USING CTA TO CAPTURE EXPERT DECISION MAKING AND PROBLEM SOLVING

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Supplemental Materials

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Global Situation and Opportunity

Situation

- Knowledge workers
- Aging boomer experts
- Gen X/Y/millennium novice replacements
- Limited opportunities for classroom training
- Tribal lore versus intellectual capital

Opportunity

- Decrease ramp-up time to competent performance
- Provide timely access to learning, information, and tools

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Objectives

- ✓ Articulate differences between novice and expert cognition.
- Describe a cognitive task analysis (CTA) approach using inputs, processes, decisions, and outputs.
- Apply the approach to specify an expert decision.
- Use the results of a CTA to support problem solving and decision making.
- State lessons learned in applying the CTA approach.

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Novice/Expert Comparison

Characteristic	Novices	Experts
Context-specific knowledge	Little	Vast mental model of the job
Problem-solving ability	Limited	Ample, with apperception
Decision-making ability	Under-analyze the subtle; over-analyze the trivial	Appropriate analytical levels
Working memory capacity	Limited, small chunks	Almost unlimited, large chunks
Self-monitoring ability	Limited, can't triage among multiple options	Vast
Reactions to the unexpected	Novelty is catastrophic	Routine

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Experts Can't Always Tell You What They Know

- Expertise ≠ Articulation
  - ♦Automaticity
  - ♦Implicit learning
  - ♦Idiosyncratic experience

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CTA Defined

A broad area consisting of tools and techniques for describing the knowledge and strategies required for task performance (Schraagen, Chipman, & Shalin, 2000, p. xiii). It is the extension of traditional task analysis techniques to yield information about the knowledge, thought processes, and goal structures that underlie observable task performance (p. 3).

Job & Task Analysis Continuum

Job Analysis → Task Analysis → Cognitive Task Analysis

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How to Know When You Need a CTA

- Huge differences between novice and expert cognition and performance.
- Statements such as “instinct,” “art,” “gut feeling.”
- Lots of cognitive verbs used in task statements (e.g., determine, assess, evaluate, analyze, decide).
- Eyes roll upwards when answering questions.

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CTA Has Measurable Results

In a statistical review of studies (meta-analysis), Lee (2005) noted that interventions based on CTA results improve performance by 35 percent.

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CTA Approaches

http://mentalmodels.mitre.org/
www.ctaresource.com

CTA Approach	Researchers
Facilitated Case-Based Reasoning (F-CBR)	Stone & Villachica (1999)
PARI (Precursors ♦ Actions ♦ Results ♦ Interpretation)	Hall, Gott, & Pokorny (1995)

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The Opportunity at POST

- Public expectation of service
- Retirement Incentives
  - ♦ 3 percent at age 50
- Updated take on performance before making curriculum revisions
  - ♦ Feasibility study
  - ♦ Current curriculum didn't focus on decision-making
  - ♦ Tasks, decisions, and stories
- Variance
  - ♦ Geographic issues
  - ♦ Agency size

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DLS CTA Approach
Facilitated Case-Based Reasoning (F-CBR)

1. Set Up CTA Workshops
- Determine number of workshops
- Identify participants
- Ask participants to bring workbasket samples

2. Conduct Workshops
- Decompose job tasks
- Identify cognitive tasks
- Complete complex decision tables
- Identify novice/expert differences

3. Validate and Socialize the Mental Model
- Internally validate the mental model
- Protoype solutions
- Externally validate the mental model

--Villachica & Stone (in press)

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The Project with POST

What tasks comprise the investigative process detectives use on the job?

