Requirements Analysis, *Modeling* and Specification

- Requirements Analysis, Modeling and Specification
- Problem
- Carving the Solution Space
- Prioritizing Requirements
What is a Model?
Requirements Analysis, Modeling & Specification

A continuous loop

Problem

Problem Elicitation

Text, Notes, Knowledge

Problem Analysis

Diagrams, Charts, Tables

Problem Specification

Modelling

(often informal models)

(concrete models)

(reqs. spec. models)

mediating representations
It is more important to understand the problem than the solution. [Albert Einstein]

“A problem unstated is a problem unsolved”
Douglas Ross, 1977

From Sam Supakkul’s presentation
What is a problem?
Is storm coming a problem?
Yes, if we want to have outdoor fun

Problem
No, if we’re dying for it

Blessing

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Problem or not depending on the goal we have

Problem

Blessing

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What is a problem?

Undesirable situation  Goal

hurts

causes

A phenomenon or a situation that hurts our goals

Phenomenon

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Problem = TO-BE – AS-IS

A problem can be defined as the difference between things as *they are now* and things as *they are desired*.

It is more important to understand the problem than the solution. [Albert Einstein]
Exercise: Student Application Processing System

(AS-IS) (Problem) (TO-BE)

To be continued later ...

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A Problem Analysis Roadmap

Enterprise/Business Problem

- Identify stakeholders for problem.
- Root cause analysis.

Actual problem identified and defined

- Understand the problem in the context of the business goals.
- Identify constraints on the system/project.

Problem validated/adjusted

- Gain agreement on the problem def. wrt. root causes.
- Identify constraints on the system/project.

Best solution identified

- Consider alternatives & choose the best solution(s) to meet the goals.
- Define the solution system boundary.
- Reassess that the solution idea is the best solution.

Elicit Requirements

- Expand stakeholder list for solution.

Establish common vocabulary => Glossary with a Domain Model
One Man's Ceiling is Another Man's Floor!

One Man's Problem is Another Man's Solution!

One Man's Floor is Another Man's Ceiling!

One Man's Solution is Another Man's Problem!

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Carving the Product Space

Requirements represent a compromise.

- Environmental
- Economic
- Political

User Needs \(\rightarrow\) Wants \(\rightarrow\) Customer Needs

Admissible Product Space Solution

- Feasibility
- Technology Risks
  - (acceptable)
  - (unacceptable)

Developer Perspective
- (acceptable)
- (unacceptable)

(acceptable) Laws & Standards
Carving the Product Space

Requirements represent a compromise.

Example

E.g., Wired/Wireless phone & PCS

User Needs
- WANTS: all in one device
  - phone, pager, TV, computer
  - answering machine
- NEEDS: cellular + wired service
- Office worker
- Wants: video phone + pager + teleconferencing
- Needs: cellular + wired service + ID

Wants
- Ordinary
- Sprint: 2 yr $2 billion across US
- Guarantee w. CDMA only
- Needs: SY/F3B, MANs, CDMA-1x/FDMA

Customer Needs
- Developer Perspective
  - (acceptable)
  - (unacceptable)

Admissible Product Space Solution

Technology Risks
- (acceptable)
- (unacceptable)

- Unacceptable:
  - 95% guarantee w. CDMA only
  - only 7-layer
- Acceptable:
  - 90% guarantee w. CDMA + FDMA

Unacceptable:
- Towers/cells every 100 meters
- Use any frequency -> hearing aid
- Acceptable:
- Close to hexagonal, but special BSs
  in subway, dense areas

Varying degrees of acceptable/unacceptable solutions
What Is the Problem Behind the Problem?

Fishbone Diagram Techniques

- The perceived business problem:
  - Customers are dissatisfied with our service.

List contributing causes to the identified problem. Keep asking “Why?” (expand each rib).

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Problem Analysis – Validating a Solution

We need ATMs.

The perceived solution to some ill-defined problem.

