Requirements Engineering I

Chapter 4

Elaboration of Requirements

Chapter roadmap

4.1 Information sources
Where to look

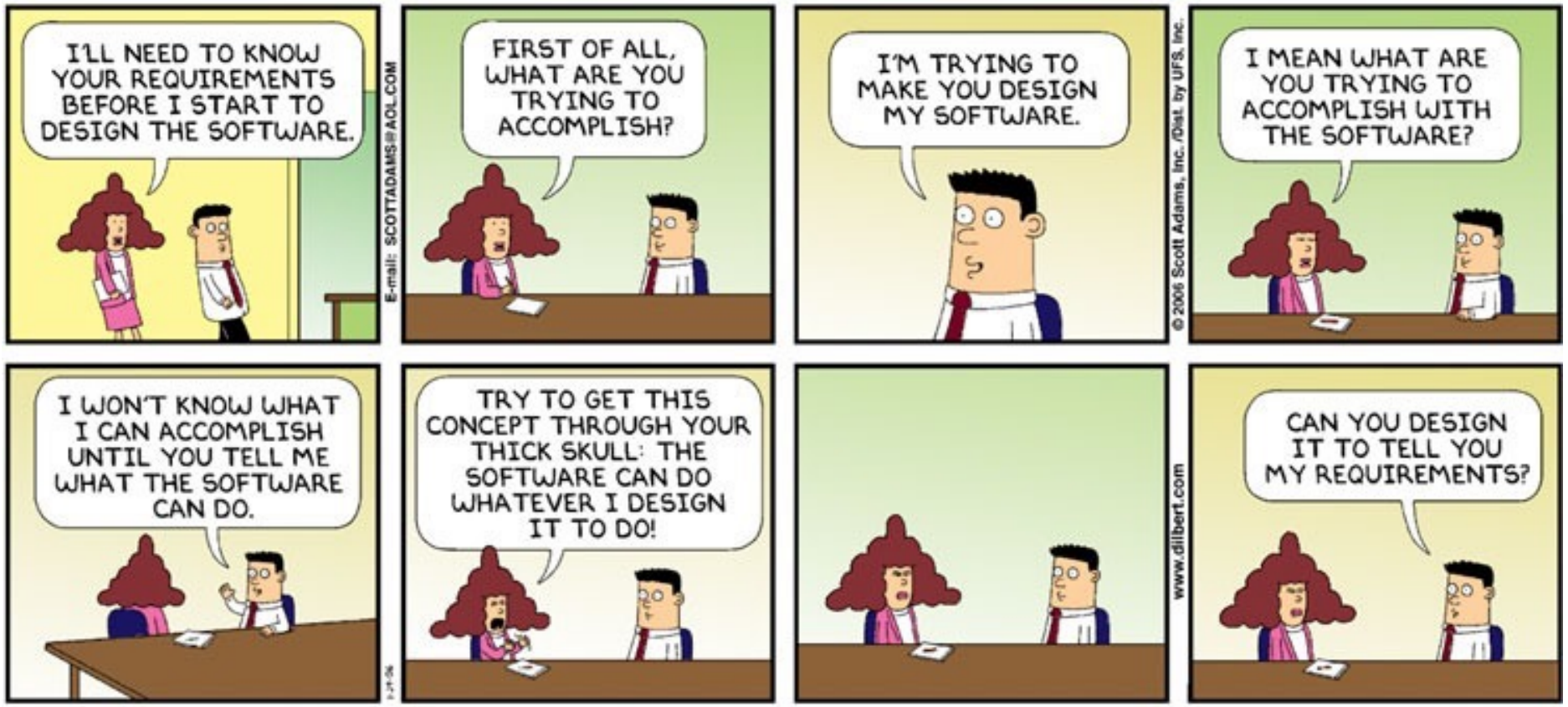
4.2 Elicitation practices
The toolbox for requirements engineers

4.3 Analyzing and documenting
From chaos to structure

4.4 Eliciting innovative requirements
Making stakeholders happy

4.5 Requirements negotiation
Resolving conflicts

The Problem



GenAI will not do this job either.

