Chapter 10

## Knowledge Elicitation – Converting Tacit Knowledge to Explicit

Chapter Objectives

- Introduce the student to capturing tacit knowledge from human sources and convert it into explicit knowledge.

- Introduce the student to the various stages of the traditional one-on-one interview and how they can be managed for effectiveness.

- Other elicitation techniques such as observation, role-reversal, etc.

- The variations of the one-on-one interview when more than one person participates.

Section 10.1 - Objectives

- Introduction of chapter contents

Figure 10.1

Knowledge Elicitation

Knowledge Capture = Knowledge Elicitation + Knowledge Representation
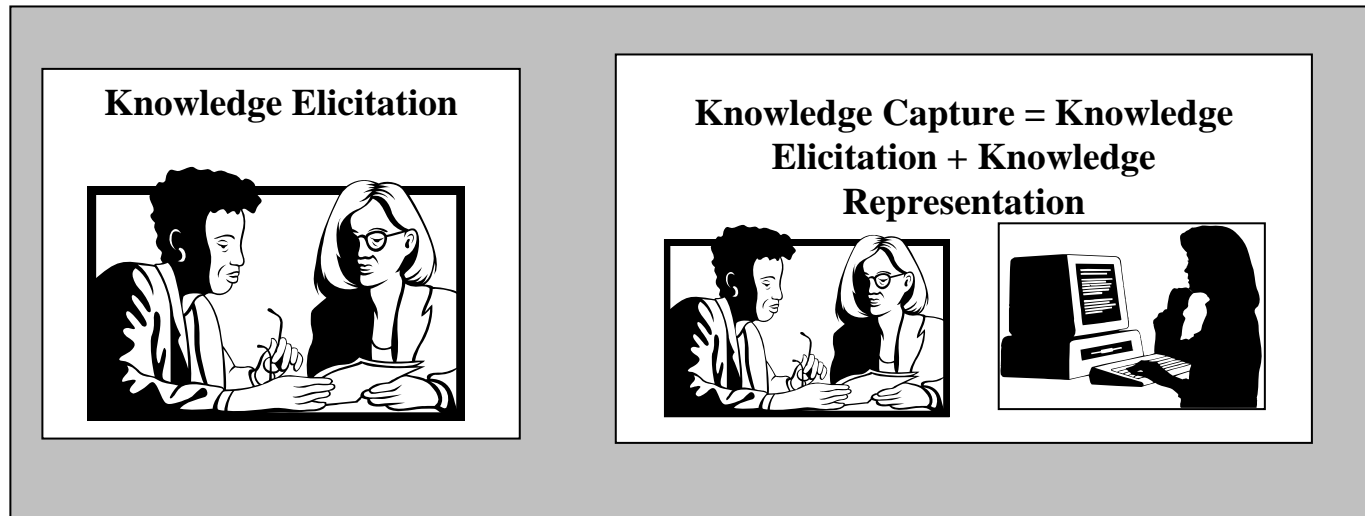
Section 10.2 - Objectives

- Introduce the basic approach to face-to-face knowledge elicitation from an expert: the one-on-one **interview**.

- Introduce the Output-Input-Middle method for organizing captured knowledge

- Introduce alternate knowledge elicitation techniques

- Introduce variations to the one-on-one interview when more than two participants are present.

Basic One-On-One Interviews: Kickoff Interview

- Objective: establish good rapport with the expert
- Demonstrate to the expert that the KE has made an honest attempt to gain familiarization with the domain before the meeting
- Typical agenda (max 1 hour):
  - Introduction and light conversation
  - Explanation of the objectives of the elicitation process
  - Discussion of the importance of the project
  - Discussion of what is expected of the expert, and what the expert can expect from the KE
  - Identification of reading materials the expert recommends for the KE to review
  - Scheduling of subsequent meetings

Basic One-On-One Interviews: General Knowledge-Gathering Sessions

- One kind of **knowledge elicitation session**
- Objective: learn general principles about the domain from the expert
  - Better understand the subject matter
  - Better understand the expert's opinions and viewpoints on the domains
- Wide-ranging, emphasizing breadth
- Knowledge gathered probably will not be explicitly expressed
- Relieves some of the burden from the expert, by not requiring a continual definition of every term used
- Facilitates **open-ended questions** which
  - require discussion
  - cannot be answered simply with a yes, no, simple term, or number
- 1-2 hours per session

Basic One-On-One Interviews: Specific Problem-Solving, Knowledge-Gathering Sessions

