What are requirements?

- **Domain Properties:**
  - things in the application domain that are true whether or not we ever build the proposed system

- **Requirements:**
  - things in the application domain that we wish to be made true by delivering the proposed system
  - Many of which will involve phenomena the machine has no access to

- **A Specification:**
  - is a description of the behaviours that the program must have in order to meet the requirements
  - Can only be written in terms of shared phenomena!
Systems vs. Software Engineering

IN (Properties of the input device)

SOFT (properties of the software)

OUT (Properties of the output device)

REQ (the requirements - relationships between monitored and controlled variables that the system is required to establish or maintain)

NAT (natural relationships between monitored and controlled variables that are part of the domain)

Functional requirements
Functional requirements

• You have understood
  – *Why* the system will be built, and
  – For *Whom* it is useful.

  – *What* is going to be built and have broken the functionality down into functional requirements
Requirements Elicitation

• **Starting point**
  - Some notion that there is a “problem” that needs solving
    - e.g. dissatisfaction with the current state of affairs
    - e.g. a new business opportunity
    - e.g. a potential saving of cost, time, resource usage, etc.
  - A requirements analyst is an **agent of change**

• The requirements analyst must:
  - **identify the “problem”/“opportunity”**
    - Which problem needs to be solved? (identify problem **Boundaries**)
    - Where is the problem? (understand the **Context/Problem Domain**)
    - Whose problem is it? (identify **Stakeholders**)
    - Why does it need solving? (identify the stakeholders’ **Goals**)
    - How might a **software system help**? (collect some **Scenarios**)
    - When does it need solving? (identify **Development Constraints**)
    - What might prevent us solving it? (identify **Feasibility and Risk**)
  - and become an expert in the problem domain
    - although ignorance is important too -- “the intelligent ignoramus”

Difficulties of Elicitation

• **Thin spread of domain knowledge**
  - The knowledge might be distributed across many sources
    - It is rarely available in an explicit form (i.e. not written down)
  - There will be conflicts between knowledge from different sources
    - Remember the principle of complementarity!

• **Tacit knowledge (The “say-do” problem)**
  - People find it hard to describe knowledge they regularly use

• **Limited Observability**
  - The problem owners might be too busy coping with the current system
  - Presence of an observer may change the problem
    - E.g. Probe Effect; Hawthorne Effect

• **Bias**
  - People may not be free to tell you what you need to know
  - People may not want to tell you what you need to know
    - The outcome will affect them, so they may try to influence you (hidden agendas)
Example

- Loan approval department in a large bank
  - The analyst is trying to elicit the rules and procedures for approving a loan

- Why this might be difficult:
  - *Implicit knowledge:*
    - There is no document in which the rules for approving loans are written down
  - *Conflicting information:*
    - Different bank staff have different ideas about what the rules are
  - *Say-do problem:*
    - The loan approval process described to you by the loan approval officers is quite different from your observations of what they actually do
  - *Probe effect:*
    - The loan approval process used by the officers while you are observing is different from the one they normally use
  - *Bias:*
    - The loan approval officers fear that your job is to computerize their jobs out of existence, so they are deliberately emphasizing the need for case-by-case discretion (to convince you it has to be done by a human!)

Bias

- What is bias?
  - Bias only exists in relation to some reference point
    - can there ever be “no bias”?
  - All views of reality are filtered
  - All decision making is based partly on personal values.

- Types of bias:
  - *Motivational bias*
    - expert makes accommodations to please the interviewer or some other audience
  - *Observational bias*
    - Limitations on our ability to accurately observe the world
  - *Cognitive bias*
    - Mistakes in use of statistics, estimation, memory, etc.
  - *Notational bias*
    - Terms used to describe a problem may affect our understanding of it

<table>
<thead>
<tr>
<th>Examples of Bias</th>
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<td>Social pressure</td>
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<td>Group think</td>
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<td>Availability</td>
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<td>Underestimation</td>
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</tbody>
</table>

