
# Domain Understanding & Requirements Elicitation

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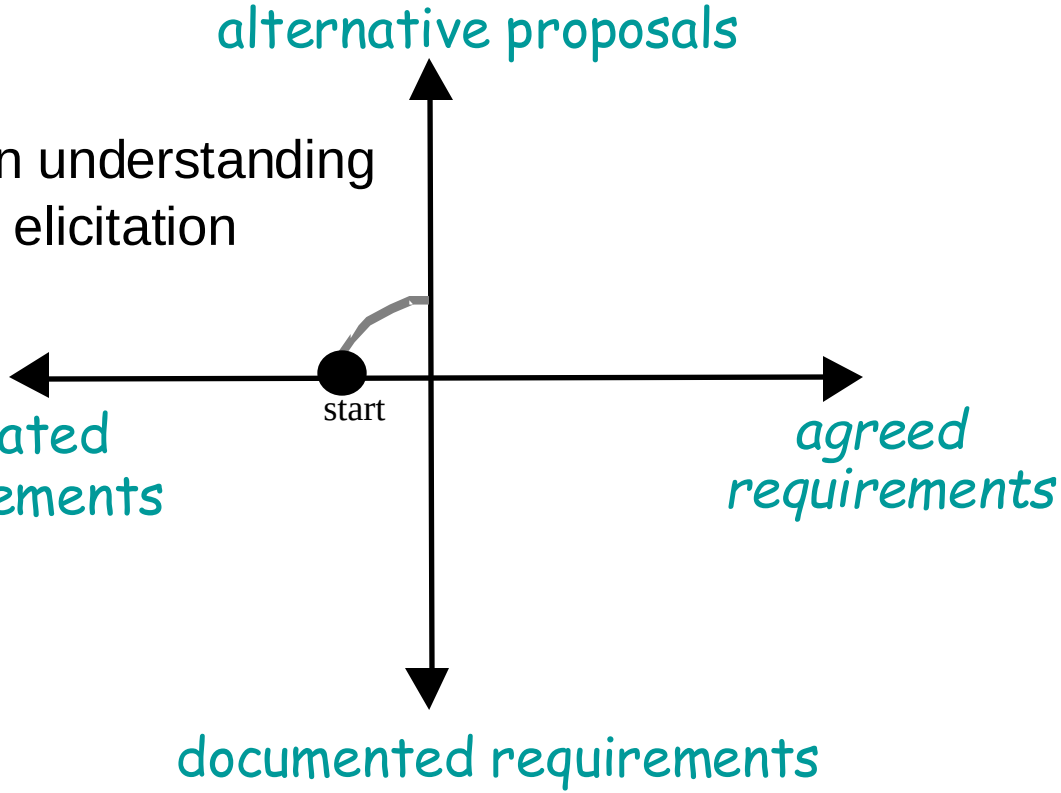
# RE products and processes

domain understanding
& elicitation



# Knowledge acquisition

- Studying the system-**as-is:**

  - Business organization: structure, dependencies, strategic objectives, policies, workflows, operational procedures, ...
  - Application domain: concepts, objectives, tasks, constraints, regulations, ...
  - Analysis of problems with system-as-is: symptoms, causes, consequences
- Analyzing technology opportunities, new market conditions
- Identifying the system **stakeholders**
- Identifying improvement **objectives**; organizational & technical **constraints** on system-to-be; **alternative options** for satisfying objectives, for assigning responsibilities; **scenarios** of hypothetical software-environment interaction; **requirements** on software, **assumptions** on environment

# Outline

- Identifying stakeholders & interacting with them
- **Artefact-driven** elicitation techniques
  - Background study
  - Data collection, questionnaires
  - Repertory grids, card sorts for concept acquisition
  - Scenarios, storyboards for problem world exploration
  - Prototypes, mock-ups for early feedback
  - Knowledge reuse: domain-independent, domain-specific
- **Stakeholder-driven** elicitation techniques
  - Interviews
  - Observation and ethnographic studies
  - Group sessions