What to do

The prerequisites

- Knowing and tapping the information sources
- Knowing the goals
- Considering the context

The tasks

- Elicit, analyze and document requirements
- Negotiate
- Validate (→ Chapter 9)

4.1 Information sources

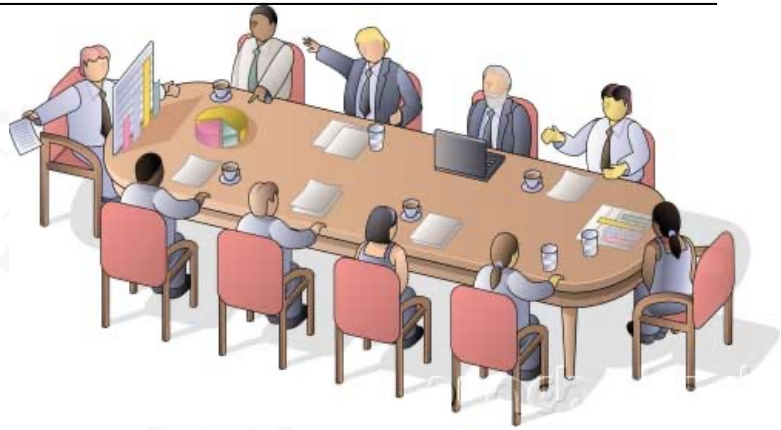
Main sources

- Stakeholders
- Documents
- Existing systems

Requirements are also influenced by

- Context
- Goals
- Observations

Stakeholder analysis



Identify stakeholder roles

End user, customer, operator, project manager, regulator,...

In complex cases: Build model of stakeholder goals, dependencies and rationale

[Yu 1997]
[van Lamsweerde 2001]

Classify stakeholders

- Critical
- Major
- Minor

[Glinz and Wieringa 2007]

Identify/determine concrete persons for each stakeholder role

Identifying stakeholders / stakeholder roles

- Start with the obvious ones: end user, customer, ...
- Consider all people, organizations, systems who will directly interact with the system
- Consider further people and organizations in the system context who influence the system, e.g., regulators
- Ask already identified stakeholders (snowballing)
- Ask a GenAI to propose a list of potential stakeholders (and validate that proposal carefully)

Personas

What if no concrete persons can be determined for a stakeholder role? → Define personas

DEFINITION. Persona – A fictitious character representing a group of people with similar needs, values and habits who are expected to use a system or benefit from it in a similar way.

- A persona typically comprises
  - Personal info: Name, photo, age, gender, family, profession,...
  - Personality: Introvert/extrovert, conservative/open, ...
  - Values, goals, frustrations, motivations
- GenAI can help create personas

A sample persona

Personal

Name:	Anna Schneider
Age:	30
Gender:	female (she/her)
Family:	Married, a son (2 y.)
Education:	MSc in Informatics
Profession:	Software Engineer
Works:	60%

"Do things well and enjoy it"

Goals

Develop good&useful products
Become a digital design expert
Have her own company in 6-8 years
Good family life, have a 2nd child

Frustrations

Unrealistic expectations
Ignorant bosses / colleagues
Routine tasks

Personality

introvert — extrovert
conservative — open&curious
rational — feeling
acting — let it grow

Motivation

Task-intrinsic
Incentives/Praise
Fear
Social

Values

Work-life balance over high income
Quality over speed
Analytic thinking over hacking

Bio

here

Manage your stakeholders

Keep a list of your stakeholders with relevant information

Name	Persona	Role	Influence	Contact	Availability
Dan Downhill	yes	Skier	Critical	N/A	N/A
Petra Meier	no	Ticket clerk	Major	petra@whiteresorts.ch 099 777 66 22	Mon-Wed
(...)					

Mini-Exercise

Consider the chairlift access control case study.

Perform the following elements of a stakeholder analysis:

- Identify stakeholder roles (beyond those on the previous slide)
- Assess the degree of influence of the stakeholder roles found
- For which roles will it be possible to identify concrete people as representatives – and where do you need to create personas?

Documents as sources for requirements

Documents can be a rich source for requirements

- Artifacts produced or consumed in business processes
- Process or procedure descriptions
- Regulatory documents
- Company guidelines
- Internal e-mail and memos

  ...