- One kind of **knowledge elicitation session**
- Objective: learn how the expert solves specific problems or answers questions in the domain
- Highly directed, emphasizing depth instead of breadth of coverage
- Knowledge gathered probably will be explicitly expressed using the system's knowledge representation language
- Ask many **close-ended questions** which
  - ◆ are quite specific
  - ◆ can be answered simply with a yes, no, simple term, or number

Basic One-On-One Interviews: Knowledge Elicitation Sequence

- **Output-Input-Middle method**
- Output
    - Identify the answers or solutions to the problem under discussion (goals)
    - KE should focus on understanding subtle differences between goals
- Input
    - Identify the sources of information that the expert uses to deduce the solution/answer
    - KE should make sure how these inputs are identified, determined, or generated is known and understood
- Middle
    - Determine the links between the inputs and outputs
    - These connections represent the core of the expert's knowledge
    - Some inputs may not be required initially, but may be requested later after the initial inputs are interpreted
    - Intermediate goals/hypotheses may be required to complete the connections

Basic One-On-One Interviews: Weaknesses

- The Q&A interview is not always the most efficient means of eliciting knowledge from an expert

- In some domains, considerable expertise is documented in instruction manuals or books
  - ◆ eg, maintenance manuals for automobile diagnosis

- Sometimes even cooperative experts have difficulty articulating their expertise

- Other elicitation techniques can be used when appropriate
  - ◆ Observational elicitation
  - ◆ Role reversal

Observational Elicitation

- KE observes the expert at work, trying to understand and duplicate the expert's problem-solving methods

- Types:
  - ◆ Quiet on-site observation
  - ◆ On-site observation with discussion
  - ◆ Exercising the expert
  - ◆ Problem description and analysis

Observational Elicitation: Quiet on-site observation

- KE cannot question experts while they work
- Pros:
  - Experts' train of thought is not continually interrupted by questions, so they can proceed at their most effective and realistic form
- Cons:
  - Lack of interaction leaves KE wondering about the solution approaches taken by the expert
  - If expert is asked to talk out loud as they work, can make experts self-conscious causing them to alter it or to create a verbalization that is much more or less complex than what they are actually doing
- Should be used:
  - to get a feel for the total magnitude of the problem-solving process
  - to verify (or reject) that a hypothesized approach is in use
- Should not be used:
  - to obtain details about the process
- Q&A session should follow

Observational Elicitation: On-site observation with discussion

- KE may interact with the experts while they work
- Pros:
  - Permits KE to better probe the process observed
- Cons:
  - Expert may become distracted by the questions and not follow the normal procedure
- Should be used:
  - when the observed task does not significantly challenge the expert's problem-solving abilities (eg, is fairly routine)
- Should not be used:
  - when the expert needs to struggle to reach a solution
    - Symptoms: uneasiness, hesitation in decision-making, refusing to create a solution in front of the KE
- Q&A session should follow

Observational Elicitation: Exercising the expert

- In some domains, problems arise only seldom and unpredictably
  - Even when problems arise frequently, the difficulty level of the usual problems may not be sufficiently high
- Impedes knowledge elicitation by observation
- In such cases, KE may prepare **cases** of varying difficulty from historical data
- Presented to expert in an "off-line" environment to observe the expert's methodology
- May also be used to supplement a case library for CBR
- Improvements to elicit experts' abilities to provide additional information about their problem-solving expertise: [Hoffman 1987]
  - **Limited information tasks**: A routine task is performed, but the expert is not provided certain information that is typically available
  - **Constrained processing tasks**: A routine task is performed, but the expert must execute it under some constraint (eg, within a limited amount of time)

Observational Elicitation: Problem description and analysis

- Sometimes it is useful to observe cases that are classical problems, rather than real or historical cases
  - eg, cases typically discussed and analyzed by instructors in classroom situations
  - designed/chosen because they illustrate important or significant relationships within the domain that every problem solver should possess
- Normally such cases are selected by the expert
  - But occasionally the KE may find them useful to select when questioning the expert
- KE should make sure the expert explains the rationale behind distinguishing these problems as classics: what are the key relationships/features that make these cases significant?
- May also be used to supplement a case library for CBR

