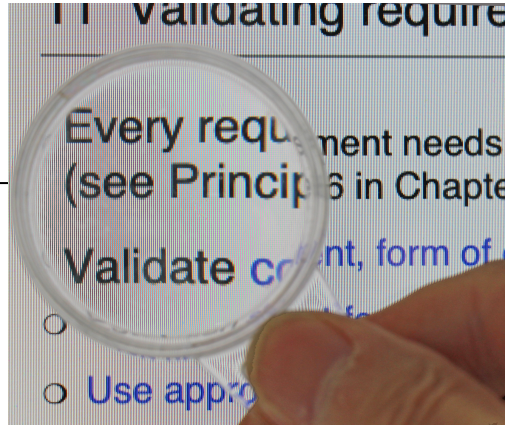
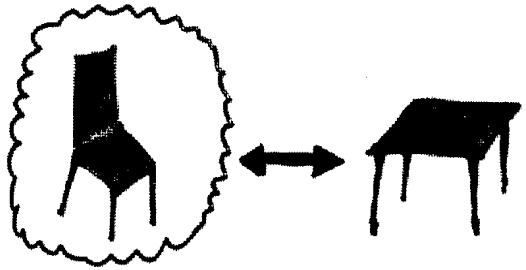
11 Validating requirements



- Every requirement needs to be validated (see Principle 6 in Chapter 2)
- Validate content, form of documentation and agreement
- Establish short feedback cycles
- Use appropriate techniques
- Work with the right people (i.e., stakeholders for requirements)
- Separate the processes of problem finding and correction
- Validate repeatedly / continuously

Validation of content



Identify requirements that are

- Inadequate or wrong
- Incomprehensible
- Incomplete or missing
- Ambiguous

Also look for requirements with these quality defects:

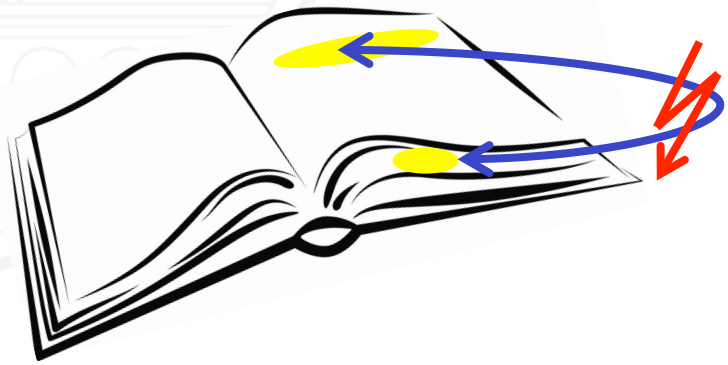
- Not verifiable
- Unnecessary
- Infeasible
- Not traceable
- Premature design decisions

Validation of requirements work products

Scope: checking the requirements work products (e.g., a systems requirements specification or a collection of user stories) for formal problems

Identify requirements that are

- Inconsistent with each other
- Missing
- Non-conforming to documentation rules, structure or format
- Redundant
- Hard to modify



Validation of agreement

- Requirements elicitation involves achieving consensus among stakeholders having divergent needs
- When validating requirements, we have to check whether agreement has actually been achieved
  - All known conflicts resolved?
  - For all requirements: have all relevant stakeholders for a requirement agreed to this requirement in its documented form?
  - For every changed requirement, have all relevant stakeholders agreed to this change?

Requirements validation techniques

Review

- Main means for requirements validation
- Walkthrough: author guides experts through the specification
- Inspection: Experts check the specification
- Author-reviewer-cycle: Requirements engineer continuously feeds back requirements to stakeholder(s) for review and receives feedback

Construction of other work products

- Acceptance criteria / test cases help disambiguate / clarify requirements
- Writing user manuals or creating models for textual requirements may help identify missing or wrong requirements

Requirements validation techniques – 2

Prototyping

- Lets stakeholders judge the practical usefulness of the specified system in its real application context
- Prototype constitutes a sample model for the system-to-be
- Most powerful, but also most expensive means of requirements validation

Simulation/Animation

- Means for investigating dynamic system behavior
- Simulator executes specification and may visualize it by animated models

Requirements validation techniques – 3

Requirements Engineering tools

- Help find gaps and contradictions

Formal Verification / Model Checking / Model Analysis

- Formal proof of critical properties
- Automated, systematic and comprehensive test of critical properties (when proofs are not tractable)