Task Characteristics
- Frequency
- Importance
- When learned
- Conditions

SKAs
- Skills
- Knowledge
- Attitudes

Cognitive Task Analysis
- Mental Model
- Inputs
- Process
- Decision Rules
- Outputs

Prototypes of the Revised Core Course & Plan
- Classroom training
- Online knowledge bases

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CTA Participants & Iterations

- Steering Committee Workshop
- Journeymen Investigator Workshop
- Expert Investigator & Supervisor Workshops
- Steering Committee Approval
- Field Review
- Advisory Board Approval

Mental Model
- Tasks
- Inputs
- Process
- Decision Rules
- Outputs

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Mental Model Sample (Release 2.0)
Part 1: Major Tasks

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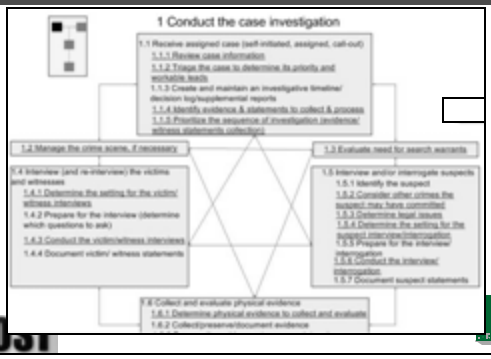
Mental Model Sample
Part 2: Sub-Tasks



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Mental Model Sample
Part 3: Decision Table

Job Aid 1

1.6.1. Determine physical evidence to collect and evaluate.

Input (What Prompts You)	Process (Activities)	Decision Rule (Questions that Help You Make a Decision)	Output (Results)

• Experience level of CSI
• Experience level of investigator
• Experience level of first responders (patrol, fire, child protective services, etc.)
• New technology that allows new evidence collection
• Investigation to this point
	• Direct CSI or self to collect physical evidence
	• Conduct physical and photo line-ups
	• Place pretext calls
	• Identify victim's property
		• **What are the 4th amendment issues, including search warrants?***
		• What is the evidence?
		• Why is it there? (reconstruction)
		• What is its source?
		• How is the evidence relevant or prove elect?
		  ◦ What additional forensic testing can enhance the value of the evidence?
		• What evidence do I need in order to disprove possible defenses (e.g., self defense and relationship to suspect)?
		• What is the experience level of CSI and investigator
		• What can I do to ensure the collection of not-so-obvious evidence?
		  ◦ Trace evidence?
		  ◦ DNA evidence?
		  ◦ Latent prints?
		  ◦ Etc.?
			• Evidence to support/non-support of your case
			• Case disposition
			• Links to other crimes

Boldfaced text indicates high-priority questions that take precedence over others

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Interactive Exercise
Complete A CTA Table

- Break into groups.
- Select a task.
  - Use the task from Exercise 1.
  - Select a gift for someone.
  - Find a sponsor for a project.
  - Select a performance intervention.
  - Something else.
- Specify someone to act as an expert.
- For the task you select, complete the CTA table, filling in the columns in this order:
  1. Inputs.
  2. Outputs.
  3. Processes/Activities.
  4. Decisions/Questions/Rules of Thumb.
- Time = 20 minutes.

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Interactive Exercise 2 Debriefing
Complete A CTA Table

The "cognitive magic" usually lies in the decisions and questions.

- What task did you select?
- Who was your expert?
- What inputs did you identify?
- What processes did you identify?
- What questions/rules of thumb did you identify?
- What outputs did you identify?
- What made this activity easy or difficult?

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CTA Outputs
Learning (Training)

- Cognitive apprenticeship
- Application of the mental model
- Use of online resources
- Interactive group exercises
- Simulated investigation
- Practica

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Lessons Learned

1. Work in collaborative teams of novices and experts.
2. Look for the right experts in the room.
3. Iterate to success.
4. Use the mental model to drive appropriate revisions to learning, information, and tool assets.
5. Validate the mental model using a variety of methods.
6. Use this process to facilitate change management efforts.

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Thank You!

http://www.dls.com/Resources.htm

Your questions and comments?