Role Reversal Techniques

- KE acts as the expert (**pseudoexpert**)
- The pseudoexpert attempts to solve a problem in the presence of the true expert (**role-playing**)
- The true expert questions the pseudoexperts about what they are doing and why
  - Like the observation process, but the with roles reversed
- May be used when:
  - KE already has a significant understanding of the provlem-solving process
  - KE wishes to verify correctness of understanding
- Can clarify, modifiy, and provide significant new knowledge not previously uncovered by the KE

Team Interviewing

- Under some circumstances, interviewing may involve more than one KE and one expert
- Types:
  - One-on-many
  - Many-on-one
  - Many-on-many

Team Interviewing: One-on-many

- Common when several experts work closely together
- Each expert may be specialized in slightly different areas, in complementary fashion
- If differences of opinion arise during a discussion, good chance of resolving them immediately and amicably
  - Typically in such an environment, this immediately uncovers a deeper level of knowledge (benefiting both KE and experts)
- Cons:
  - Sometimes the experts do not get along; can undermine team's productivity
  - Can be redundant especially in general knowledge-gathering sessions, which is wasteful of experts' time
  - Inexperienced KEs may be overwhelmed by multiple experts
  - Even experienced KEs may be exhausted quickly, since the KE must maintain concentration while each expert can drift in and out of "high gear"

Team Interviewing: Many-on-many

- Pros:
  - Few-on-few interviews may realize the benefits of both one-on-many and many-on-one interviews – synergism between experts as well as multiple observer perspectives
    - Only holds for few-on-few interviews, eg, two-on-two or two-on-three
  - Sometimes unavoidable to external pressures (eg, time constraints dictated by management)
- Cons:
  - Difficult to accomplish anything with larger groups
  - High redundancy is wasteful of experts' and KEs' time

Team Interviewing: Many-on-one

- Pros:
  - Multiple sets of eyes and ears are better than one
  - Each KE can subsequently provide an alternative perspective about what happened during the interview, leading to a clearer picture
- Cons:
  - The single expert often feels overwhelmed by the multiple KEs – may become more defensive
  - Little chance for synergism, since no one else present has the expert's level of domain understanding
  - Even a cooperative expert easily gets exhausted quickly

Section 10.3 - Objectives

- Introduce the concept of repertory grids as a tool to facilitate the elicitation of knowledge from a human expert

- Provide a detailed example of how an automated knowledge elicitation system that uses repertory grids would operate

Repertory Grids

- A **repertory grid** is a list of specific characteristics of a domain that are to be evaluated by an expert
  - Mathematically: an attribute-value vector
  - Attributes are also sometimes called elements or labels
  - Values can be binary or a range of values
  - A **construct** is an attribute-value pair (along with the specification of the range, ie, set of allowed values)
- Based on Kelly's [1955] theory of personal constructs in clinical psychology
  - Designed to improve the effectiveness of clinical sessions with a patient
  - Individuals perceive the world from a different and changing perspective
  - A model is built for particular persons that represents their views of the world, which is updated to represent the person's beliefs as they are revised
- Adopted in a number of knowledge elicitation tools during the 1980s and 1990s

Table 10.1

Table 10.1 Repertory Grid

ELEMENTS 10, CONSTRUCTS 14, RANGE 1–5
PURPOSE: Staff appraisal

	Staff member No.	1	2	3	4	5	6	7	8	9	10	
1	Intelligent	1	1	4	5	3	3	5	2	3	5	Dim
2	Willing	1	2	4	5	1	1	4	3	1	2	Unwilling
3	New boy	1	2	3	5	4	4	4	1	4	3	Old sweats
4	Little supervision	3	1	4	5	2	1	5	2	2	3	Needs supervis.
5	Motivated	1	1	4	5	2	2	5	3	3	2	Unmotivated
6	Reliable	3	2	2	5	1	1	5	1	2	3	Unreliable
7	Mild	3	4	5	2	2	3	1	5	4	5	Abrasive
8	Idea person	1	1	5	4	2	3	1	3	4	4	Staid
9	Self-starter	2	1	5	5	1	3	5	3	4	5	Needs a push
10	Creative	1	1	5	5	2	3	4	3	4	5	Uncreative
11	Helpful	4	3	4	2	3	5	1	4	5	5	Unhelpful
12	Professional	1	2	3	3	2	1	5	2	4	4	Unprofessional
13	overall rating high	2	1	3	4	1	2	5	2	3	4	overall rating lo
14	Messer	2	2	5	4	3	5	1	5	3	1	Tidy
	Staff member No.	1	2	3	4	5	6	7	8	9	10	