Reviewing practices

- Paraphrasing
  - Explaining the requirements in the reviewer's own words
- Perspective-based reading
  - Analyzing requirements from different perspectives, e.g., end-user, tester, architect, maintainer,...
- Playing and executing
  - Playing scenarios
  - Mentally executing acceptance test cases
- Checklists
  - Using checklists for guiding and structuring the review process

Requirements negotiation

- Requirements negotiation implies
  - Identification of conflicts
  - Conflict analysis
  - Conflict resolution
  - Documentation of resolution

- Requirements negotiation can happen
  - While eliciting requirements
  - When validating requirements

Conflict analysis

Identifying the underlying reasons of a conflict helps select appropriate resolution techniques

Typical underlying reasons are

- Subject matter conflict (divergent factual needs)
- Conflict of interest (divergent interests, e.g. cost vs. function)
- Conflict of value (divergent values and preferences)
- Relationship conflict (emotional problems in personal relationships between stakeholders)
- Organizational conflict (between stakeholders on different hierarchy and decision power levels in an organization)

Conflict resolution

- Various strategies / techniques
- Conflicting stakeholders must be involved in resolution
- Win-win techniques
  - Agreement
  - Compromise
  - Build variants
- Win-lose techniques
  - Overruling
  - Voting
  - Prioritizing stakeholders (important stakeholders override less important ones)

Conflict resolution – 2

- Decision support techniques
  - PMI (Plus-Minus-Interesting) categorization of potential conflict resolution decisions
  - Decision matrix (Matrix with a row per interesting criterion and a column per potential resolution alternative. The cells contain relative weights which can be summarized per column and then compared)

Acceptance testing

DEFINITION. Acceptance – The process of assessing whether a system satisfies all its requirements.

DEFINITION. Acceptance test – A test that assesses whether a system satisfies all its requirements.

Requirements and acceptance testing

Requirements engineering and acceptance testing are naturally intertwined

- For every requirement, there should be at least one acceptance test case
- Requirements must be written such that acceptance tests can be written to validate them
- Acceptance test cases can serve
  - for disambiguating requirements
  - as detailed specifications by example → acceptance criteria for user stories

Choosing acceptance test cases

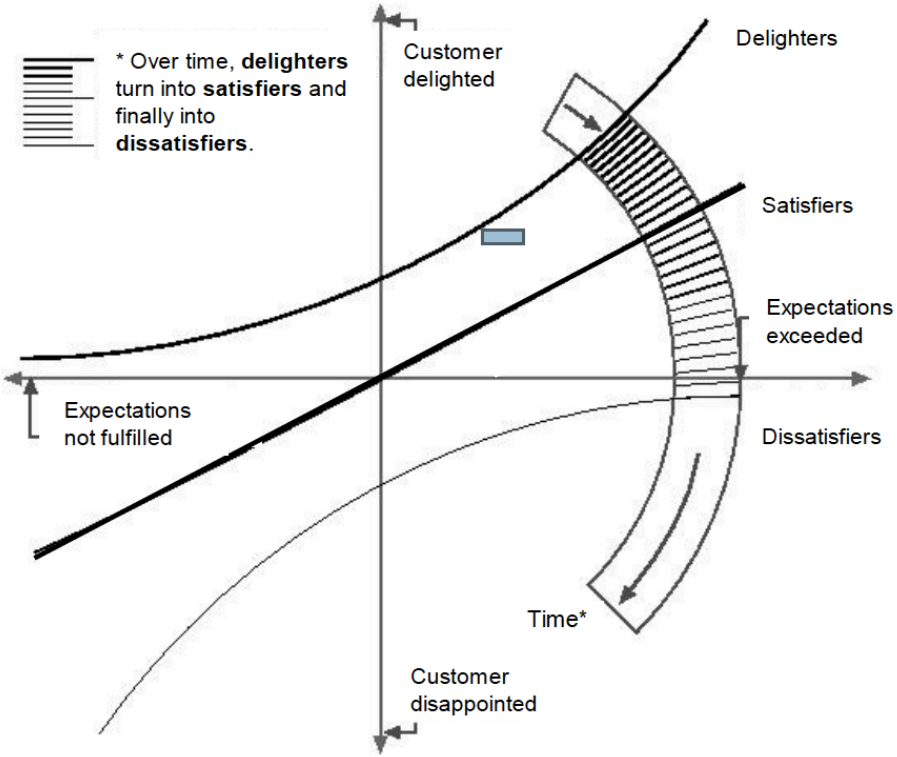
Potential coverage criteria:

- Requirements coverage: At least one case per requirement
- Function coverage: At least one case per function
- Scenario coverage: For every type scenario / use case
  - All actions covered
  - All branches covered
- Consider the usage profile: not all functions/scenarios are equally frequent / important

12 Innovative requirements

Satisfying stakeholders is not enough
(see Principle 8 in Chapter 2)

[Kano et al. 1984]



- Kano's model helps identify...
  - what is implicitly expected (dissatisfiers)
  - what is explicitly required (satisfiers)
  - what the stakeholders don't know, but would delight them if they get it: innovative requirements
- Over time, delighters degrade toward plain expectations

How to create innovative requirements?

