

University of Toronto Department of Computer Science

## Lecture 4: Requirements Elicitation

**Last Week:**  
 Initiating an RE process:  
 Stakeholders and Boundaries  
 Goals and Scenarios  
 Feasibility and Risk

**This Week:**  
 Elicitation Techniques  
 Interviews, Questionnaires, etc.  
 Cognitive approaches  
 Contextual approaches  
 Ethnography as an RE technique

**Next Week:**  
 Modeling and Analysis (I)  
 Intro to RE Modeling  
 Modeling Organisations  
 Modeling soft systems

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## Elicitation Techniques

→ **Traditional techniques**

- ☞ Introspection
- ☞ Reading existing documents
- ☞ Analyzing hard data
- ☞ Interviews
  - > Open-ended
  - > Structured
- ☞ Surveys / Questionnaires
- ☞ Meetings

→ **Collaborative techniques**

- ☞ Group techniques
  - > Focus Groups
  - > Brainstorming
- ☞ JAD/RAD workshops
- ☞ Prototyping
- ☞ Participatory Design

→ **Cognitive techniques**

- ☞ Task analysis
- ☞ Protocol analysis
- ☞ Knowledge Acquisition Techniques
  - > Card Sorting
  - > Laddering
  - > Repertory Grids
  - > Proximity Scaling Techniques

→ **Contextual approaches**

- ☞ Ethnographic techniques
  - > Participant Observation
  - > Ethnomethodology
- ☞ Discourse Analysis
  - > Conversation Analysis
  - > Speech Act Analysis
- ☞ Sociotechnical Methods
  - > Soft Systems Analysis

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## 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 tell you the 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**

- ☞ projects where analyst is not familiar with the organization being investigated.

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## "Hard Data" Collection

→ **Identify Collections of Hard Data**

- ☞ Facts and figures, 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 kth 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 to be sampled - e.g. all transactions at 5 local branches over one week
  - > Choose type of sample - e.g. simple random sampling
  - > Choose sample size - e.g. every 10th transaction

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## Example of hard data

→ Questions:

- ↳ What does this data tell you?
- ↳ What would you do with this data?

**Agate**  
Campaign Summary

**Date** 23rd February 1999

**Client** Yellow Partridge  
Park Road Workshops  
Park Road  
Jewellery Quarter  
Birmingham B2 3DT  
U.K.

**Campaign** Spring Collection 1999

**Billing Currency** GB £

Item	Curr	Amount	Rate	Billing amount
Advert preparation: photography, artwork, layout etc.	GB £	15,000.00	1	15,000.00
Placement French Vogue	FFr.	47 000,00	11.35	4,140.97
Placement UK Vogue	GB £	5,000.00	1	5,000.00
Placement US Vogue	US \$	15,000.00	2.47	6,072.87
<b>Total</b>				<b>30,213.84</b>

This is not a VAT Invoice. A detailed VAT Invoice will be provided separately.

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## 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 followup 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

→ Watch for

- ↳ Unanswerable questions ("how do you tie your shoelaces?")
- ↳ Tacit knowledge (and post-hoc rationalizations)
- ↳ Removal from context
- ↳ Interviewer's attitude may cause bias (e.g. variable attentiveness)

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## 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

- ↳ but put tape recorder in front of person
- ↳ say that they can turn it off 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. watch for things people say that indicate that your plan of action may be wrong,
  - > e.g., "Could we pursue what you just said a little further?"

→ Ask open-ended questions last

- > e.g. "Is there anything else you would like to add?"

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## 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)

**Questionnaires MUST be prototyped and tested!**

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## 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 system development project forward.
- ↳ Need to determine objectives for the meeting:
  - > 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
  - > The meeting itself may be structured or unstructured depending on objective;
  - > 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 (and how to prepare them), project walkthroughs, brainstorming,...

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## 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

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## Joint/Rapid Application Development

→ **JAD & RAD Principles:**

- ↳ **Group Dynamics**
  - > one-to-one or group interview formats replaced with workshops
- ↳ **Visual Aids**
  - > Use lots of visualization media, ranging from wall charts to large monitors or graphical interfaces
- ↳ **Organized, Rational Process**
  - > Using techniques such as brainstorming and top-down analysis to structure the elicitation and analysis process
- ↳ **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

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## Knowledge Elicitation Techniques in RE

→ **Background**

- ↳ Knowledge elicitation is concerned with discovering 'expert' knowledge
- ↳ Grew out of Expert Systems work in the 80's
- ↳ Originally focussed on deriving expert's "rules" for Rule-based Systems
- ↳ More recently, focussed on "problem solving methods"

