall manage library book loans.*
    - The system shall allow taxpayers to make their tax declaration over the Internet.*

\* Requirements documentation tool to be used in lab sessions.

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- Objectives [REM icon] ← REM\* icon
  - In moderately complex systems, objectives are usually organized **hierarchically** at various levels of sub-objectives.
  - It is usually the first level of requirements obtained in the development process. Then, they are **refined** to obtain more detailed requirements.

\* Requirements documentation tool to be used in lab sessions.

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- Functional requirements
  - Define the **services** to be provided by the system to the users in order to achieve the system objectives.
  - Traditionally, they have been documented as paragraphs of free text, for example:
    - The system shall print, at user request, a list of loans whose return date has expired at least one week before the current date.*
  - It is increasingly common for these type of requirements to be expressed as **use cases**, especially for interactive information systems.

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- Information (storage) requirements
  - Describe what **information** the system shall store to meet the higher-level, general requirements/objectives.
  - They should identify the **relevant concept** whose information must be stored and also what **specific data** of the relevant concept are important to meet the system objectives.
  - Example:
    - The system shall store the information corresponding to **the library book loans**. More precisely: the loan member, the loaned book or books, the loan date and, for each loaned book, the scheduled return date and the actual return date, if returned.*

relevant concept


specific data

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- Business rules requirements (constraints) 
  - Define constraints, **business rules** or policies that cannot be broken by the system to be developed.
  - Examples:
    - *The system shall meet the following business rule: customer data should not be deleted as long as the customer has unpaid bills or pending orders to be served.*
    - *The system shall meet the following business rule: a library member can not loan more than 3 books simultaneously.*
  - Business rules are usually relatively **unstable** requirements. E.g. the penalty for late return or the maximum number of simultaneous loans in a library might change in the future due to changes in the library policy.

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Introduction to Requirements Engineering

- Interface Requirements
  - Define which **interfaces** should the system use when communicating with other systems.
  - Examples:
    - *The system shall access the Central Human Resources System through the corporate Intranet using the XML Web services described below ...*
    - *The system shall be able to communicate with devices with a Bluetooth wireless interface.*
    - *The system shall allow user access using Facebook accounts.*
    - *The system shall publish user activity of those users who have requested it, in their Twitter accounts.*

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- Use cases [UML]
  - Are a way of expressing functional requirements which describe how the system to be developed would be used by one or more users (called **actors**) in order to achieve a certain goal.
  - Example: Withdrawing money from an ATM
    - The system shall behave as described in the following use case:
      1. The user enters their card in the ATM slot.
      2. The ATM requests the user PIN.
      3. The user enters the PIN.
      4. The ATM requests the type of operation to be performed.
      5. The user selects the operation to get money.
      6. The ATM requests the amount.
      7. The user enters the amount.
      8. The ATM requests confirmation of the amount.
      9. The user confirms the amount.
      10. The ATM returns the card to the user.
      11. The user removes the card.
      12. The ATM prints the receipt and provides the money.
      13. The user removes the receipt and the money.

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- Non-functional requirements [NFR]
  - Are conditions on the system to be developed mainly related to **quality** aspects: usability, performance, availability, reliability, security, hardware or software compatibility, etc..
  - Examples:
    - The system shall support up to 1000 concurrent users without the average response time increases by more than 10%.
    - The system shall run on personal computers running Linux and KDE graphical environment.
    - The system shall run on an AS/400 server with the following configuration: ...

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• Traditional view of requirements

- Traditionally, it has been assumed that requirements development was **exclusively** a customer **responsibility**.
- All development processes used to begin with the *analysis* of a requirements supposedly provided by the customer.
- This is one of the reasons that have caused the problems identified in the CHAOS reports.
- Currently, it is assumed that requirements development is a **shared responsibility** between customers, users and developers.
- This new vision is what has led to the definition of a **requirements engineering**.