Encourage out-of-the-box thinking

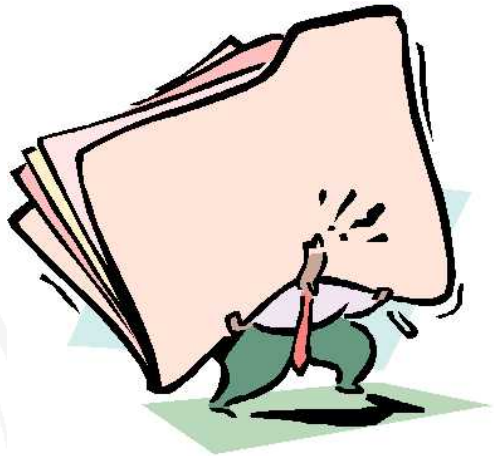
- Stimulate the stakeholders' creativity
  - Imagine/ make up scenarios for possible futures
  - Imagine a world without constraints and regulators
  - Find and explore metaphors
  - Study other domains
- Involve solution experts and explore what's possible with available and future technology
- Involve smart people without domain knowledge

[Maiden, Gitzikis and Robertson 2004]
[Maiden and Robertson 2005]

Where to innovate

- Functionality – new exciting features
- Performance – not just a bit more, but significantly more powerful than previous or competing systems
- Usability – making usage an exciting experience

13 Requirements management



- Organize
  - Store and retrieve
  - Record metadata (author, status,...)
- Prioritize
- Keep track: dependencies, traceability
- Manage change

13.1 Organizing requirements

Every requirement needs

- a unique identifier as a reference in acceptance tests, review findings, change requests, traces to other artifacts, etc.
- some metadata, e.g.
  - Author
  - Date created
  - Date last modified
  - Source (stakeholder(s), document, minutes, observation...)
  - Status (created, ready, released, rejected, postponed...)
  - Necessity (critical, major, minor)

Storing, retrieving and querying

Storage

- Paper and folders
- Files and electronic folders
- A requirements management tool

Retrieving support

- Keywords
- Cross referencing
- Search machine technology

Querying

- Selective views (all requirements matching the query)
- Condensed views (for example, statistics)

13.2 Prioritizing requirements

- Requirements may be prioritized with respect to various criteria, for example
  - Necessity
  - Cost of implementation
  - Time to implement
  - Risk
  - Volatility

- Prioritization is done by the stakeholders
- Only a subset of all requirements may be prioritized
- Requirements to be prioritized should be on the same level of abstraction

Simple prioritization (by necessity)

Ranks all requirements in three categories with respect to necessity, i.e., their importance for the success of the system

- Critical (also called essential, or mandatory)

  The system will not be accepted if such a requirement is not met

- Major (also called conditional, desirable, important, or optional)

  The system should meet these requirements, but not meeting them is no showstopper

- Minor (also called nice-to-have, or optional)

  Implementing these requirements is nice, but not needed

Selected prioritization techniques

Single criterion prioritization

- **Simple ranking**

  Stakeholders rank a set of requirements according to a given criterion

- **Assigning points**

  Stakeholders receive a total of n points that they distribute among m requirements

- Prioritization by multiple stakeholders may be consolidated using weighted averages. The weight of a stakeholder depends on his/her importance

Selected prioritization techniques – 2

Multiple criterion prioritization

- Wiegers' matrix [Wiegers 1999]
  - Estimates relative benefit, detriment, cost, and risk for each requirement
  - Uses these values to calculate a weighted priority
  - Ranks according to calculated priority values
- AHP (Analytic Hierarchy Process) [Saaty 1980]
  - An algorithmic multi-criterion decision making process
  - Applicable for prioritization by a group of stakeholders

13.3 Traceability

[Gotel and Finkelstein 1994]