Repertory Grids

- Automated tools exploit the idea of repertory grids by trying to help elicit:
  - ◆ what attributes are important for the domain
  - ◆ what range of values the attributes should have

Table 10.2

Table 10.2 Automobile Selection Grid

Car	High-Perform?	Cost	Size	Functional?	Type	Fuel-efficcient?	Speed
P-911	yes	High	small	no	coupe	no	fast
Van	no	Medium	Large	yes	van	yes	slow
Caddy	no	High	Large	yes	sedan	no	medium
Focus	no	Low	small	yes	sedan	yes	slow
Miata	yes	High	small	no	coupe	yes	fast
M-B	yes	High	large	yes	sedan	no	fast
BMW	yes	High	medium	yes	sedan	no	fast
Jeep	no	Medium	small	no	suv	no	slow
S-10	no	Low	medium	yes	truck	yes	slow

Repertory Grids

- Knowledge captured in repertory grids is rarely sufficient to build a complete knowledge-based system
  - but provides an excellent starting point to simplify the KEs' job to be one of refinement, instead of bulk knowledge capture
- Excellent means of acquiring knowledge that has the following characteristics:
  - It is easily characterized as attribute-value pairs
  - The values can vary over a range covering two extremes
  - Certain characteristics of the object of knowledge can be easily defined
  - The knowledge centers about knowing how an object fits within this template

Section 10.4 – Objectives (skip section)

- Introduces techniques to automate the knowledge acquisition process when the human knowledge is resident in databases

