Requirements Engineering Processes

1. Processes used to discover, analyse and validate system requirements

Requirements engineering processes

1. The processes used for requirements engineering vary widely depending on the application domain, the people involved and the organisation developing the requirements
2. However, there are a number of generic activities common to all processes
   - Requirements elicitation
   - Requirements analysis
   - Requirements validation
   - Requirements management

Feasibility studies

1. A feasibility study decides whether or not the proposed system is worthwhile
2. A short focused study that checks
   - If the system contributes to organisational objectives
   - If the system can be engineered using current technology and within budget
   - If the system can be integrated with other systems that are used

Feasibility study implementation

1. Based on information assessment (what is required), information collection and report writing
2. Questions for people in the organisation
   - What if the system wasn’t implemented?
   - What are current process problems?
   - How will the proposed system help?
   - What will be the integration problems?
   - Is new technology needed? What skills?
   - What facilities must be supported by the proposed system?
Elicitation and analysis

1. Sometimes called requirements elicitation or requirements discovery
2. Involves technical staff working with customers to find out about the application domain, the services that the system should provide and the system’s operational constraints
3. May involve end-users, managers, engineers involved in maintenance, domain experts, trade unions, etc. These are called stakeholders.

Problems of requirements analysis

1. Stakeholders don’t know what they really want
2. Stakeholders express requirements in their own terms
3. Different stakeholders may have conflicting requirements
4. Organisational and political factors may influence the system requirements
5. The requirements change during the analysis process. New stakeholders may emerge and the business environment change.

The requirements analysis process includes these activities:

1. Domain understanding
2. Requirements collection
3. Classification
4. Conflict resolution
5. Prioritisation
6. Requirements checking

Viewpoint-oriented elicitation

1. Stakeholders represent different ways of looking at a problem or problem viewpoints
2. Each stakeholder who will interact with the system will have a different point of view, or viewpoint, of what the system should do.
3. This multi-perspective analysis is important as there is no single correct way to analyse system requirements
4. Viewpoints and services may be used to structure non-functional requirements

Question

6.1 Who are the stakeholders in a university student records system? Why it is almost inevitable that the requirements of different stakeholders will conflict in some way?

• University central administration including those responsible for registration, payment of fees, examinations and assessment and graduation.
• The students whose details are recorded in the system.
• University departmental administrators who supply information to the system and use information from it.
• Academic staff who use information from the system.
• Data protection officers (local and national).
• Potential employers of students (who may require information from the system).

Question

6.1 Who are the stakeholders in a university student records system? Why it is almost inevitable that the requirements of different stakeholders will conflict in some way?
Extended Example: Banking ATM system

1. The example used here is an automated teller machine (ATM) which provides some automated banking services.
2. Services include cash withdrawal, message passing (send a message to request a service), ordering a statement and transferring funds.

Autoteller viewpoints

1. Bank customers
2. Representatives of other banks
3. Hardware and software maintenance engineers
4. Marketing department
5. Bank managers and counter staff
6. Database administrators and counter staff
7. Communications engineers
8. Personnel department

Viewpoint identification

- Query balance
- Machine supplies
- User interface
- Account holder
- Remote diagnostics
- Reliability
- Update account
- Security
- Card validation
- Cash withdrawal
- Transaction log
- Customer database
- Card returning
- Order cheques
- Foreign customer
- Prent
- Security
- Bank teller
- Invalid user
- Software size
- System cost
- Order statement
- Hardw...
- Account holder
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- Invalid user
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- Hardw...

Viewpoint service information

**ACCOUNT HOLDER**
- Service list
  - Withdraw cash
  - Query balance

**FOREIGN CUSTOMER**
- Service list
  - Withdraw cash
  - Query balance

**BANK TELLER**
- Service list
  - Run diagnostics
  - Add cash
  - Add paper
  - Send message

Viewpoint data/control

<table>
<thead>
<tr>
<th><strong>ACCOUNT HOLDER</strong></th>
<th><strong>Control input</strong></th>
<th><strong>Data input</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Start transaction</td>
<td>Card details</td>
<td></td>
</tr>
<tr>
<td>Cancel transaction</td>
<td>PIN</td>
<td></td>
</tr>
<tr>
<td>End transaction</td>
<td>Amount required</td>
<td></td>
</tr>
<tr>
<td>Select service</td>
<td>Message</td>
<td></td>
</tr>
</tbody>
</table>

Viewpoint hierarchy

- All VPs
  - Customer
  - Bank staff
  - Teller
  - Manager
  - Engineer
  - Account holder
  - Foreign customer
  - Services
    - Order cheques
    - Send message
    - Transaction list
    - Order statement
    - Transfer funds
Customer/cash withdrawal templates

Reference: Customer
Attributes: Account number, PIN
Events: Select service, Cancel transaction, End transaction
Services: Cash withdrawal, Balance enquiry
Sub-VPs: Account holder, Foreign customer