- Social pressure
  - response to verbal and non-verbal cues from interviewer
- Group think
  - response to reactions of other experts
- Impression management
  - response to imagined reactions of managers, clients,…
- Wishful thinking
  - response to hopes or possible gains.
- Appropriation
  - Selective interpretation to support current beliefs.
- Misrepresentation
  - expert cannot accurately fit a response into the requested response mode
- Anchoring
  - contradictory data ignored once initial solution is available
- Inconsistency
  - assumptions made earlier are forgotten
- Availability
  - some data are easier to recall than others
- Underestimation of uncertainty
  - tendency to underestimate by a factor of 2 or 3.
Elicitation Techniques

• **Traditional techniques**
  – Reading existing documents
  – Analyzing hard data
  – Interviews
    • Open-ended
    • Structured
  – Surveys / Questionnaires
  – Meetings

• **Collaborative techniques**
  – Focus Groups
    • Brainstorming
    • JAD/RAD workshops
  – Prototyping
  – Participatory Design

• **Contextual (social) approaches**
  – Ethnographic techniques
    • Participant Observation
    • Ethnomethodology
  – Discourse Analysis
    • Conversation Analysis
    • Speech Act Analysis
  – Sociotechnical Methods
    • Soft Systems Analysis

• **Cognitive techniques**
  – Task analysis
  – Protocol analysis
  – Knowledge Acquisition Techniques
    • Card Sorting
    • Laddering
    • Repertory Grids
    • Proximity Scaling Techniques

Background Reading

• **Sources of information:**
  – company reports, organization charts, policy manuals, job descriptions, reports, documentation of existing systems, etc.

• **Advantages:**
  – Helps the analyst to get an understanding of the organization before meeting the people who work there
  – Helps to prepare for other types of fact finding
    • e.g. by being aware of the business objectives of the organization.
    • may provide detailed requirements for the current system

• **Disadvantages:**
  – written documents often do not match up to reality
  – Can be long-winded with much irrelevant detail

• **Appropriate for**
  – Whenever you not familiar with the organization being investigated
“Hard Data” and Sampling

• Hard data includes facts and figures...
  – Forms, Invoices, financial information,…
  – Reports used for decision making,…
  – Survey results, marketing data,…

• Sampling
  – Sampling used to select representative set from a population
    • Purposive Sampling - choose the parts you think are relevant without worrying about statistical issues
    • Simple Random Sampling - choose every $k$th element
    • Stratified Random Sampling - identify strata and sample each
    • Clustered Random Sampling - choose a representative subpopulation and sample it
  – Sample Size is important
    • balance between cost of data collection/analysis and required significance

• Process:
  – Decide what data should be collected - e.g. banking transactions
  – Determine the population - e.g. all transactions at 5 branches over one week
  – Choose type of sample - e.g. simple random sampling
  – Choose sample size - e.g. every 20th transaction

Example of hard data

• Questions:
  – What does this data tell you?
  – What would you do with this data?
Interviews

• **Types:**
  – Structured - agenda of fairly open questions
  – Open-ended - no pre-set agenda

• **Advantages**
  – Rich collection of information
  – Good for uncovering opinions, feelings, goals, as well as hard facts
  – Can probe in depth, & adapt follow-up questions to what the person tells you

• **Disadvantages**
  – Large amount of qualitative data can be hard to analyze
  – Hard to compare different respondents
  – Interviewing is a difficult skill to master

Source: Adapted from Goguen and Linde, 1993, p154.

Interviewing Tips

• **Starting off…**
  – Begin the interview with an innocuous topic to set people at ease
    • e.g. the weather, the score in last night’s hockey game
    • e.g. comment on an object on the person’s desk: “My,… what a beautiful photograph! Did you take that?”

• **Ask if you can record the interview**
  – Make sure the tape recorder is visible
  – Say that they can turn it off at any time.

• **Ask easy questions first**
  – perhaps personal information
    • e.g. “How long have you worked in your present position?”

• **Follow up interesting leads**
  – e.g. if you hear something that indicates your plan of action may be wrong,
    • e.g., “Could we pursue what you just said a little further?”