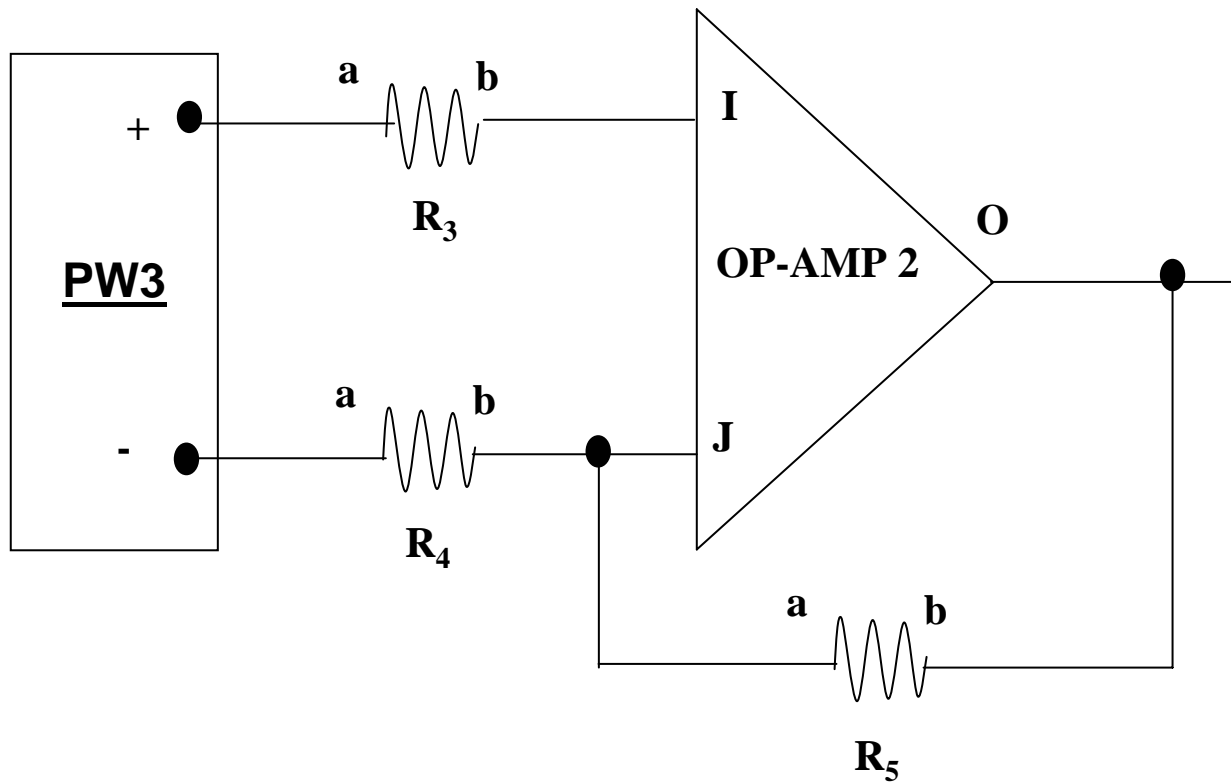- Provides a detailed example of this approach
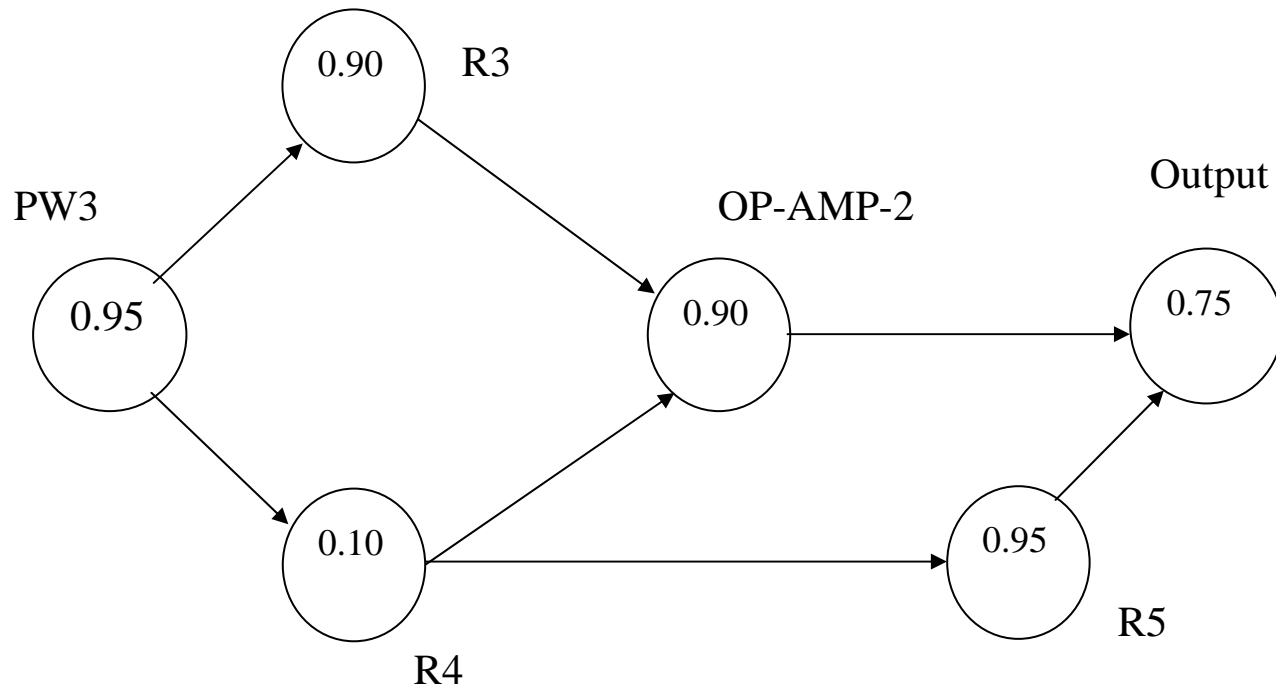
Figure 10.2

Figure 10.3

Table 10.3

Component Name	Description	Units
PW3	Power Supply	VDC
OP-AMP2	Operational Amplifier	Volts
R3	Resistor	Ohms
R4	Resistor	Ohms
R5	Resistor	Ohms

Table 10.4

Comp. Name	Connect pt.	Comp. Name	Connect pt.
PW3	+	R3	A
PW3	−	R4	A
R3	b	OP-AMP2	I
R4	b	OP-AMP2	J
R4	b	R5	A
OP-AMP2	O	R5	B

Table 10.5

Net#	Component name	Connect point
026	PW3	+
026	R3	A
027	R3	B
027	OP-AMP2	I
028	OP-AMP2	O
028	R5	B
029	R5	A
029	OP-AMP2	J
029	R4	B
030	R4	A
030	PW3	–

Section 10.5 - Objectives

- Summarize the chapter
- Provide Key terms
- Provide Review Questions
- Provide Review Exercises

Conclusions

- The student should be familiar with:
  - How to conduct a one-on-one interview with an expert to elicit her knowledge.
  - Alternative techniques for knowledge elicitation and when it is appropriate to use them.
  - Tools that can facilitate the knowledge elicitation process from an expert.
  - Techniques to automate the knowledge capture process from electronic databases.

Chapter 10

Knowledge Elicitation – Converting Tacit Knowledge to Explicit