- Keep a list of identified documents, their relevance and where to find them
- GenAI can help search and analyze vast amounts of documents

Existing systems as sources for requirements

- Existing systems as a source of requirements:
  - Renewing/renovating legacy systems
  - Copying/mimicking successful parts of an existing system ("The user interface shall look and feel the same as the order processing interface of system xxx")
  - Developing a new product shall beat an existing product of a competitor
- Existing system as partial specifications by example
- Beware: Existing legacy systems can also be a source of negative requirements: what stakeholders do not want

Context analysis

Determine the system's context and the context boundary

Identify context constraints

- Physical, legal, cultural, environmental
- Embedding, interfaces

Photo © Universitätsklinikum Halle (Saale)

Identify assumptions about the context of your system and make them explicit

Map real world phenomena adequately on the required system properties and capabilities (and vice-versa)

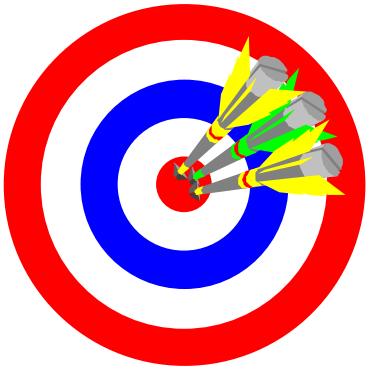
Determine the system scope (cf. Chapter 2.4)

Goal analysis

Knowing your destination is more important than the details of the timetable.

Before eliciting detailed requirements, the general goals and vision for the system to be built must be clear

- What are the main goals?
- How do they relate to each other?
- Are there goal conflicts?



The role of (informal) observations

When interacting with stakeholders, keep an open eye on informal observations, such as

- Stakeholder behavior (who is open for change, who is afraid of change, who is central in the social network, who dominates,...)
- Conflicts and power relationships between stakeholders
- Coffee break chats

→ Can be a source for requirements and also helps when negotiating requirements conflicts

Mini-Exercise

Consider the chairlift access control case study.

(a) How can you map the context property that a skier passes an unlocked turnstile to a system property which can be sensed and controlled by the system?

(b) Identify a business goal.

4.2 Elicitation practices

DEFINITION. Requirements elicitation – The process of seeking, capturing and consolidating requirements from available sources, potentially including the re-construction or creation of requirements.

- Determine the stakeholders' desires and needs
- Elicit information from all available sources and consolidate it into well-documented requirements
- Make stakeholders happy, not just satisfy them
- Every elicited and documented requirement must be validated and managed
- Work value-oriented and risk-driven

Elicitation techniques

Ask

- Interview stakeholders
- Use questionnaires and polls
- Reply/follow-up to user feedback

Collaborate

- Hold requirements workshops
- Provide community platforms

Build and play

- Build, explore and discuss prototypes (cf. Chapter 3)
- Perform role playing

[Zowghi and Coulin 2005]
[Dieste, Juristo, Shull 2008]
[Gottesdiener 2002]
[Hickey and Davis 2003]
Kolpondinos and Glinz 2019]
[Goguen and Linde 1993]

Elicitation techniques – 2

Observe

- Observe stakeholders in their work context

Analyze

- Analyze work products
- Analyze user feedback
  - Direct feedback: problem/bug reports, app reviews, tweets, explicit feedback channels, ...
  - Indirect feedback: user forums, system usage monitoring, ...
- Conduct market studies
- Perform benchmarking

Which technique for what?

Technique	Suitability for			
	Express needs	Demonstrate opportunities	Analyze system as is	Explore market potential
Interviews	+	–	+	o
Questionnaires and polls	o	–	+	+
Workshops, Community platforms	+	o	o	o
Explorative prototypes	o	+	–	o
Role play	+	o	o	–
Stakeholder observation	o	–	+	o
Work product analysis	o	–	+	–
User feedback analysis	+	–	–	o
Market studies	–	–	o	+
Benchmarking	o	+	–	+

Can AI provide help?

- No substitute for requirements engineers, but GenAI can act as an elicitation assistant
  - Preparing interviews and workshops
  - Helping with stakeholder and document analysis
  - Summarizing interviews or workshop results
  - Creating proper requirements from collected information
  - Doing completion work (e.g., proposing acceptance criteria for user stories)
- Proper prompting is key

→ Chapter 11.4

Typical problems

Inconsistencies among stakeholders in

- needs and expectations
- terminology

Stakeholders who know their needs, but can't express them

Stakeholders who don't know their needs

Stakeholders with a hidden agenda

Stakeholders thinking in solutions instead of problems

Stakeholders frequently neglect quality requirements and constraints

➔ Elicit them explicitly

Who should elicit requirements?