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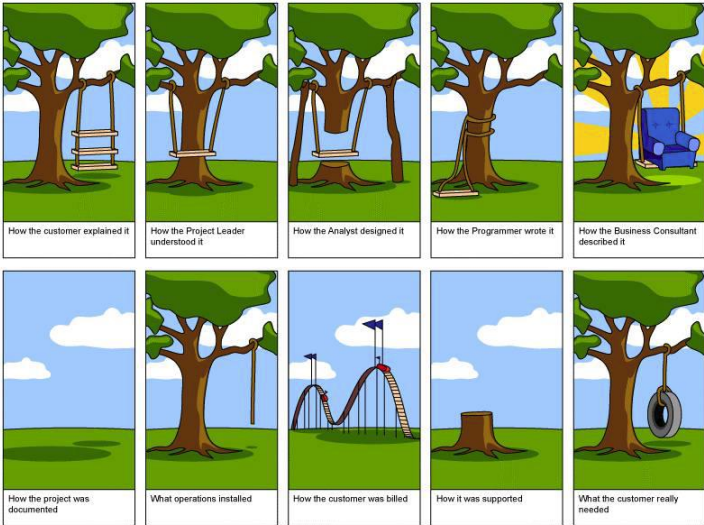
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• Communication problems




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Introduction to Requirements Engineering


• Communication problems




What the customer really needed




How the Business Consultant described it




How the customer explained it




How the Project Leader understood it




How the Analyst designed it




Stakeholder needs



Customer Requirements




Product Requirements



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• Communication problems




What the customer really needed



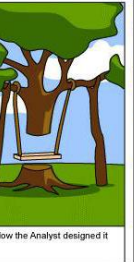
How the Business Consultant described it




How the customer explained it




How the Project Leader understood it




How the Analyst designed it



Stakeholder needs



Customer Requirements



Product Requirements

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• Requirements engineering [ Hsia *et al.*1993]

– All activities of system/software engineering relating to the:

• Identification and documentation of **customer & user needs**.

• Creation of a document that describes the **external behavior** and the associated **constraints** that will satisfy those needs.

• **Analysis and validation** of the requirements document to ensure consistency, completeness, and feasibility.

• **Evolution of needs**.

Versions

Requirements

Development

Evaluation

P. Hsia, A. Davis, y D. Kung. *Status Report: Requirements Engineering*. IEEE Software, 10(6), November 1993.

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• Requirements engineering [ Christel and Kang 1992]

– The **systematic** process of developing requirements through an **iterative , cooperative** process of analyzing a problem, documenting the resulting observations, and checking the accuracy of the understanding gained.

Versions

Requirements

Development

Evaluation

M. G. Christel and K. C. Kang. *Issues in Requirements Elicitation*. Technical Report CMU/SEI-92-TR-12, Software Engineering Institute, Carnegie Mellon University, 1992.

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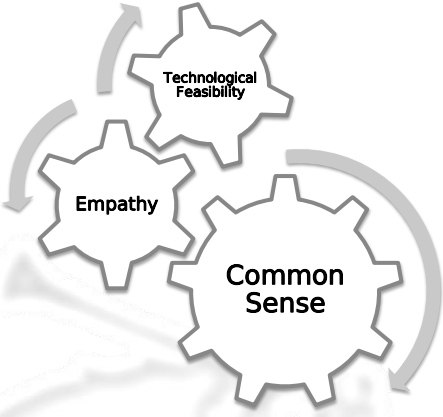
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• In a few words...




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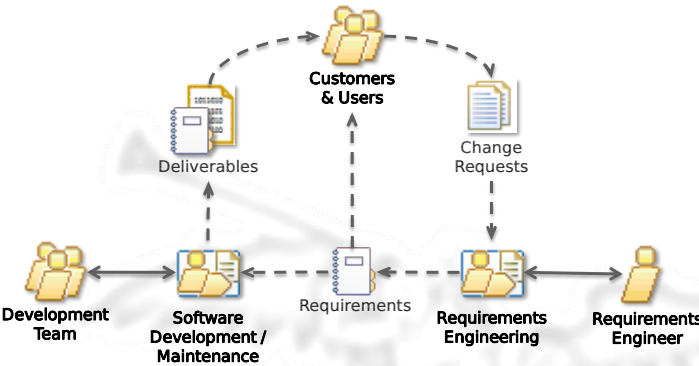
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• RE in the lifecycle

– RE starts with the project and continues throughout the software life.

– Normally, the main RE effort is performed at the beginning of the project.