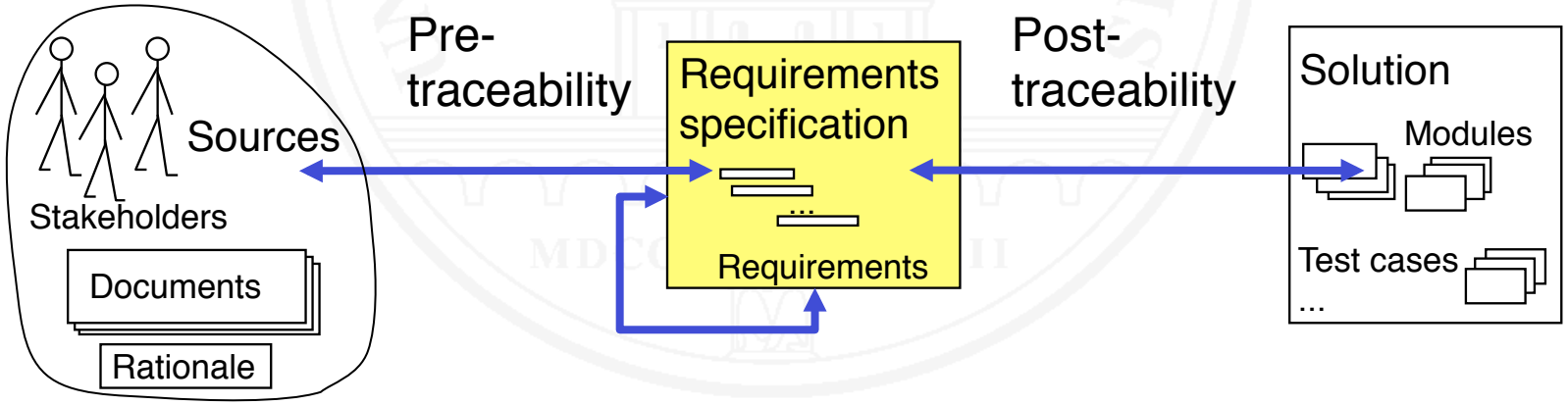
DEFINITION. Traceability – The ability to trace a requirement

(1) back to its origins,

(2) forward to its implementation in design and code,

(3) to requirements it depends on (and vice-versa).

Origins may be stakeholders, documents, rationale, etc.



Establishing and maintaining traces

- Manually
  - Requirements engineers explicitly create traces when creating artifacts to be traced
  - Tool support required for maintaining and exploring traces
  - Every requirements change requires updating the traces
  - High manual effort; cost and benefit need to be balanced
- Automatic
  - Automatically create candidate trace links between two artifacts (for example, a requirements specification and a set of acceptance test cases)
  - Uses information retrieval technology
  - Requires manual post processing of candidate links

13.4 Requirements evolution

The problem (see Principle 7 in Chapter 2):

Keeping requirements stable...

... while permitting requirements to change

Potential solutions

- Agile / iterative development with short development cycles (1-6 weeks)
- Explicit requirements change management

Every solution to this problem further needs requirements configuration management

Requirements configuration management

Keeping track of changed requirements

- Versioning of requirements
- Ability to create requirements configurations, baselines and releases
- Tracing the reasons for a change, for example
  - Stakeholder demand
  - Bug reports / improvement suggestions
  - Market demand
  - Changed regulations

Classic requirements change management

Adhering to a strict change process

(1) Submit change request

(2) Triage. Result: [OK | NO | Later (add to backlog)]

(3) If OK: Perform impact analysis

(4) Submit result and recommendation to Change Control Board

(5) Decision by Change Control Board

(6) If positive: make the change, create new baseline/release,
(maybe) adapt the contract between client and supplier

Change control board – A committee of client and supplier representatives that decides on change requests.

Requirements change in agile development

In agile and iterative development processes, a requirements change request ...

- ... never affects the current sprint / iteration, thus ensuring stability
- ... is added to the product backlog

Decisions about change requests are made when prioritizing and selecting the requirements for the subsequent sprints / iterations

14 Requirements and design

A traditional belief:

- Requirements are about what a system ought to do
- Design deals with the problem of how to realize what has been stated in the requirements
- Requirements Engineering and System Design should be kept separate, with requirements preceding design