→ **But KE is hard**

- ↳ Separation of domain knowledge from performance knowledge
- ↳ Modeling problems
  - > Brittleness
  - > Assumption of rationality
- ↳ Representational Problem
  - > epistemological inadequacy
  - > expressiveness vs. acquirability
- ↳ Expert Bias

**Example Techniques**

- ↳ Eliciting domain knowledge
  - > Card Sorting
  - > Laddering
  - > Proximity Scaling Techniques
- ↳ Eliciting performance knowledge
  - > Protocol Analysis
- ↳ Using Multiple Experts
  - > Delphi Technique
  - > Focus Groups
  - > Repertory Grids
- ↳ Automated Techniques
  - > Machine Learning

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## The Knowledge Level

→ View knowledge modelling as:

- ↳ Observe behaviour of an agent as black box
  - It acts as if it has some knowledge about its environment which it uses rationally
  - It takes actions to achieve ascribed goals
- ↳ Construct two models:
  - Symbol Level - descriptions for mechanising behaviour
  - Knowledge Level - descriptions of the agent's knowledge of the world

→ Two-step rationality:

- ↳ Agent applies its knowledge in two stages:
  - First creates a task specific model from the KL model based on features of the task.
- ↳ Hence, we actually need 3 models:
  - Domain model - a systematic way of talking about a domain, with a coherent ontology.
  - Task model - models goals, what it means to achieve a goal, and how goals are related.
  - Problem-solving method - a way of relating task and domain models to accomplish goals.

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## Knowledge Elicitation Techniques

→ Protocol Analysis

- ↳ based on vocalising behaviour
  - Think aloud vs. retrospective protocols
- ↳ Advantages
  - Direct verbalisation of cognitive activities
  - Embedded in the work context
  - Good at revealing interaction problems with existing systems
- ↳ Disadvantages
  - Essentially based on introspection, hence unreliable
  - No social dimension

→ Proximity Scaling Techniques

- ↳ Given some domain objects, derive a set of dimensions for classifying them:
  - step 1: pairwise proximity assessment among domain elements
  - step 2: automated analysis to build multi-dimensional space to classify the objects
- ↳ Advantages
  - help to elicit mental models, where complex multivariate data is concerned
  - good for eliciting tacit knowledge
- ↳ Disadvantages
  - Requires an agreed on set of objects
  - Only models classification knowledge (no performance knowledge)

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## more KE techniques

→ Card Sorting

- ↳ For a given set of domain objects, written on cards:
  - Expert sorts the cards into groups...
  - ...then says what the criterion was for sorting, and what the groups were.
- ↳ Advantages
  - simple, amenable to automation
  - elicits classification knowledge
- ↳ Problems
  - suitable entities need to be identified with suitable semantic spread across domain.
  - No performance knowledge

→ Laddering

- ↳ Uses a set of probes (types of question) to acquire structure and content of stakeholders' knowledge.
  - Interview the expert.
  - Use questions to move up and down a conceptual hierarchy
- ↳ Advantages
  - deals with hierarchical knowledge, including poly-hierarchies (e.g., goal trees, "is-a" taxonomies).
  - knowledge is represented in standardised format
  - can elicit structural knowledge
  - suitable for automation.
- ↳ Disadvantages
  - assumes hierarchically arranged knowledge.

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## KA from Multiple Experts

→ Delphi technique

- ↳ Used where contact between experts is difficult:
  - Each expert submits their judgement
  - All judgements are circulated anonymously to all experts
  - Each expert then submits a revised judgement
  - Iterate until judgements converge

→ Focus Groups

- ↳ A technique derived from marketing:
  - Assemble experts together and discuss the problem
  - Discussion may be structured (e.g. debate) or unstructured

→ Repertory Grids (based on Kelly's Personal Construct Theory)

- ↳ Used to detect terminological differences
  - Get the experts to agree a set of entities
  - Each expert provides attributes and values
  - For each attribute in expert A's grid, find the closest match in expert B's grid. (i.e. are there attributes which have the same discriminatory function?)
  - Experts then rate the entities using each other's attributes

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## Abstractionism vs. Contextualism

→ **Abstractionism**

- ↳ Builds models abstracted from a domain; the model is used to answer questions
  - (1) Decide on the ontology of the phenomena we wish to describe
  - (2) Use this ontology to represent the domain of discourse
- ↳ Assumes knowledge and understanding are independent from context
- ↳ Used by natural scientists and engineers.
  - > ...although many scientists don't realize that step 1 involves choice
  - > logical positivism vs. theory-driven observation

→ **Contextualism**

- ↳ Emphasizes the details and idiosyncrasies of the domain
  - (1) Collect naturalistic data from the domain of study (Rich descriptions)
  - (2) Use the data to support explanations (but don't build abstract models)
- ↳ Assumes it is impossible to build models that have meaning when removed from their context
- ↳ Used by many social scientists
  - > but generally limits them to the descriptive rather than predictive/prescriptive

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## Participant Observation

→ **Approach**

- ↳ longitudinal studies:
  - > Observer spends time with the subjects, joining in, long enough to become a member of the group

→ **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!