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• Basic RE activities

Activity in which the participation of customers & users is essential

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• RE process model

Requirements [Versioned]

Requirements [Draft]

Requirements [Analyzed]

Requirements [Verified]

Requirements [Validated]

Requirements [Pending]

Conflicts [Solved]

Conflicts [Pending]


Defects

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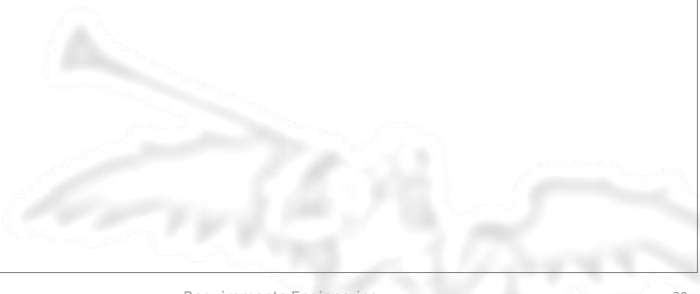
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Introduction to Requirements Engineering


- Requirements management
  - Requirements management deals with:
    - Controlling the Requirements Engineering process.
    - Generating requirements documents **baselines**.
    - Managing requirements **change** requests.
    - Defining requirements attributes (metainformation).
    - Maintaining **traceability**.



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- Requirements management
  - Requirements document **baseline**
    - It is a document **agreed** with customers & users that contains all the system requirements as known in the date of agreement.
    - Any change request after the agreement must follow the **change control procedure** agreed for the project; the budget, resources and delivery date originally agreed might be modified as a result.
    - The better the requirements document baseline, the fewer changes should be made during the project and the greater the chance of meeting deadlines and budget.




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- Requirements change requests
  - In case of submission of requirements change requests, the process is usually as follows:
    1. The request for change is **recorded**.
    2. The change **impact** is analyzed.
    3. The **Change Control Board**, formed by customers and developers, make the decision to accept or reject the change based on the impact analysis report.
    4. If the change is **accepted**, previous agreements on costs, resources and deadlines are reviewed, appropriate changes are incorporated into a new agreed requirements document baseline, and the change is tracked during the rest of development.
    5. If the change is **rejected**, the rejection reasons are recorded and the requester is informed.
  - Change requests are usually submitted by customers & users with new needs, but they can also come from the development team because of unforeseen technical problems.

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- Requirements attributes
  - Requirements are not only the text describing the condition to be met by the system to be developed.
  - Usual requirements attributes are:
    - unique identifier (required for traceability)
    - version and date
    - authors
    - (information) sources
    - dependencies (traces)
    - priority (importance and urgency)
    - status (draft, analyzed, verified, ...)
    - estimation of stability
    - comments
    - etc.
  - Depending on project needs, other attributes can be used (cost, difficulty, etc..).

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Introduction to Requirements Engineering

• Requirements traceability

– Traceability is a property that allows to know the **dependencies** between the artifacts created during development, including requirements.

– Every time a new artifact (an objective, a requirement, a modeling element, a module, a source code file, a test, etc.) is created, its dependencies with other artifacts, usually in higher levels, should be recorded.

– It is the only way to conduct an **impact analysis** when managing a change request.

– When an artifact is changed, all dependent artifacts, directly or indirectly, could be affected.

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1. The concept of requirement

2. Types of requirements

3. Classic view of requirements

4. Requirements Engineering definition

5. Requirements Engineering process

6. Requirements Management

Introduction to Requirements Engineering

• Requirements traceability

```
socket_error = lambda err: print('socket error: %s' % err)
print('socket_error: %s' % socket_error)

for h3 in page.findall('h3'):
    value = (h3.contents[0])
    if value != 'Afooling':
        print '>> txt, value'
        import codecs
        f = codecs.open('alle.txt', 'r', encoding='utf-8')
        text = f.read()
        f.close()
        # open the file again for writing
        f = codecs.open('alle.txt', 'w', encoding='utf-8')
        f.write(value+'\\n')
        # write the original contents
```


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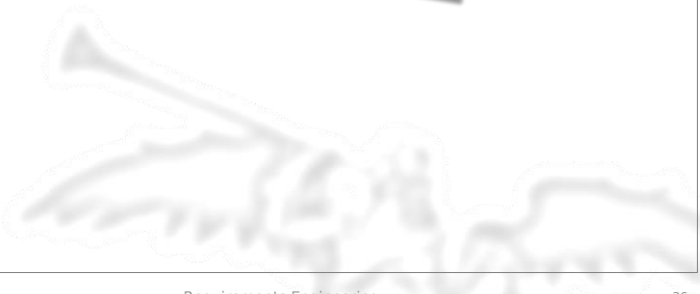
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Introduction to Requirements Engineering

- Comments, suggestions, ...



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