List the reasons why the solution is the right solution.
Keep asking “Why?” (expand each rib).

What is the problem of your project? Why is your solution the right solution?
Representation of problems
fault tree diagram

- Hot Water Heater Explodes
  - Pressure Relief Valve Fails
    - Relief Valve Frozen
    - Relief Valve Disch Line Plugged
      - RV Line Frozen
      - RV Line Crimped
      - Pipe Plug Installed in line
  - High Water Temperature
    - Temp Regulator Fails
    - High Temp Cut-off Fails

Symbol Legend:
- A1H Symbol
- OR Symbol
- Transfer Symbol

Representation of problems
fault tree diagram

- Clear relationships between siblings
  - AND/OR

- No relationship with
  - Goals
  - Alternatives

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Problem Interdependency Graph (PIG)
**But what if there are too many problems?**

**Pareto principle**

**In economics**

The original observation was in connection with income and wealth. Pareto noticed that 80% of Italy's wealth was owned by 20% of the population.\(^4\) He then carried out surveys on a variety of other countries and found to his surprise that a similar distribution applied. [Wikipedia]
Pareto effect Analysis

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Focus on Largest Contributors - **Pareto's Law**

**Vital-few-trivial-many; 80-20 rule**

**Priority; criticality**

- 80% of the benefit comes from 20% of the effort.
- Rank in order. Use the 80-20 Rule to focus on the top contributing causes to address the greatest portion of the problem.

What are in the 20% of the problem of your project?
Requirements Prioritization


Given n requirements,

- Create n x n matrix
- Compare each pair
  - entry (i, j) =
    - 1 if i and j are of equal value
    - 3 if i is slightly more preferred than j
    - 5 if i is strongly more preferred than j
    - 7 if i is very strongly more preferred than j
    - 9 if i is extremely more preferred than j
  - entry (j, i) = 1/entry (l, j)

- Estimate the eigenvalues
  - Calculate the sum of each column
  - Divide each entry by the sum of its column
  - Calculate the sum of each row
  - Divide each row sum by n

This gives a value for each requirement based on estimated percentage of total value of the project
Requirements Prioritization

An Analytic Hierarchy Process (AHP) Approach

Example

<table>
<thead>
<tr>
<th></th>
<th>r1</th>
<th>r2</th>
<th>r3</th>
<th>r4</th>
</tr>
</thead>
<tbody>
<tr>
<td>r1</td>
<td>1</td>
<td>1/3</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>r2</td>
<td>3</td>
<td>1</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>r3</td>
<td>1/2</td>
<td>1/5</td>
<td>1</td>
<td>1/3</td>
</tr>
<tr>
<td>r4</td>
<td>1/4</td>
<td>1/3</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

normalize columns

<table>
<thead>
<tr>
<th></th>
<th>r1</th>
<th>r2</th>
<th>r3</th>
<th>r4</th>
</tr>
</thead>
<tbody>
<tr>
<td>r1</td>
<td>0.21</td>
<td>0.18</td>
<td>0.18</td>
<td>0.48</td>
</tr>
<tr>
<td>r2</td>
<td>0.63</td>
<td>0.54</td>
<td>0.45</td>
<td>0.36</td>
</tr>
<tr>
<td>r3</td>
<td>0.11</td>
<td>0.11</td>
<td>0.09</td>
<td>0.04</td>
</tr>
<tr>
<td>r4</td>
<td>0.05</td>
<td>0.18</td>
<td>0.27</td>
<td>0.12</td>
</tr>
</tbody>
</table>

sum Sum/4

<table>
<thead>
<tr>
<th></th>
<th>sum</th>
<th>Sum/4</th>
</tr>
</thead>
<tbody>
<tr>
<td>r1</td>
<td>1.05</td>
<td>0.26</td>
</tr>
<tr>
<td>r2</td>
<td>1.98</td>
<td>0.50</td>
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<tr>
<td>r3</td>
<td>0.34</td>
<td>0.09</td>
</tr>
<tr>
<td>r4</td>
<td>0.62</td>
<td>0.16</td>
</tr>
</tbody>
</table>

*Also should compute the consistency index, since the pairwise comparisons may be inconsistent
Using "Shall" and Related Words

• "shall" indicates a binding provision, i.e., one that must be implemented by the specification users.