• **Ask open-ended questions towards the end**
  • e.g. “Is there anything else you would like to add?”
Questionnaires

- **Advantages**
  - Can quickly collect info from large numbers of people
  - Can be administered remotely
  - Can collect attitudes, beliefs, characteristics

- **Disadvantages**
  - Simplistic (presupposed) categories provide very little context
    - No room for users to convey their real needs

- **Watch for:**
  - Bias in sample selection
  - Bias in self-selecting respondents
  - Small sample size (lack of statistical significance)
  - Open ended questions (very hard to analyze!)
  - Leading questions ("have you stopped beating your wife?")
  - Appropriation ("What is this a picture of?")
  - Ambiguous questions (I.e. not everyone is answering the same question)

*Source: Adapted from Goguen and Linde, 1993, p154.*

Meetings

- **Used for summarization and feedback**
  - E.g. meet with stakeholders towards the end of each stage:
    - to discuss the results of the information gathering stage
    - to conclude on a set of requirements
    - to agree on a design etc.
  - Use the meeting to confirm what has been learned, talk about findings

- **Meetings are an important managerial tool**
  - Used to move a project forward.
  - Every meeting should have a clear objective:
    - E.g. presentation, problem solving, conflict resolution, progress analysis, gathering and merging of facts, training, planning,...
  - Plan the meeting carefully:
    - Schedule the meeting and arrange for facilities
    - Prepare an agenda and distribute it well in advance
    - Keep track of time and agenda during the meeting
    - Follow up with a written summary to be distributed to meeting participants
    - Special rules apply for formal presentations, walkthroughs, brainstorming, etc.
Group Elicitation Techniques

- **Types:**
  - Focus Groups
  - Brainstorming

- **Advantages**
  - More natural interaction between people than formal interview
  - Can gauge reaction to stimulus materials (e.g. mock-ups, storyboards, etc)

- **Disadvantages**
  - May create unnatural groups (uncomfortable for participants)
  - Danger of Groupthink
  - May only provide superficial responses to technical questions
  - Requires a highly trained facilitator

- **Watch for**
  - sample bias
  - dominance and submission

Joint/Rapid Application Development

- **JAD & RAD Principles:**
  - Group Dynamics - use workshops instead of interviews
  - Visual Aids
    - Lots of visualization media, e.g. wall charts, large monitors, graphical interfaces
  - Organized, Rational Process
    - Techniques such as brainstorming and top-down analysis
  - WYSIWYG Documentation Approach
    - each JAD session results in a document which is easy to understand and is created and agreed upon during the session

- **Notes:**
  - Choose workshop participants carefully
    - they should be the best people possible representing various stakeholder groups
  - Workshop should last 3-5 days.
    - Must turn a group of participants into a team - this takes 1-2 days.
    - Session leader makes sure each step has been completed thoroughly.
    - Session leader steps in when there are differences of opinion - “open issues”.
    - Meeting room should be well-equipped for presentations, recording etc.
Participant Observation

- **Approach**
  - Observer spends time with the subjects
    - Joining in long enough to become a member of the group
    - Hence appropriate for longitudinal studies

- **Advantages**
  - Contextualized;
  - Reveals details that other methods cannot

- **Disadvantages**
  - Extremely time consuming!
  - Resulting ‘rich picture’ is hard to analyze
  - Cannot say much about the results of proposed changes

- **Watch for**
  - going native!

### Suitability of the Techniques for Sub-activities

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<tr>
<th>Technique</th>
<th>Effort</th>
<th>Identifying requirements sources</th>
<th>Eliciting existing requirements</th>
<th>Developing new and innovating requirements</th>
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<td>Interview</td>
<td>Medium to high</td>
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<td>x</td>
<td>x</td>
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<td>Workshop</td>
<td>High to very high</td>
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<td>x</td>
<td>x</td>
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<tr>
<td>Focus groups</td>
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<td>x</td>
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<td>x</td>
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<tr>
<td>Observation</td>
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<tr>
<td>Questionnaire</td>
<td>Low to medium</td>
<td>x</td>
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<tr>
<td>Perspective-based reading</td>
<td>Medium to high</td>
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</table>
Combine Different Techniques

Elicitation technique Selection: How do experts do it

- Collaborative Sessions
  - Such as joint application development, brainstorming, group sessions
- Interviewing
- Team-building
- Ethnography
- Issue list
- Models
- Questionnaire

- Data gathering from existing systems
- Requirements categorization
- Conflict awareness and resolution
- Prototyping
- Role playing
- Formal methods
- Extreme programming