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The Rest

Contents & Goals

Last Lecture:
• process models: V-Modell XT, agile (XP, Scrum); process metrics: CMMI, SPICE
This Lecture:
• Educational Objectives:
  - Capabilities for following tasks/questions.
  - What is requirements engineering (RE)?
  - Why is it important, why is it hard?
  - What are the two (three) most relevant artefacts produced by RE activities?
  - What is a dictionary?
  - What are desired properties of requirements specification (documents)?
  - What are hard/soft/open/tacit/functional/non-functional requirements?
  - What is requirements elicitation?
  - Which analysis technique would you recommend in which situation?
• Content:
  - motivation and vocabulary of requirements engineering,
  - the documents of requirements analysis, and desired properties of RE,
  - guidelines for requirements specification using natural language

F.P. Brooks (Brooks, 1995)

The hardest single part of building a software system is deciding precisely what to build. No other part of the conceptual work is as difficult as establishing the detailed technical requirements for the system. No other part of the work so cripples the resulting system if done wrong. No other part is as difficult to rectify later.
Requirements and Requirements Analysis

- Requirement (1) A condition or capability needed by a user to solve a problem or achieve an objective.
- Requirement (2) 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.
- Requirement (3) A documented representation of a condition or capability as in (1) or (2).

IEEE 610.12 (1990)

Requirements Analysis
- Requirement (1) The process of studying user needs to arrive at a definition of system, hardware, or software requirements.
- Requirement (2) The process of studying and refining system, hardware, or software requirements.

IEEE 610.12 (1990)

The Requirements Engineering Problem

- \( \sum \times A \) \( \omega \)
- All computation paths over \( \sum \) and \( A \), aka. chaos requirements, all these computation paths are allowed one software which satisfies the requirements.

Requirements engineering:
- Describe/specify the set of the allowed computation paths.

Software development:
- Create one software \( S \) whose computation paths \( \llbracket S \rrbracket \) are all allowed.

Note: different programs in different programming languages may also describe \( \llbracket S \rrbracket \).

Often allowed: any refinement of \( \rightarrow \) later; e.g. allow intermediate transitions.

Purposes of the Requirements Specification

- Coordination with the customer (or the marketing department, or . . . )
- Not properly clarified/specified requirements are hard to satisfy — mismatches with customer’s needs turn out in operation the latest additional effort.
- Design and implementation, programmers may use different interpretations of unclear requirements → difficult integration.
- The user’s manual, if the user’s manual author is not developer, he/she can only describe what the system does, not what it should do (“no more bugs, every observation is a feature”)
- Preparation of tests, without a description of allowed outcomes, tests are randomly searching for generic errors (like crashes) → systematic testing impossible.
- Acceptance by customer, resolving later objections or regress claims, at delivery time unclear whether behaviour is an error (developer needs to fix) or correct (customer needs to accept and pay) → nasty disputes, additional effort.
- Re-use, re-use based on re-reading the code → risk of unexpected changes.
- Later re-implementations.

And What’s Hard About That?

Once Again: The Software People’s View on Requirements

Example: children’s birthday present requirements (birthday on May, 27th).

- “Ich will’n Pony!” (“I want a pony!”)
- Common sense understanding:
  - “Ford Mustang on Felixstowe beach” by Steve Arnold — CC BY 2.0 ✘

That is: we’re looking for one small horse-like animal; we may (guided by economic concerns, taste, etc.) choose exact breed, size, color, shape, gender, age (may not even be born today, only needs to be alive on birthday) . . .

- Software Engineering understanding:
  - We may give everything as long as there’s a pony in it:
    - a herd of ponies,
    - a whole zoo (if it has a pony),
    - . . .
arising during development.

The requirements specification should answer

• (iv) (a selection of)

functional and non-functional,

• *sigh*

understand and describe requirements.

Complex systems may need a preliminary system design

• requirements specification documents,

• requirements/feature specification.

In practice, this separation is often neither possible nor advisable:

(i) of requirements

kinds

(ii) prevents us from doing

writing or describing (a) subset(s) of chaos.

Note

Writing a requirements specification means

• requirements

• requirements specification documents

or describing (a) subset(s) of chaos.

In the following we shall discuss:

• analysis

• analysis in the sense of

dictionary,

• analysis:

Requirements Engineering: Basics

• characteristics:

requirements

• properties

→

Design

Design

Choosing from the obtained subset(s) of chaos.