# Stakeholder analysis

- Stakeholder cooperation is essential for successful RE
  - Elicitation = cooperative learning
- Representative sample must be selected to ensure adequate, comprehensive coverage of the problem world
  - dynamic selection as new knowledge is acquired
- Selection based on:
  - relevant position in the organization
  - role in making decisions, reaching agreement
  - type of contributed knowledge, level of domain expertise
  - exposure to perceived problems
  - personal interests, potential conflicts
  - influence in system acceptance

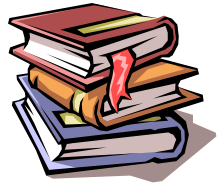
# Knowledge acquisition from stakeholders is difficult

- Distributed sources, conflicting viewpoints
- Difficult access to key people & data
- Different background, terminology, culture
- Tacit knowledge, hidden needs
- Irrelevant details
- Internal politics, competition, resistance to change, …
- Personnel turnover, changes in organization, in priorities, …

**Needed**:

- Communication skills: for talking to, listening from diverse people
- Trust relationship
- Knowledge reformulation & restructuring (review meetings)

# Background study



- Collect, read, synthesize documents about:
  - the **organization**: organizational charts, business plans, financial reports, meeting minutes, etc
  - the **domain**: books, surveys, articles, regulations, reports on similar systems in the same domain
  - the **system-as-is**: documented workflows, procedures, business rules; exchanged documents; defect/complaint reports, change requests, etc.
- Provides basics for getting prepared before meeting stakeholders → prerequisite to other techniques
- Data mining problem: huge documentation, irrelevant details, outdated info
- Solution: use meta-knowledge to prune the doc space
  - know what you need to know & what you don't need to know

# Data collection

- Gather undocumented facts & figures
  - marketing data, usage statistics, performance figures, costs, ...
  - by designed experiments *or* selection of representative data sets from available sources (use of statistical sampling techniques)
- May complement background study
- Helpful for eliciting non-functional reqs on performance, usability, cost etc.
- Difficulties:
  - Getting reliable data may take time
  - Data must be correctly interpreted

# Questionnaires

- Submit a list of questions to selected stakeholders, each with a list of possible answers (+ brief context if needed)
  - **Multiple choice** question: one answer to be selected from answer list
  - **Weighting** question: list of statements to be weighted...
    - qualitatively ('high', 'low", ...), or
    - quantitatively (percentages)
    - to express perceived importance, preference, risk etc.
- Effective for acquiring subjective info quickly, cheaply, remotely from many people
- Helpful for preparing better focused interviews

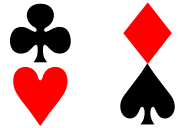
# Questionnaires should be carefully prepared

- Subject to ...
  - multiple **biases**: recipients, respondents, questions, answers
  - unreliable info: misinterpretation of questions, of answers, inconsistent answers, ....

→ Guidelines for questionnaire design/validation:

- Select a representative, statistically significant sample of people; provide motivation for responding
- Check coverage of questions, of possible answers
- Make sure questions, answers, formulations are unbiased & unambiguous
- Add implicitly redundant questions to detect inconsistent answers
- Have your questionnaire checked by a third party

# Card sorts & repertory grids



- **Goal**: acquire further info about concepts already elicited
- **Card sort**: ask stakeholders to partition a set of cards:
  - Each card captures a concept textually or graphically
  - Cards grouped into subsets based on stakeholder's criteria
  - For each subset, ask:
    - implicit shared property used for grouping
    - descriptive, prescriptive
  - Iterate with same cards for new groupings/properties

- Example: meeting scheduling system
  - Iteration 1: "Meeting", "Participant" grouped together
    → "participants shall be *invited to* the meeting"
  - Iteration 2: "Meeting", "Participant" grouped together
    → "participant *constraints* for the meeting must be *known*"

# Card sorts & repertory grids


- **Repertory grid**: ask stakeholders to characterize target concept through attributes and value ranges