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JOB AID 1: GLOSSARY OF CTA TERMS

Apperception	"Rapid, knowledge-guided perception" that guides expert problem-solving and decisions (Ross, 2006). Apperception allows expert chess players to know the right move instantaneously and law enforcement personnel to follow correct hunches and instincts.
Automaticity	"When cognitive processes [are practiced to the point they] become automatic, they demand very little space in working memory, they occur rapidly, and they often occur without conscious effort. Automaticity is sometimes called fluency" (Willingham, 2004).
Cognitive task analysis	A broad area consisting of tools and techniques for describing the knowledge and strategies required for task performance (Schraagen, Chipman, & Shalin, p. xiii). It is the extension of traditional task analysis techniques to yield information about the knowledge, thought processes, and goal structures that underlie observable task performance (p. 3).
Context-specific knowledge	Knowledge about a given domain, including concepts, facts, procedures, rules of thumb (heuristics), and learning strategies (Collins, Brown , and Holum, 1991).
Decision-making ability	The ability to choose among options and reach conclusions within a given situation (MSN Encarta, accessed 2007). Problem solvers must make multiple decisions.
Implicit learning	"…a person typically learns about the structure of a fairly complex stimulus environment, without necessarily intending to do so, and in such a way that the resulting knowledge is difficult to express" (Berry and Dienes, 1993, p. 2). Implicit learning is unintentional and usually constructed while "mucking around."

Intellectual capital	Knowledge that can be exploited for some money-making or other useful purpose. The term combines the idea of the intellect or brain-power with the economic concept of capital, the saving of entitled benefits so that they can be invested in producing more goods and services. Intellectual capital can include the skills and knowledge that a company has developed about how to make its goods or services; individual employees or groups of employees whose knowledge is deemed critical to a company's continued success; and its aggregation of documents about processes, customers, research results, and other information that might have value for a competitor that is not common knowledge (searchcrm.com, accessed 2007).
Knowledge workers	Workers who make a living by making decisions and solving problems on the job. "The term 'knowledge worker' was coined by Peter Drucker some thirty years ago to describe someone who adds value by processing existing information to create new information which could be used to define and solve problems" (Kumar, 2000). "Knowledge workers cannot be managed as subordinates; they are associates… This difference is more than cosmetic. Once beyond the apprentice stage, knowledge workers must know more about their job than their boss does - or what good are they? The very definition of a knowledge worker is one who knows more about his or her job than anyone else in the organization" (Drucker, 1998).
Mental model	Networks of facts, concepts and principles, along with their supporting facts and concepts, stored in a meaningful structure based on the context for which it was created and the past experiences of the learner (Foshay, Silber, and Stelnicki, 2003).
Problem-solving ability	Problems arise when individuals have goals they do not know how to achieve. Some problems are well-structured, and problem solvers can identify the problems, develop straightforward processes for solving them, and know what the solved problems will look like. Other problems are ill-structured. Problem solvers cannot necessarily identify the problem at the start, they don't know exactly how to solve it, and they don't know what it will look like when they are done (Villachica, 1999).

Reactions to the unexpected	When problem solvers encounter a problem, they will apply their context-specific knowledge to solve it. When novices encounter a novel problem, their existing context-specific knowledge does not apply, and they resort to what they know how to do—regardless of whether it solves a problem.
Self-monitoring ability	Problem solvers must monitor their own progress as they solve a problem. This self-monitoring ability requires them to employ control (or metacognitive) strategies. Self monitoring involves selecting possible problem-solving strategies, monitoring how well they are working, deciding when to change strategies, and knowing when the problem is solved. Decisions about proceeding in a problem-solving task generally depend on an assessment of one's current state relative to one's goals, on an analysis of current difficulties, and on the strategies available for dealing with difficulties (Collins, Brown , and Holum, 1991).
Tribal lore	Context-specific knowledge, problem-solving ability, decision-making ability, self-monitoring ability that knowledge workers communicate and learn informally. Tribal lore is often shared around the water cooler.
Working memory capacity	Working memory is a short-term store for about 3-9 bits of information used when learning, reasoning, or comprehending. It is involved in attending, encoding, storing, and retrieving of information (medicinenet.com, accessed 2007).