Scenarios

1. Scenarios are descriptions of how a system is used in practice
2. They are helpful in requirements elicitation as people can relate to these more readily than to an abstract statement of what they require from a system
3. Scenarios are useful for adding detail to an outline of requirements description

Scenario descriptions

1. System state at the beginning of the scenario
2. Normal flow of events in the scenario
3. What can go wrong and how this is handled
4. Other concurrent activities
5. System state on completion of the scenario

Event scenarios

1. Event scenarios may be used to describe how a system responds to the occurrence of some particular event such as ‘start transaction’
2. A diagrammatic convention for event scenarios might include:
   * Data provided and delivered
   * Control information
   * Exception processing
   * The next expected event

Event scenario - start transaction

Key to diagram in the previous slide

1. Ellipses (ovals): data provided from or delivered to a viewpoint
2. Control information enters and leaves at the top of each box
3. Data leaves from the right of each box
4. Exceptions are shown at the bottom of each box
5. Name of next event is in box with thick edges
Use cases

1. Use-cases are a scenario based technique in the UML which identify the actors in an interaction and which describe the interaction itself.
2. A set of use cases should describe all possible interactions with the system.
3. Sequence diagrams may be used to add detail to use-cases by showing the sequence of event processing in the system.

Library use-cases

<table>
<thead>
<tr>
<th>Library User</th>
<th>Lending services</th>
</tr>
</thead>
<tbody>
<tr>
<td>User administration</td>
<td></td>
</tr>
<tr>
<td>Library Staff</td>
<td></td>
</tr>
<tr>
<td>Supplier</td>
<td></td>
</tr>
<tr>
<td>Catalog services</td>
<td></td>
</tr>
</tbody>
</table>

Catalogue management

<table>
<thead>
<tr>
<th>Bookshop: Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item: Library Item</td>
</tr>
<tr>
<td>Books: Catalog</td>
</tr>
<tr>
<td>Cataloguer: Library Staff</td>
</tr>
<tr>
<td>Acquire</td>
</tr>
<tr>
<td>New</td>
</tr>
<tr>
<td>Catalog Item</td>
</tr>
<tr>
<td>Catalog</td>
</tr>
<tr>
<td>Uncatalog Item</td>
</tr>
<tr>
<td>Uncatalog</td>
</tr>
<tr>
<td>Dispose</td>
</tr>
</tbody>
</table>

Exercise

1. 6.5 Using your own knowledge of how an ATM is used, develop a set of use cases that could be used to derive the requirements for an ATM system.

Requirements validation

1. The process of demonstrating that the requirements define the system that the customer really needs.
2. Requirements error costs are high so validation is very important:
   - Fixing a requirements error after delivery may cost up to 100 times the cost of fixing an implementation error.

Issues to validate

1. Completeness. Are all functions required by the customer included?
2. Consistency. Are there any requirements conflicts?
3. Realism. Can the requirements be implemented given available budget and technology?
4. Verifiability. Can the requirements be checked?
Requirements validation techniques

1. Prototyping
   - Using an executable model of the system to check requirements.
     Covered in Chapter 8

2. Test-case generation
   - Developing tests for requirements to check testability

3. Requirements reviews
   - Systematic manual analysis of the requirements

Requirements reviews

1. Regular reviews should be held while the requirements definition is being formulated
2. Both client and contractor staff should be involved in reviews
3. Reviews may be formal (with completed documents) or informal. Good communications between developers, customers and users can resolve problems at an early stage

Exercise

6.7 Who should be involved in a requirements review? Draw a process model showing how a requirements review might be organized.

Traceability

1. Traceability is one aspect of requirements management, and is concerned with the relationships between requirements, their sources and the system design
2. Source traceability
   - Links from requirements to stakeholders who proposed these requirements
3. Requirements traceability
   - Links between dependent requirements
4. Design traceability
   - Links from the requirements to the design

A traceability matrix and requirements cross-reference

<table>
<thead>
<tr>
<th>Req. id</th>
<th>1.1</th>
<th>1.2</th>
<th>1.3</th>
<th>2.1</th>
<th>2.2</th>
<th>2.3</th>
<th>3.1</th>
<th>3.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td>R</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>R</td>
<td>R</td>
<td>U</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2.2</td>
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<td>3.2</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R</td>
</tr>
</tbody>
</table>

Notation used in this diagram:
U = The requirement in the row uses that in the column
R = Some other weaker relationship between the two
**Requirements Engineering Processes—Summary**

1. The requirements engineering process includes a feasibility study, requirements elicitation and analysis, requirements specification and requirements management
2. Requirements analysis is iterative involving domain understanding, requirements collection, classification, structuring, prioritisation and validation
3. Systems have multiple stakeholders with different requirements

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**Requirements Engineering Processes—Summary**

1. Social and organisation factors influence system requirements
2. Requirements validation is concerned with checks for validity, consistency, completeness, realism and verifiability
3. Business changes inevitably lead to changing requirements
4. Requirements management includes planning and change management