  → concept-attribute grid

  e.g. (Date, *Mon-Fri*), (Location, *Europe*)

  for grid characterizing Meeting concept

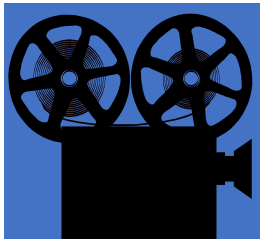
- **Conceptual laddering**: ask stakeholders to classify target concepts along class-subclass links

  e.g. subclasses RegularMeeting, OccasionalMeeting of Meeting

☺ Simple, cheap, easy-to-use techniques for prompt elicitation of missing info

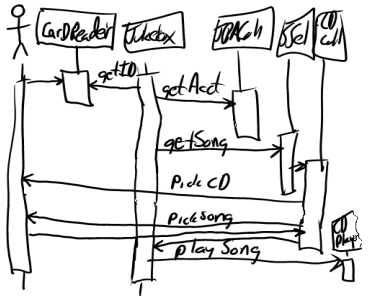
☹ Results may be subjective, irrelevant, inaccurate

# Scenarios & storyboards



- **Goal**: acquire or validate info from concrete examples through narratives:
  - how things are running in the system-*as-is*
  - how things should be running in the system-*to-be*
- **Storyboard**: tells a story by a sequence of snapshots
  - Snapshot = sentence, sketch, slide, picture, etc.
  - Possibly structured with annotations:
    - WHO are the players, WHAT happens to them, WHY this happens, WHAT IF this does / does *not* happen, etc
  - **Passive** mode (for validation): stakeholders are told the story
  - **Active** mode (for joint exploration): stakeholders contribute

# Scenarios




- Illustrate typical sequences of interaction among system components to meet an implicit objective
- Widely used for:
  - **explanation** of system-*as-is*
  - **exploration** of system-*to-be* + elicitation of further info

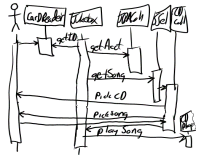
    e.g. WHY this interaction sequence ?

    WHY among these components ?
  - specification of acceptance test cases
- Represented by text or diagram

# Scenario example: meeting scheduling

1. The **initiator** *asks* the **scheduler** for planning a meeting within some date range. The request includes a list of desired participants.
2. The **scheduler** checks that the initiator is entitled to do so and that the request is valid. It *confirms* to the **initiator** that the requested meeting is initiated.
3. The **scheduler** *asks* all **participants** in the submitted list to send their date and location constraints back within the prescribed date range.
4. When a **participant** *returns* her constraints, the **scheduler** validates them (e.g., with respect to the prescribed date range). **It** *confirms* to the **participant** that the constraints have been safely received.
5. Once all valid constraints are *received*, the **scheduler** determines a meeting date and location that fit them.
6. The **scheduler** *notifies* the scheduled meeting date and location to the **initiator** and to all invited **participants**

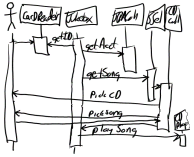
# Types of scenario



- **Positive** scenario = one behavior the system should cover (example)
- **Negative** scenario = one behavior the system should exclude (counter-example), e.g.
  1. A participant returns a list of constraints covering all dates within the given date range
  2. The scheduler forwards this message to all participants asking them for alternative constraints within extended date range
- **Normal** scenario: everything proceeds as expected
- **Abnormal** scenario = a desired interaction sequence in exception situation (still positive)

  e.g. meeting initiator not authorized
  participant constraints not valid

# Scenarios: pros & cons



- ☺ Concrete examples/counter-examples
- ☺ Narrative style (appealing to stakeholders)
- ☺ Yield animation sequences, acceptance test cases
- ☹ Inherently partial (cf. test coverage problem)
- ☹ Combinatorial explosion (cf. program traces)
- ☹ Potential overspecification: unnecessary sequencing, premature software-environment boundary
- ☹ May contain irrelevant details, incompatible granularities from different stakeholders
- ☹ Keep requirements implicit