- Stakeholders must be involved
- Domain knowledge is essential
  - Stakeholders need to have it (of course)
  - Requirements engineers need to know the main domain concepts
  - A “smart ignoramus” can be helpful [Berry 2002, Sect. 7]
- Don’t let stakeholders specify themselves without professional support
- Best results are achieved when stakeholders and requirements engineers collaborate

Mini-Exercise

Consider the chairlift access control case study.

Which technique(s) would you select to elicit requirements

(a) from the chairlift ticket office clerks?

(b) from the skiers?

Eliciting functional requirements

- Who wants to achieve what with the system?
- For every identified function
  - What's the desired result and who needs it?
  - Which transformations and which inputs are needed?
  - In which state(s) shall this function be available?
  - Is this function dependent on other functions?
- For every identified behavior
  - In which state(s) shall the system have this behavior?
  - Which event(s) lead(s) to this behavior?
  - Which event(s) terminate(s) this behavior?
  - Which functions are involved?

Eliciting functional requirements – 2

- For every identified data item
  - What are the required structure and the properties of this item?
  - Is it static data or a data flow?
  - If it's static, must the system keep it persistently?
- Analyze mappings
  - How do real world functions/behavior/data map to system functions/behavior/data and vice-versa?
- Specify normal and exceptional cases

Eliciting quality requirements

Stakeholders frequently state quality requirements in qualitative form:

"The system shall be fast."

"We need a secure system."

Problem: Such requirements are

- Ambiguous
- Difficult to achieve and verify

❍ Classic approach:

- Quantification ➔ ⊕ measurable ⊖ maybe too expensive
- Operationalization ➔ ⊕ testable ⊖ implies premature design decisions

Value-based approach

[Glinz 2008]

Represent quality requirements such that they deliver optimum value

Value of a requirement = benefit of development risk reduction minus cost for its specification

- Assess the criticality of a quality requirement
- Represent it accordingly
- Broad range of possible representations

The range of adequate representations

Situation	Representation	Verification
1. Implicit shared understanding	Omission	Implicit
2. Need to state general direction Customer trusts supplier	Qualitative	Inspection
3. Sufficient shared understanding to generalize from examples	By example	Inspection, (Measurement)
4. High risk of not meeting stake-holders' desires and needs	Quantitative in full	Measurement
5. Somewhere between 2 and 4	Qualitative with partial quantification	Inspection, partial measurement

Eliciting performance requirements

Things to elicit

- Time for performing a task or producing a reaction
- Volume of data
- Throughput (data transmission rates, transaction rates)
- Frequency of usage of a function
- Resource consumption (CPU, storage, bandwidth, battery)
- Accuracy (of computation)

Eliciting performance requirements – 2

- What's the meaning of a performance value:
  - Minimum?
  - Maximum?
  - On average?
  - Within a given interval?
  - According to some probability distribution?
- How much deviation can be tolerated?

Eliciting specific quality requirements

- Ask stakeholders explicitly
- A quality model can be used as a checklist
- Quality models also help when a specific quality requirement needs to be quantified

The ISO/IEC 25010:2023 quality model (formerly ISO/IEC 9126) has major issues that limit its usability

There is ongoing work to improve the situation

[Glinz et al. 2023]

Eliciting constraints

- Ask about restrictions of the potential solution space
  - Technical, e.g., given interfaces to neighboring systems
  - Legal, e.g., restrictions imposed by law, standards or regulations
  - Organizational, e.g. organizational structures or processes that must not be changed by the system
  - Cultural, environmental, ...
- Check if a requirement is concealed behind a constraint
  - Constraint stated by a stakeholder: "When in exploration mode, the print button must be grey."
  - Actual requirement: "When the system is used without a valid license, the system shall disable printing."

Mini-Exercise

Consider the chairlift access control case study.

Identify some constraints for the chairlift access control system.

Elicit at least one legal and one physical constraint.