• To state non-binding provisions, use "should" or "may."

• Use "will" to express a declaration of purpose (e.g., "The government will furnish ...") or to express future tense.

• Appendix
D, S achieves R to solve P in D

Domain/World/Enterprise/Business

D, Problem => Requirements => Specification

What next?

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Define Boundaries for the Enterprise/Business and the Solution

D, S achieves R to solve P in D

Consider Application Processing

More on this in Enterprise Modeling
**Exercise**

**An Application Processing System**

**D**: include a functional model, a workflow model, an informational model, a BM

**P**: include complaints (both external and internal), weaknesses, etc.

**G**: include wants and needs countering **P** – both hard and soft

**R**: include an interaction model between **D** and **S**

**S**: include a functional model, an informational model, a behavioral model

---

Requirements should contain *nothing but* information about the environment.
Modeling is Everywhere

- Problem Elicitation
  - exploratory, brain-storming, open-ended thinking
  - elaboration of unclear goals and needs
  - identification of sources, views, needs & wants

- Wicked Problem
  - process of understanding real-world problems, how they relate to stakeholder needs, and proposing solutions to meet those needs.

- Problem Analysis
  - Detect Defects
  - Resolve Defects

  Intermediate representations

- Modeling is NOT Perfect
  - [adapted from Jackson, 1995, p124-5]
  - There will always be phenomena in the model that are not present in the application domain
  - There will always be phenomena in the application domain that are not in the model
  - Perfecting the model is not always a good use of your time

- Problem Specification
  - choose formal notations
  - create a formal model of the requirements
### Stakeholders in the Vision Document

**Stakeholder** - An individual who is materially affected by the outcome of the system or the project(s) producing the system.

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Registrar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Representative</td>
<td>Kelly Hansen</td>
</tr>
<tr>
<td>Description</td>
<td>User</td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td>The Registrar is typically a college-educated professional with full computer skills. The Registrar is trained and experienced with the use of the current batch-oriented registration.</td>
</tr>
<tr>
<td><strong>Responsibilities</strong></td>
<td>The Registrar is responsible for administering course registration for each school term. This includes supervising administrative and data entry personnel.</td>
</tr>
<tr>
<td><strong>Success Criteria</strong></td>
<td>The registrar’s primary responsibility will be maintaining student and professor databases, and opening/closing courses to registration. The registrar’s office will also be required to perform ....</td>
</tr>
<tr>
<td><strong>Involvement</strong></td>
<td>The registrar’s primary responsibility will be maintaining student and professor databases, and opening/closing courses to registration. The registrar’s office will also be required to perform.....</td>
</tr>
<tr>
<td><strong>Deliverables</strong></td>
<td>Management reviewer – especially related to functionality and usability of features required by the Registrar staff.</td>
</tr>
<tr>
<td><strong>Comments/Concerns</strong></td>
<td>None</td>
</tr>
</tbody>
</table>
Carving the Product Space

- **Needs**
  - An externally observable service by which the system directly fulfills one or more stakeholder requests.

- **Features**
  - Specifies, from a black-box perspective, how the solution interacts with the outside world.

- **Software Requirements**

- **Traceability**

- **Solution Space**
  - The system to be built

- **Problem Space**
  - Problem

- **Test Procedures**
- **Design**
- **User Doc**
Carving the Product Space

Requirements exist at many levels of abstraction, possibly with different terminology.

- **What**
  - Stakeholder *Needs*
  - Product or System *Features*
  - Software *Requirements*
  - Design Spec
  - Test Procedures
  - Documentation Plans

- **Why?**

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One Man’s Ceiling is Another Man’s Floor!