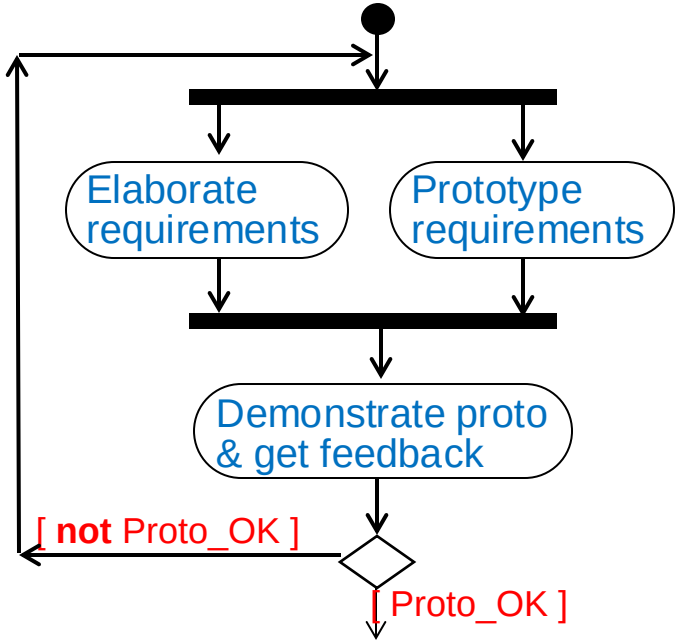
*Concrete scenarios naturally jump in anyway...*
*invaluable as initial elicitation vehicles*

# Prototypes & mock-ups

- **Goal**: check req adequacy from direct user feedback, by showing reduced sketch of software-to-be in action
  - focus on unclear, hard-to-formulate reqs to elicit further
- **Prototype** = quick implementation of some aspects ...
  - **Functional** proto: focus on specific functional reqs
    - e.g. initiating meeting, gathering participant constraints
  - **User interface** proto: focus on usability by showing input-output forms, dialog patterns
    - e.g. static/dynamic interaction to get participant constraints
- Quick implementation: by use of very high-level programming language, executable spec language, generic services, ...


# Requirements prototyping

- **Mock-up**: proto is thrown away (product = adequate reqs)
- **Evolutionary proto**: transformed towards efficient code



# Prototypes & mock-ups: pros & cons

☺ Concrete flavor of what the software will look like
→ clarify reqs, elicit hidden ones, improve adequacy, understand implications, ...

☺ Other uses: user training, stub for integration testing, ...

☹ Does not cover all aspects
- missing functionalities
- ignores important non-functional reqs (performance, cost, ...)