- Sounds good and is popular, but does not work

Design has two facets

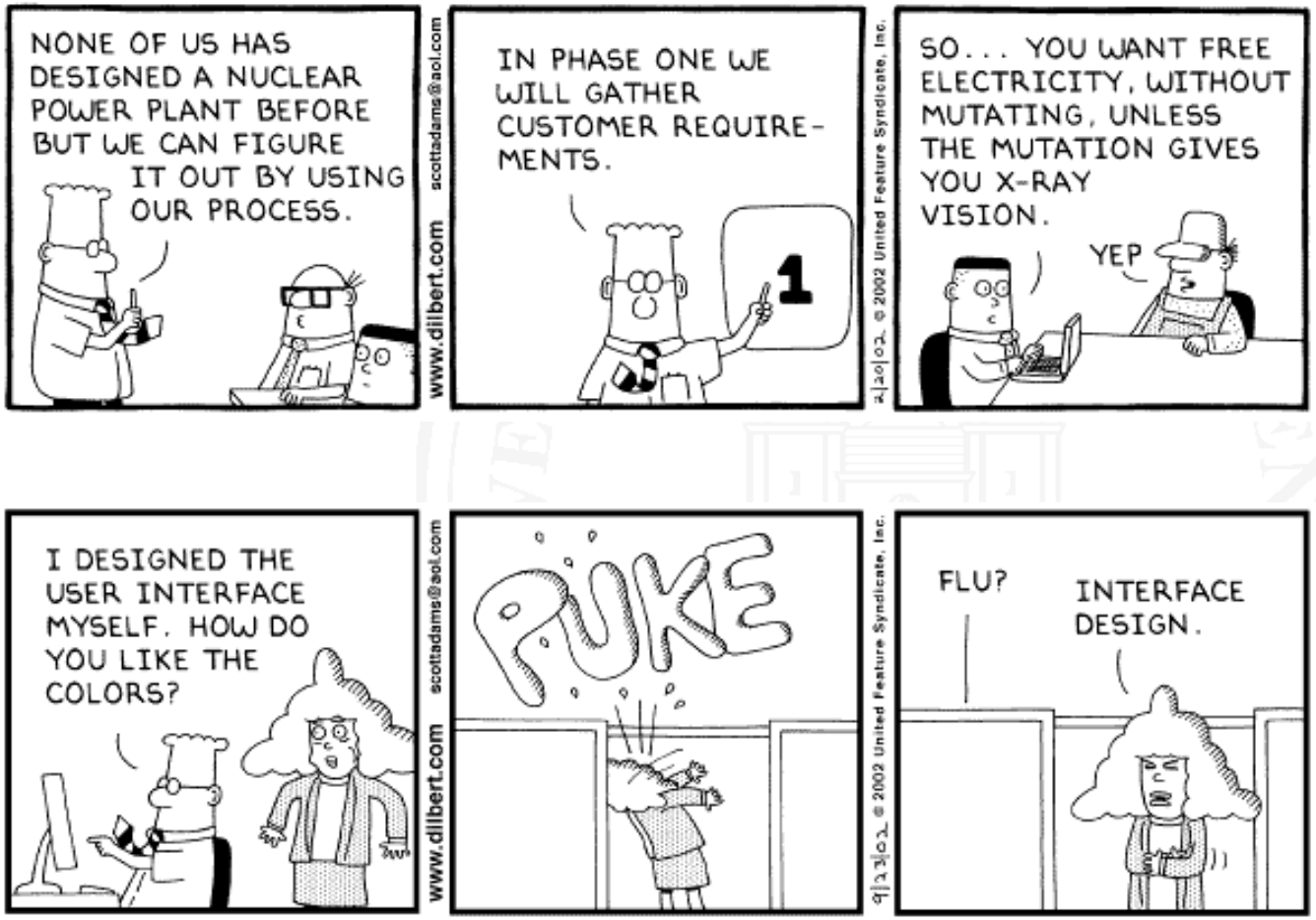
- Technical Design: Creating the architectural structure of a system and designing its components in detail
- Product Design: Shaping a product (or a system) with respect to its capabilities, behavior, outer form, and usage

Traditional RE: Product Design comes after RE

Modern RE: Product design shapes the essence of a product
→ crucial for meeting the stakeholders' desires and needs
→ Product Design and RE are strongly intertwined

Product design for digital products is also called "Digital Design"

Why care about both RE and product design?



→ We need RE competencies

→ and product design competencies

Complementary contributions

- RE contributes competencies about
  - Stakeholder identification
  - Elicitation of wishes and needs
  - Documentation of non-touchable things
  - Requirements negotiation, prioritization, and validation
- Product Design contributes competencies about
  - Usability
  - User experience design
  - Materials for physical & cyber-physical products, “digital materials” for digital products
  - Empirical product validation

Meeting requirements may not suffice to satisfy stakeholders

A requirement

The participant entry form shall have fields for the participant data *name*, *first name*, *sex*, and *person ID* and a *submit button*.

can be ruined by bad product design