Fixing chaos means: choosing from the obtained subset(s) of chaos.

Many requirements analysis:

• (i) and (ii).

A First Summary

A Bit More Abstract: Software vs. 'Real World' Requirements
A requirements specification should be
- comprehensible,
- traceable,
- consistent,
- free of contradictions,
- neutral,
- abstract
and used in
- all requirements
- collection of requirements
- developed
- focus on
- and maintain only the
- relevant
- present,
- things which are not relevant to the project should not be
- constrained,
- correctly represents the wishes/needs of the customer,
- it correctly represents the wishes/needs of the customer,
- not realisable.
Note
- a requirements specification does not constrain the realisation more than necessary,
- each requirement is compatible with all other requirements; otherwise the requirements
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Kinds of Requirements: Functional and Non-Functional

- Requirements on Requirements Specification Documents

Kinds of Requirements: Hard and Soft Requirements

- Examples

Kinds of Requirements: Open and Tacit

- Note

Requirements Analysis Techniques

- Note

Functional requirements: software is a function which maps input to output sequences:

\[ \sigma \rightarrow_o \sigma \rightarrow_i \]

Another view

- \[ \sigma \rightarrow_o \sigma \rightarrow_i \]

- [1] 0 \rightarrow 1 \rightarrow 2 \rightarrow \cdots \rightarrow \sigma

- (most changes require reading beforehand).

- [2] 0 \rightarrow 1 \rightarrow 2 \rightarrow \cdots \rightarrow \sigma

- (because it requires something for the function requirement)

- [3] 0 \rightarrow 1 \rightarrow 2 \rightarrow \cdots \rightarrow \sigma

- (because it requires something for the function requirement)

- [4] 0 \rightarrow 1 \rightarrow 2 \rightarrow \cdots \rightarrow \sigma

- (because it requires something for the function requirement)

- [5] 0 \rightarrow 1 \rightarrow 2 \rightarrow \cdots \rightarrow \sigma

- (because it requires something for the function requirement)

- [6] 0 \rightarrow 1 \rightarrow 2 \rightarrow \cdots \rightarrow \sigma

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- (because it requires something for the function requirement)

- [27] 0 \rightarrow 1 \rightarrow 2 \rightarrow \cdots \rightarrow \sigma

- (because it requires something for the function requirement)

- [28] 0 \rightarrow 1 \rightarrow 2 \rightarrow \cdots \rightarrow \sigma

- (because it requires something for the function requirement)
Nouns like "registration" often hide complex processes. Are sentences with "never", "always", "each", "any", "all" really universally valid? Are "all" really all or are there exceptions.

Discovering tools and techniques for requirements engineering.

• Specification of the software and its external interfaces.
• Identification of the software requirements (functions, performance, design constraints, and attributes).

Conditions of the form "if-else" need descriptions of the if- and the then-case.

Conditions do not state the "when", "where", "what", etc., but the "if", "then" procedure.

Not "is", "has", but "reads", "creates"; full verbs require information which describe the process more precisely. Not "when data is consistent" but "after program P has checked consistency of the data".

Express processes by incompletely defined verbs.

Name the actors, indicate whether the user or the system does something. Not "the item is deleted".

State each requirement in full verbs.

Behavior, or other characteristics of a system or component. For example, a solution of natural and formal language, used to express the requirements, design, behavior, or other characteristics of a system or component.

Their argumentation is based on the formal or natural language, used to express the requirements, design, behavior, or other characteristics of a system. The argumentation of the natural language is based on the formal or natural language, used to express the requirements, design, behavior, or other characteristics of a system.

Good questions: How're things done today? What should be improved?

Many customers do not want (radical) change, but (formal) change is sometimes easier to achieve.

• Analysts may make proposals.
• Analysts may make suggestions.

The "raw material" is basis of a preliminary requirements specification.

The resulting "raw material" is basis of a preliminary requirements specification.

The customer decides: "I need..." (and the choice is documented.)

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The customer decides: "I need..." (and the choice is documented.)

The customer decides: "I need..." (and the choice is documented.)

The customer decides: "I need..." (and the choice is documented.)

Then it also remains closed of course.

Then the first client will knock on the window.

Then Mr. M opens the door.

Then Mr. M opens the door.

Then Mr. M opens the door.

Then Mr. M opens the door.

Then Mr. M opens the door.

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