☹ Can be misleading, set expectations too high

☹ 'Quick-and-dirty' code, hard to reuse for sw development

☹ Potential inconsistencies between modified code and documented reqs

# Knowledge reuse

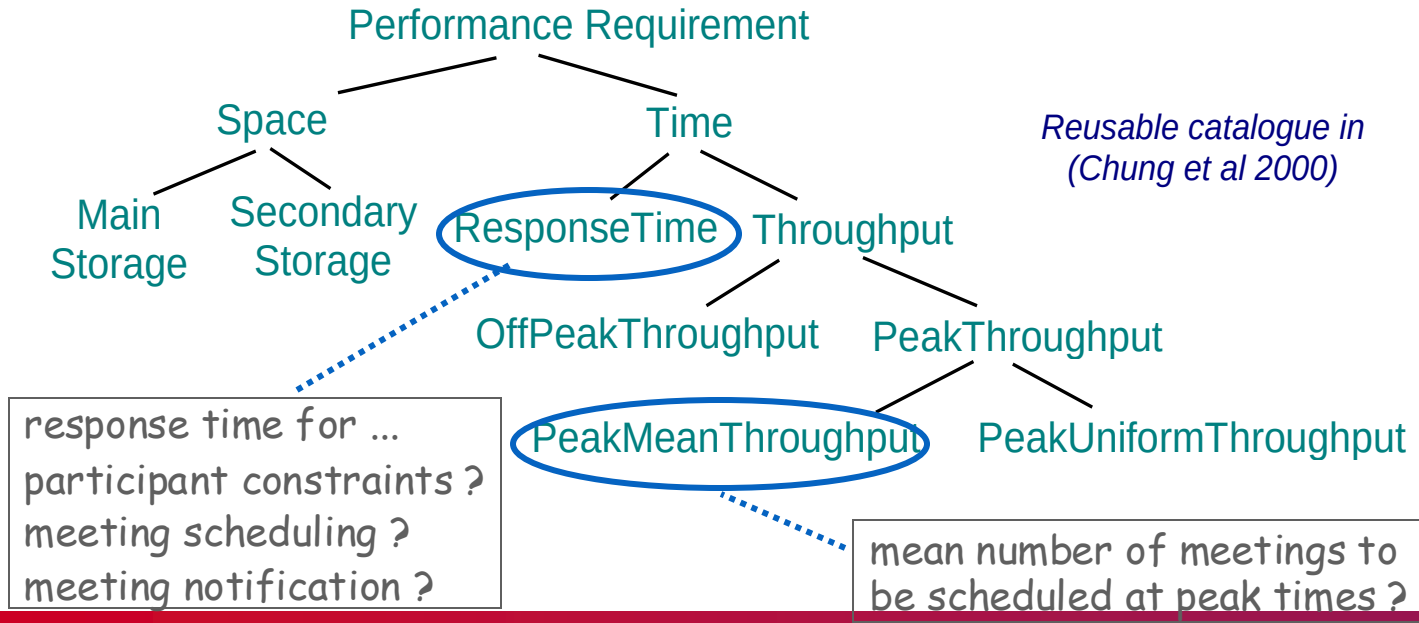
- **Goal**: speed up elicitation by reuse of knowledge from experience with related systems
  - knowledge about similar organization, domain, problem world: requirements, assumptions, dom props, …
- General reuse process:
  1. **RETRIEVE** relevant knowledge from other systems
  2. **TRANSPOSE** it to the target system
  3. **VALIDATE** the result, **ADAPT** it if necessary & **INTEGRATE** it with the system knowledge already acquired
- Transposition mechanisms:
  - **instantiation** (memberOf)
  - **specialization** (subClassOf) + feature inheritance
  - **reformulation** in vocabulary of target system

# Reuse of domain-independent knowledge: requirements taxonomies

- For each leaf node in available req taxonomies:

  *"Is there any system-specific req instance from this class?"*

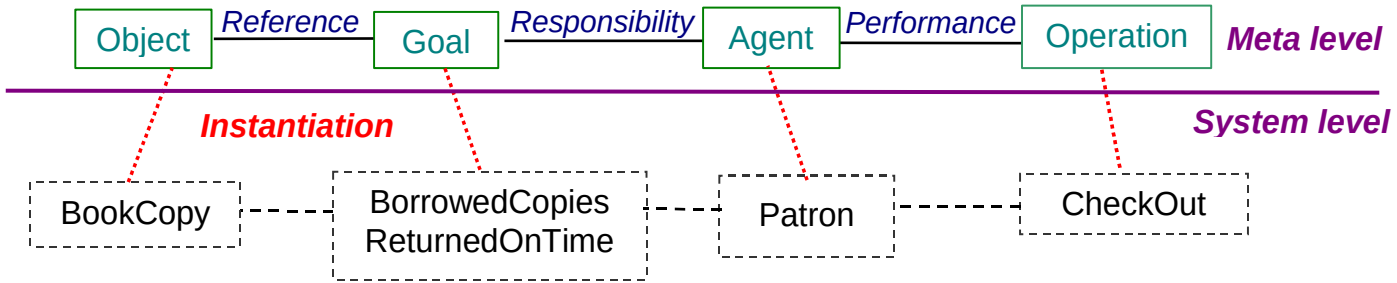
- More specific taxonomy → more focused search




