Requirements Engineering

Chapter 2 Requirements Engineering Processes

Learning Objective

...to give a general introduction to the requirements engineering process. Different approaches to modeling requirements engineering processes are suggested and why human, social and organizational factors are important influences on those processes. Other concepts that are evaluated include process maturity, tools and process improvement.

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Objectives

- To introduce the notion of processes and process models for requirements engineering
- To explain the critical role of people in requirements engineering processes
- To explain why process improvements is important and to suggest a process improvement model for requirements engineering
Processes

- A process is an organized set of activities which transforms inputs to outputs
- Process descriptions encapsulate knowledge and allow it to be reused
- Examples of process descriptions
  - Instruction manual for a dishwasher
  - Cookery book
  - Procedures manual for a bank
  - Quality manual for software development

Design processes

- Processes which involve creativity, interactions between a wide range of different people, engineering judgement and background knowledge and experience
- Examples of design processes
  - Writing a book
  - Organizing a conference
  - Designing a processor chip
  - Requirements engineering
RE process - inputs and outputs

Existing systems information

Stakeholder needs

Organisational standards

Regulations

Domain information

Requirements engineering process

Agreed requirements

System specification

System models

Input/output description

<table>
<thead>
<tr>
<th>Input or output</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing system information</td>
<td>Input</td>
<td>Information about the functionality of systems to be replaced or other systems which interact with the system being specified</td>
</tr>
<tr>
<td>Stakeholder needs</td>
<td>Input</td>
<td>Descriptions of what system stakeholders need from the system to support their work</td>
</tr>
<tr>
<td>Organisational standards</td>
<td>Input</td>
<td>Standards used in an organisation regarding system development practice, quality management, etc.</td>
</tr>
<tr>
<td>Regulations</td>
<td>Input</td>
<td>External regulations such as health and safety regulations which apply to the system</td>
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<tr>
<td>Domain information</td>
<td>Input</td>
<td>General information about the application domain of the system</td>
</tr>
<tr>
<td>Agreed requirements</td>
<td>Output</td>
<td>A description of the system requirements which is understandable by stakeholders and which has been agreed by them</td>
</tr>
<tr>
<td>System specification</td>
<td>Output</td>
<td>This is a more detailed specification of the system functionality which may be produced in some cases</td>
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<tr>
<td>System models</td>
<td>Output</td>
<td>A set of models such as a data-flow model, an object model, a process model, etc. which describes the system from different perspectives</td>
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RE process variability

- RE processes vary radically from one organization to another
- Factors contributing to this variability include:
  - Technical maturity
  - Disciplinary involvement
  - Organizational culture
  - Application domain
- There is therefore no ‘ideal’ requirements engineering process

Process models

- A process model is a simplified description of a process presented from a particular perspective
- Types of process model include:
  - Coarse-grain activity models
  - Fine-grain activity models
  - Role-action models
  - Entity-relation models
Coarse-grain activity model of RE

- Requirements elicitation
  - User needs, domain information, existing system information, regulations, standards, etc.

- Requirements analysis and negotiation

- Requirements documentation

- Requirements validation
  - System specification
  - Agreed requirements

RE process activities

- Requirements elicitation
  - Requirements discovered through consultation with stakeholders

- Requirements analysis and negotiation
  - Requirements are analyzed and conflicts resolved through negotiation

- Requirements documentation
  - A requirements document is produced

- Requirements validation
  - The requirements document is checked for consistency and completeness
Waterfall model of the software process

Context of the RE process
Spiral model of the RE process

Actors in the RE process

- Actors in a process are the people involved in the execution of that process.
- Actors are normally identified by their roles rather than individually.
- Requirements engineering involves actors who are primarily interested in the problem to be solved (end-users, etc) as well actors interested in the solution (system designers, etc.)
- Role-action diagrams document which actors are involved in different activities.
RAD for software prototyping

**ROLES**

**ACTIONS**

- Understand problem
- Establish outline requirements
- Select prototyping system
- Develop prototype
- Evaluate prototype

**Roles and Descriptions**

<table>
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<th>Role</th>
<th>Description</th>
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<tr>
<td>Domain expert</td>
<td>Responsible for providing information about the application domain and the specific problem in that domain which is to be solved</td>
</tr>
<tr>
<td>System end-user</td>
<td>Responsible for using the system after delivery</td>
</tr>
<tr>
<td>Requirements engineer</td>
<td>Responsible for eliciting and specifying the system requirements</td>
</tr>
<tr>
<td>Software engineer</td>
<td>Responsible for developing the prototype software system</td>
</tr>
<tr>
<td>Project manager</td>
<td>Responsible for planning and estimating the prototyping project</td>
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Human and social factors

- Requirements engineering processes are dominated by human, social and organizational factors because they always involve a range of stakeholders from different backgrounds and with different individual and organizational goals.
- System stakeholders may come from a range of technical and non-technical background and from different disciplines.