4.3 Analyzing and documenting

Elicited information is often unstructured

→ Analysis techniques help

- shape collected information into proper requirements
- document requirements properly
- inform and structure information gathering

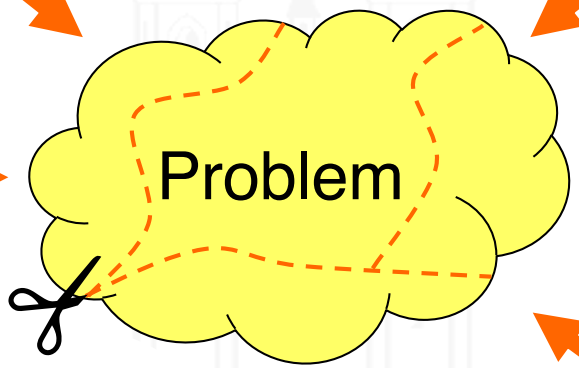
Analyzing elicited information

Structure-oriented

Process-oriented

Analyze terminology / domain properties
Build glossary

Analyze processes / workflows
Build activity / process models



Analyze business and data objects
Build object and class models

Analyze dynamic system behavior
Build behavior model

Decompose problem
Build hierarchical structure

Analyze actor-system interaction
Build scenarios / use cases

Note: requirements are about a future state of affairs; analyze the current state only when necessary

Documenting elicited requirements

Build specification incrementally and continuously

Document requirements in small units

End over means: Result → Function → Input

Consider the unexpected: specify non-normal cases

Quantify critical attributes

Document critical assumptions explicitly

Avoid redundancy

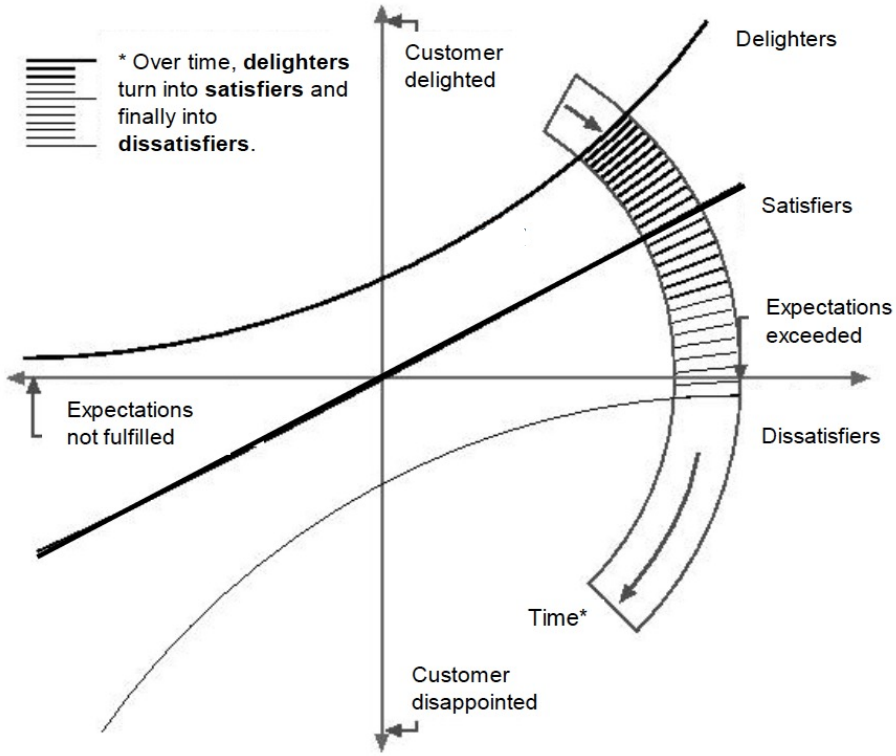
Build a glossary and stick to terminology defined in the glossary

Let a GenAI assist you

4.4 Eliciting 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 will delight them if they get it: innovative requirements

Caution: Over time, delighters degrade to 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

Mini-Exercise

Consider the chairlift access control case study.

Think about potential innovations with respect to

- Functionality
- Performance
- Usability

4.5 Requirements negotiation

Stakeholders may have conflicting requirements.

→ Negotiation of requirements needed

- 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)
- Data conflict (different interpretation of data, inconsistent data)
- Interest conflict (divergent interests, e.g., cost vs. function)
- Value conflict (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)

Mini-Exercise

Consider the chairlift access control case study.

How, for example, can you achieve consensus among the ski resort management, the technical director of chairlifts, the ticket office clerks, and the service employees about their requirements?