*Reusable catalogue in (Chung et al 2000)*

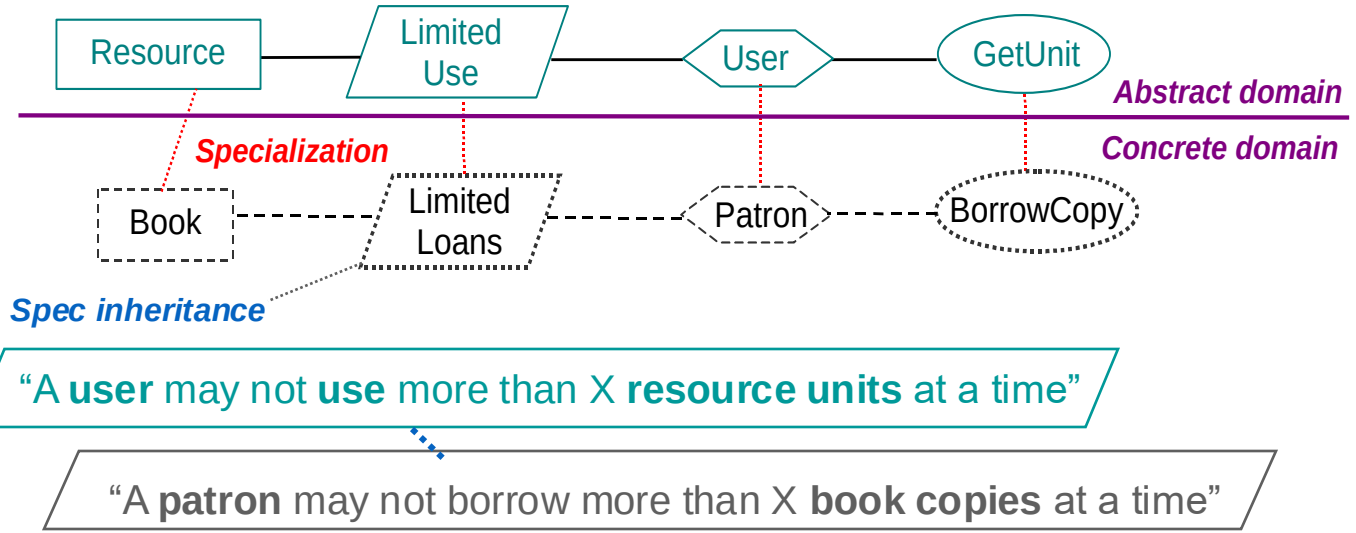
# Reuse of domain-independent knowledge: meta-model

- **RD meta-model** = concepts & relationships in terms of which RD items are captured
- Elicitation by meta-model traversal
- RD items are acquired as **instantiations** of meta-model items



# Reuse of domain-specific knowledge

- **Abstract domain** = concepts, tasks, actors, objectives, reqs, dom props abstracting from a class of domains
- RD items acquired as **specializations** of abstract items to target system (feature inheritance + system-specific renaming)



# Reuse of domain-specific knowledge

- Same abstract domain may have multiple specializations

  e.g. resource management <-- library loan management,
  videostore management, flight or concert seat allocation, ...

- Same concrete domain may specialize multiple abstract domains

  e.g. library management:
  loan management --> resource management
  book acquisition --> e-shopping
  patron registration --> group membership management

- More adequate RD items elicited by reuse of more structured, more accurate abstract domains

  e.g. resource management: returnable *vs.* consumable resource
  sharable *vs.* non-sharable resource
  => "A book copy can be borrowed by one patron at a time"
  (dom prop for non-sharable, returnable resource)