Types of stakeholder

- Software engineers responsible for system development
- System end-users who will use the system after it has been delivered
- Managers of system end-users who are responsible for their work
- External regulators who check that the system meets its legal requirements
- Domain experts who give essential background information about the system application domain
Factors influencing requirements

- Personality and status of stakeholders
- The personal goals of individuals within an organization
- The degree of political influence of stakeholders within an organization

Process support

- CASE tools provide automated support for software engineering processes
- The most mature CASE tools support well-understood activities such as programming and testing and the use of structured methods
- Support for requirements engineering is still limited because of the informality and the variability of the process
CASE tools for RE

- Modeling and validation tools support the development of system models which can be used to specify the system and the checking of these models for completeness and consistency. The tool package which supports this book includes this type of tool.

- Management tools help manage a database of requirements and support the management of changes to these requirements.

A requirements management system
Requirements management tools

- Requirements browser
- Requirements query system
- Traceability support system
- Report generator
- Requirements converter and word processor linker
- Change control system

Process improvement

- Process improvement is concerned with modifying processes in order to meet some improvement objectives
- Improvement objectives
  - Quality improvement
  - Schedule reduction
  - Resource reduction
Planning process improvement

- What are the problems with current processes?
- What are the improvement goals?
- How can process improvement be introduced to achieve these goals?
- How should process improvements be controlled and managed?

RE process problems

- Lack of stakeholder involvement
- Business needs not considered
- Lack of requirements management
- Lack of defined responsibilities
- Stakeholder communication problems
- Over-long schedules and poor quality requirements documents
Process maturity

- Process maturity can be thought of as the extent that an organization has defined its processes, actively controls these processes and provides systematic human and computer-based support for them.

- The SEI’s Capability Maturity Model is a framework for assessing software process maturity in development organizations.
Maturity levels

- **Initial level**
  - Organizations have an undisciplined process and it is left to individuals how to manage the process and which development techniques to use.

- **Repeatable level**
  - Organizations have basic cost and schedule management procedures in place. They are likely to be able to make consistent budget and schedule predictions for projects in the same application area.

- **Defined level**
  - The software process for both management and engineering activities is documented, standardized and integrated into a standard software process for the organization.

- **Managed level**
  - Detailed measurements of both process and product quality are collected and used to control the process.

- **Optimizing level**
  - The organization has a continuous process improvement strategy, based on objective measurements, in place.
RE process maturity model

Level 1 - Initial
Ad-hoc requirements engineering; requirements problems are common

Level 2 - Repeatable
Standardised requirements engineering; fewer requirements problems

Level 3 - Defined
Defined process based on best practice; process improvement in place

RE process maturity levels

 INITIAL level
- No defined RE process. Suffer from requirements problems such as requirements volatility, unsatisfied stakeholders and high rework costs. Dependent on individual skills and experience.

 REPEATABLE level
- Defined standards for requirements documents and policies and procedures for requirements management.

 DEFINED level
- Defined RE process based on good practices and techniques. Active process improvement process in place.
Good practice for RE process improvement

- RE processes can be improved by the systematic introduction of good requirements engineering practice
- Each improvement cycle identifies good practice guidelines and works to introduce them in an organization

Examples of good practice guidelines

- Define a standard document structure
- Uniquely identify each requirement
- Define policies for requirements management
- Use checklists for requirements analysis
- Use scenarios to elicit requirements
- Specify requirements quantitatively
- Use prototyping to animate requirements
- Reuse requirements
Key points

- The requirements engineering process is a structured set of activities which lead to the production of a requirements document.
- Inputs to the requirements engineering process are information about existing systems, stakeholder needs, organizational standards, regulations and domain information.
- Requirements engineering processes vary radically from one organization to another. Most processes include requirements elicitation, requirements analysis and negotiation and requirements validation.

Key points

- Requirements engineering process models are simplified process description which are presented from a particular perspective.
- Human, social and organizational factors are important influences on requirements engineering processes.
- Requirements engineering process improvement is difficult and is best tackled in an incremental way.
- Requirements engineering processes can be classified according to their degree of maturity.