JOB AID 1: MENTAL MODEL SAMPLE

1.0 Conduct case investigations

…

1.6 Collect and evaluate physical evidence

…

1.6.1. Determine physical evidence to collect and evaluate

Input (What Prompts You)	**Process (Activities)**	**Decision Rule (Questions that Help You Make a Decision)**	**Output (Results)**
➢ Experience level of CSI ➢ Experience level of investigator ➢ Experience level of first responders (patrol, fire, child protective services, etc.) ➢ New technology that allows new evidence collection ➢ Investigation to this point	➢ Direct CSI or self to collect physical evidence ➢ Conduct physical and photo line-ups ➢ Place pretext calls ➢ Identify victim's property	➢ **What are the 4th amendment issues, including search warrants?** [1] ➢ What is the evidence? ➢ Why is it there? (reconstruction) ➢ What is its source? ➢ How is the evidence relevant or prove effect? ▪ What additional forensic testing can enhance the value of the evidence? ➢ What evidence do I need in order to disprove possible defenses (e.g., self defense and relationship to suspect)? ➢ What is the experience level of CSI and investigator ➢ What can I do to ensure the collection of not-so-obvious evidence? ▪ Trace evidence? ▪ DNA evidence? ▪ Latent prints? ▪ Etc.?	➢ Evidence in support/non-support of your case ➢ Case disposition ➢ Links to other crimes

[1] Items in **bold** are high-priority questions that trump all others for this decision.

INTERACTIVE EXERCISE 1: COMPLETE A CTA TABLE

Instructions

1. Break into groups.
❷ Select a task and write it in the space below. For example:
   - ♦ Selecting a gift for someone.
   - ♦ Finding a sponsor for a project.
   - ♦ Selecting a performance intervention.
   - ♦ Something else.
3. Select a member of your group to act as an expert in the task you chose.
❹ Write the *inputs* that prompt the expert to perform the task in the right-hand column.
❺ Write the *processes* that the expert uses to perform the task in the second column.
❻ Write the *decision rules* that the expert applies when making task-related decisions in the third column.
❼ Write the *outputs* that result from the completed task in the left-hand column.
8. After 20 minutes, we'll debrief.

Task: ❷: _____

Input (What Prompts You) ④	**Process (Activities) ⑤**	**Decision Rule (Questions that Help You Make a Decision) ⑥**	**Output (Results) ⑦**

BIOGRAPHIES

Deborah L. Stone, CPT

Deborah possesses 25 years of project management and development experience. She co-authored a book chapter on rapid application development as well as 6 book chapters on HPT and 10 trade-related publications. A Certified Performance Technologist, Deborah possesses a master's degree in Instructional Technology. A frequent conference presenter, Deborah has delivered over 30 presentations to peer-reviewed conferences such as ISPI, as well as 15 invited presentations. Deborah was ISPI's 1991-93 Vice President, Technology Applications.

Sven Blomberg

Sven is Senior Instructional Designer with the California Commission on Peace Officer Standards and Training (POST). At POST, he has led the effort to revise the Robert Presley Institute of Criminal Investigations to incorporate a performance-centered instructional methodology. Prior to joining POST, he developed multimedia training for Oracle and Netscape and spent 7 years as a middle school teacher. He earned his master's degree in instructional technology from San Jose State University in 2000.

Steven W. Villachica, PhD, CPT

Steve is a member of DLS Group's Strategic Advisory Board and Associate Professor of Instructional and Performance Technology at Boise State University. His research interests include cognitive research and assessment to technology-based delivery platforms. A frequent presenter at international conferences and member of ISPI, Steve also co-authored the chapter on PSS appearing in the second edition of the Handbook of Human Performance Technology. A two-time winner of ISPI's Outstanding Systematic Approach award and Certified Performance Technologist, he completed his doctorate in educational technology at the University of Northern Colorado.

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