# Knowledge reuse: pros & cons

☺ Expert analysts naturally reuse from past experience

☺ Significant guidance and reduction of elicitation efforts

☺ Inheritance of structure & quality of abstract domain spec

☺ Effective for **completing** RD with overlooked aspects

☹ Effective only if abstract domain sufficiently “close”, accurate

☹ Defining abstract domains for significant reusability is hard

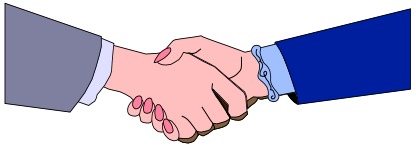
☹ Validation & integration efforts

☹ Near-matches may require tricky adaptations

# Outline

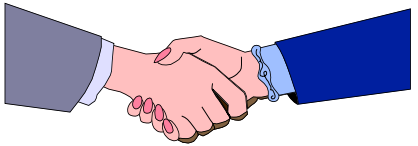
- Identifying stakeholders & interacting with them
- Artefact-driven elicitation techniques
  - Background study
  - Data collection, questionnaires
  - Repertory grids, card sorts for concept acquisition
  - Scenarios, storyboards for problem world exploration
  - Prototypes, mock-ups for early feedback
  - Knowledge reuse: domain-independent, domain-specific
- **Stakeholder-driven elicitation techniques**
  - **Interviews**
  - Observation and ethnographic studies
  - Group sessions

# Interviews



- Primary technique for knowledge elicitation
  1. Select stakeholder specifically for info to be acquired
     (domain expert, manager, salesperson, end-user, consultant, …)
  2. Organize meeting with interviewee, ask questions, record answers
  3. Write report from interview transcripts
  4. Submit report to interviewee for validation & refinement
- Single interview may involve multiple stakeholders
  - ☺ saves times
  - ☹ weaker contact; individuals less involved, speak less freely
- Interview **effectiveness**:
  (*utility* x *coverage* of acquired info) / acquisition *time*

# Types of interview



- **Structured** interview: predetermined set of questions
  - specific to purpose of interview
  - some open-ended, others with pre-determined answer set

  → more focused discussion, no rambling among topics

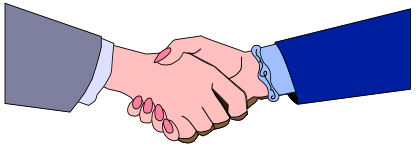
- **Unstructured** interview: no predetermined set of questions
  - free discussion about system-as-is, perceived problems, proposed solutions

  → exploration of possibly overlooked issues

→Effective interviews should mix both modes ...

  - start with structured parts
  - shift to unstructured parts as felt necessary

# Strengths & difficulties



☺ May reveal info not acquired through other techniques
- how things are running *really*, personal complaints, suggestions for improvement, ...

☺ On-the-fly acquisition of info appearing relevant
- new questions triggered from previous answers

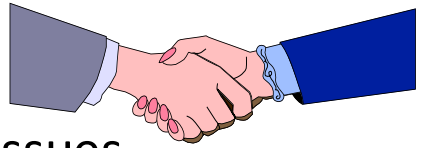
☹ Acquired info might be subjective (hard to assess)

☹ Potential inconsistencies between different interviewees

☹ Effectiveness critically relies on interviewer's attitude, appropriateness of questions

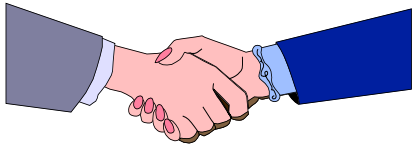
→*Interviewing guidelines*

# Guidelines for effective interviews



- Identify the right interviewee sample for full coverage of issues
  - different responsibilities, expertise, tasks, exposure to problems
- Come prepared, to focus on right issue at right time
  - background study first
  - predesign a sequence of questions for **this** interviewee
- Centre the interview on the interviewee's work & concerns
- Keep control over the interview
- Make the interviewee feel comfortable
  - *Start:* break ice, provide motivation, ask easy questions
  - Consider the person too, not only the role
  - Do always appear as a trustworthy partner