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## Ethnomethodology

→ **Basis**

- ↳ Social world is ordered
  - > The social order may not be obvious, nor describable from common sense
- ↳ The social order cannot be assumed to have an a priori structure
  - > Social order is accomplished on a moment-to-moment basis through participants' collective actions (rather than through any pre-existing structures)
  - > i.e. social order only observable when an observer immerses herself in it.
- ↳ Observation should be done in a natural setting
- ↳ Need to consider how meanings develop and evolve within context

→ **"Use the members' own Categories"**

- ↳ Most conventional approaches assume preexisting categories
  - > This may mislead the observer (e.g. appropriation)
- ↳ Ethnomethodology attempts to use the subjects' own categories
  - > What categories (concepts) do they use themselves to order the social world?
- ↳ What methods do people use to make sense of the world around them?
  - > During observation, use the same methods members use, eg by developing a legitimate role within the community under observation.

→ **Measurement**

- ↳ No scientific objectivity, so use the subjects' own measurement theory

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## Ethnomethodological approach

→ **Ethnomethodology is a subarea of Anthropology**

- ↳ Looks for behaviours that may be different in a specific culture but which have the same underlying purpose or meaning.
  - > E.g. how do people go about gaining status in different cultures:
  - > Frenchmen brag about sexual conquests to gain status;
  - > Americans brag about money to gain status.
  - > Each of these topics is taboo in the other culture

→ **Uses a very tightly controlled set of methods:**

- > Conversational analysis
- > Measurement of body system functions - e.g. heartbeat
- > Studies of Non-verbal behaviour (e.g. gestures, body language)
- > Detailed video analysis
- ↳ These techniques are useful in capturing information about a social setting.

→ **Other observation techniques can be applied:**

- ↳ Time-motion study
  - > who is where, when?
- ↳ Communication audit
  - > who talks to whom about what?
- ↳ Use of tools - status symbols plus sharing rules

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## Postscript: Postmodernism

### → Modernism

- ↳ **Rationality is the highest form of mental functioning**
- ↳ **Modern science produces universal truths**
  - > ...independent from the context and status of the scientist who produced them
- ↳ **Rationality will always lead to progress and perfection**
  - > All human institutions can be scientifically analyzed and improved
- ↳ **Reason is the ultimate judge of what is right (true, legal, ethical,...)**
- ↳ **Language must be rational**
  - > it only exists to represent the real world;
  - > there must be a firm, objective connection between the "signifier" and the "signified"
  - > the meaning cannot depend on the audience

### → Postmodernism (PoMo)

- ↳ **Questioning the grand narrative**
  - > A grand narrative is a story that a culture/society tells itself about its practices and beliefs
  - > E.g. in the US: "democracy is the most enlightened/rational form of government"
  - > E.g. in science: "scientific truths are universal and eternal"
  - > Postmodernism identifies and critiques such narratives
- ↳ **Instead, look for mini-narratives**
  - > Stories that explain small practices, local events, situated, contingent behaviour
  - > ...and don't make any claims about universality, truth, or stability
- ↳ **E.g. Literary Deconstruction**
  - > Examine what a text does not say, what it represses
  - > Reveal internal arbitrary hierarchies and dichotomies
- ↳ **E.g. Semiotics**
  - > The study of the relationship between signs and the things they signify



## What has PoMo got to do with RE?

### → logical positivist view:

- > "there is an objective world that can be modeled by building a consistent body of knowledge grounded in empirical observation"
- ↳ **In RE: "there is an objective problem that exists in the world"**
  - > Build a consistent model; make sufficient empirical observations to check validity
  - > Use tools that test consistency and completeness of the model
  - > Use reviews, prototyping, etc to demonstrate the model is "valid"

### → Popper's modification to logical positivism:

- > "theories can't be proven correct, they can only be refuted by finding exceptions"
- ↳ **In RE: "requirements models must be refutable"**
  - > Look for evidence that the model is wrong
  - > E.g. collect scenarios and check the model supports them

### → post-modern view:

- > "there is no privileged viewpoint; all observation is value-laden; scientific investigation is culturally embedded"
- ↳ **In RE: "validation is always subjective and contextualised"**
  - > Use stakeholder involvement so that they 'own' the requirements models
  - > Use ethnographic techniques to understand the participant's worldviews