# Guidelines for effective interviews



- Be focused, keep open-ended questions for the end
- Be open-minded, flexible in case of unexpected answers
- Ask *why*-questions without being offending
- Avoid certain types of questions:
  - opiniated or biased
  - affirmative
  - obvious or impossible answer for this interviewee
- Edit & structure interview transcripts while still fresh in mind
  - including personal reactions, attitudes, etc
- Keep interviewee in the loop
  - co-review interview transcript for validation & refinement

# Observation & ethnographic studies

- Focus on **task** elicitation in the system-as-is
- Understanding a task is often easier by observing people performing it (rather than verbal or textual explanation)
  - cf. tying shoelaces
- **Passive** observation: no interference with task performers
  - Watch from outside, record (notes, video), edit transcripts, interpret
  - **Protocol analysis**: task performers concurrently explain it
  - **Ethnographic studies**: over long periods of time, try to discover emergent properties of social group involved
    - about task performance + attitudes, reactions, gestures, …
- **Active** observation: you get involved in the task, even become a team member

# Pros & cons

☺ May reveal

- **tacit knowledge** that would not emerge otherwise

  e.g. ethnographic study of air traffic control → implicit mental model of air traffic to be preserved in system-to-be
- hidden problems through tricky ways of doing things
- culture-specific aspects to be taken into account

☺ Contextualization of acquired info

☹ Slow & expensive: to be done over long periods of time, at different times, under different workload conditions

☹ Potentially inaccurate (people behave differently when observed)

☹ Data mining problem, interpretation problem

☹ Focus on system-*as-is*

*Some of the interviewing guidelines are relevant*

# Group sessions

- More perception, judgement, invention from interactions within group of diverse people
- Elicitation takes place in series of group workshops (a few days each) + follow-up actions

  audiovisuals, wall charts to foster discussion, record outcome

- **Structured** group sessions:
  - Each participant has a clearly defined role
    (leader, moderator, manager, user, developer, …)
  - Contributes to req elaboration according to his/her role, towards reaching synergies
  - Generally focused on high-level reqs
  - Variants: focus groups, JAD, QFD, …

# Group sessions

- **Unstructured** group sessions (brainstorming):
  - Participants have a less clearly defined role
  - Two separate stages:
    1. **Idea generation** to address a problem:
       - as many ideas as possible
       - from each participant
       - without censorship/criticism
    2. **Idea evaluation**:
       - by all participants together
       - according to agreed criteria (e.g. value, cost, feasibility)
       - to prioritize ideas

# Group sessions: pros & cons

☺ Less formal interactions than interviews
→ may reveal hidden aspects of the system (as-is or to-be)

☺ Potentially
- wider exploration of issues & ideas
- more inventive ways of addressing problems

☺ Synergies → agreed conflict resolutions

☹ Group composition is critical
- time consuming for key, busy people
- heavily relying on leader expertise & skills
- group dynamics, dominant persons → biases, inadequacies

☹ Risk of
- missing focus & structure → rambling discussions, little concrete outcome, waste of time
- superficial coverage of more technical issues

# Combining techniques

- Elicitation techniques have complementary strengths & limitations
- Strength-based combinations are more effective for full, adequate coverage
  - artefact-driven + stakeholder-driven
- Examples
  - **Contextual Inquiry**: workplace observation + open-ended interviews + prototyping
  - **RAD**: JAD group sessions + evolutionary prototyping (with code generation tools)
- Techniques from other RE phases support elicitation too
  - Resolution of conflicts, risks, omissions, etc.

# Summary

- Identifying the right stakeholders, interacting the right way
- Artefact-driven elicitation techniques
  - Background study as a prerequisite
  - Data collection, questionnaires for preparing interviews
  - Repertory grids, card sorts for concept characterization
  - Scenarios, storyboards for concrete exploration
  - Prototypes, mock-ups for early feedback & adequacy check
  - Knowledge reuse brings a lot: domain-independent, domain-specific
- Stakeholder-driven elicitation techniques
  - Interviews are essential - structured, unstructured, cf. guidelines
  - Observation, ethnographic studies for hidden knowledge
  - Group sessions for broader, more inventive acquisition & agreement