Tutorial: Work Task Analysis

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Concept

Work tasks can be described in terms of the cognitive states established during task execution and the cognitive processes used to effect the transitions between states. A *task* is something to be achieved, in other words, an outcome (Crandall, Klein & Hoffman, 2006). Work task analysis, also known as control task analysis (Vicente, 1999), is based on the assumption that tasks are accomplished, problems resolved and decisions made via transformations between cognitive states as induced by cognitive processes. Thus, work tasks can be described in terms of the cognitive states established during task execution and the cognitive processes used to effect the transitions between states. The usual product of work task analysis is a suite of decision ladders.

A cognitive state is a condition of being (e.g., the state of being alert, the state of being aware of the situation, the state of being certain or uncertain, the state of knowing something) while a cognitive process is an activity (e.g., the process of seeking information, the process of planning). In a physical system, a state is a condition described in terms of phase, form, composition, or structure (e.g., ice is the solid state of H2O and water is its liquid state). A physical process acts on a state to change it (e.g., the process of cooling transforms water into ice). There can be no state transition in a physical system without an intervening process. Cognitive states and processes can be viewed similarly. In the realm of cognition, processes are often not accessible to conscious awareness, in which case they are said to be implicit.

Decision Ladder

As the product of work task analysis, a decision ladder (Figure 1) provides a template for mapping *the set of generic sub-tasks involved in decision making* (Rasmussen, Pejtersen & Goodstein, 1994, p 66), that is the cognitive states (depicted as ellipses) and the cognitive processes (depicted as arrows). A work narrative can be mapped onto the decision ladder to *represent observed decision paths* and *identify different decision processes* (Rasmussen, et al, 1994, p 66). The decision ladder has three main stages, situation assessment up the left hand leg, options analysis across the top, and planning down the right hand leg (Figure 1).

The decision ladder accommodates both rational and heuristic decision processes. A rational decision process will follow the perimeter of the decision ladder from the lower-left node to the lower-right node while a heuristic decision process can start and finish anywhere in the ladder and can transition across the ladder, as illustrated in Figure 2. Processes may be either explicit or implicit. An explicit process is accessible to conscious awareness while an implicit one is not. In Figure 2, explicit processes are depicted by solid arrows while the illustrative implicit process is depicted by a dotted arrow.

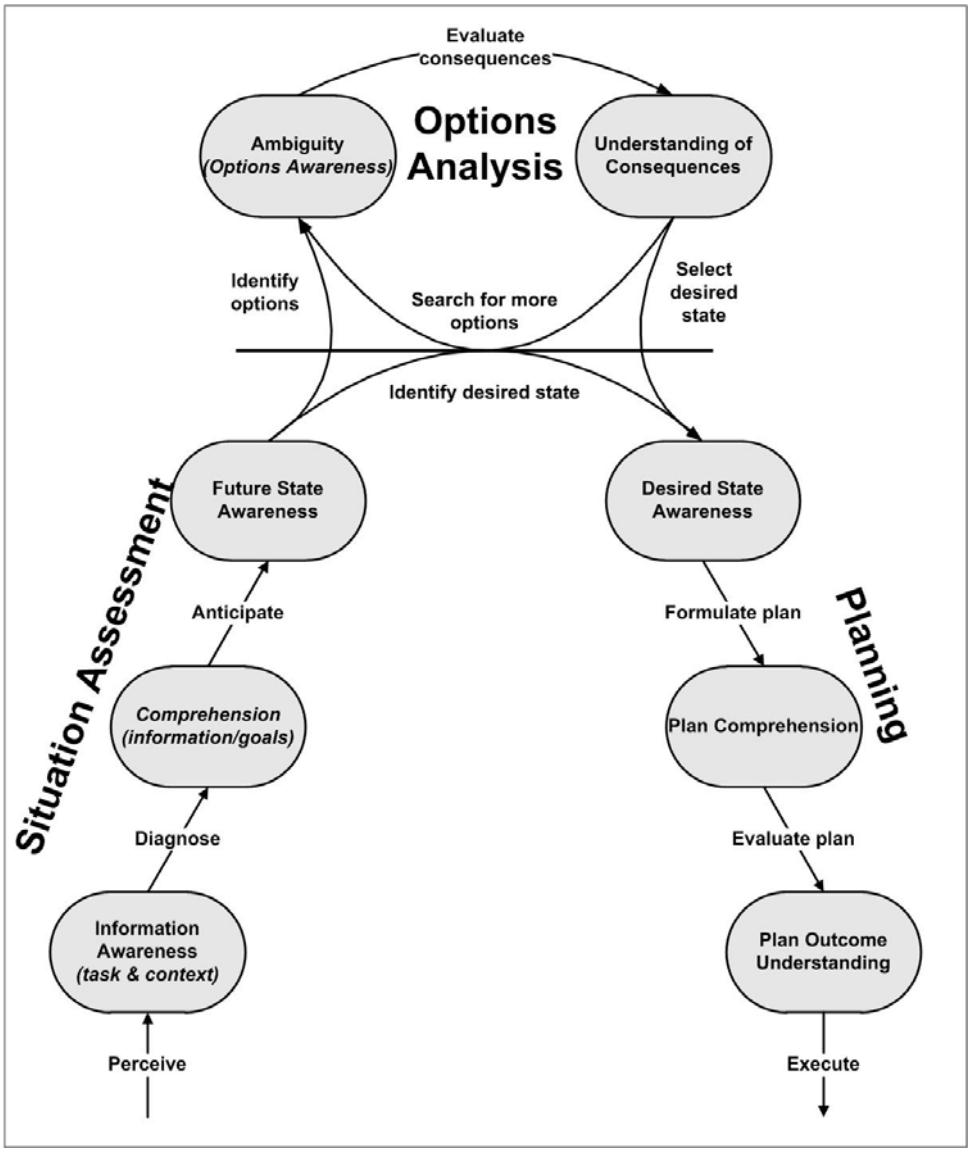

Figure 1: The Decision Ladder (adapted from Rasmussen, 1986 & Rasmussen et al, 1994)

Decision Ladders as Narrative

As I note above, the decision ladder should not be interpreted as implying a fixed sequence of cognitive states and processes for all, or even for any tasks. Nevertheless, it should be possible to first map a work narrative onto a decision ladder and then to read that decision ladder.

A work narrative that follows the perimeter of the decision ladder, starting at the lower-left node and finishing at the lower-right node might be read as follows:

> A worker who is immersed in a work situation will be aware of the types of events that demand intervention. On perceiving an event and becoming alerted to or aware of information that characterizes it, s/he will engage in diagnosis to discover what is going on. S/he will first seek information about the task and about the surrounding conditions and with that information in hand, s/he will seek to comprehend the current system state in relation to current goals and to anticipate the future system state (given no intervention) while remaining cognizant of situational exigencies that may demand reassessment. S/he will then identify a desirable and reachable system state.

Alternatively, it may be difficult to identify a desired system state directly from the comprehension of the future system state, in which case the worker will divert through the options analysis loop to identify and then evaluate options for desired states in order to compare the consequences of those options as a prelude to settling on a desirable system state.

Once a desirable system state is identified there will be a need to formulate a plan. Once that is done, the worker will evaluate the plan. If satisfied, the worker will execute the plan.

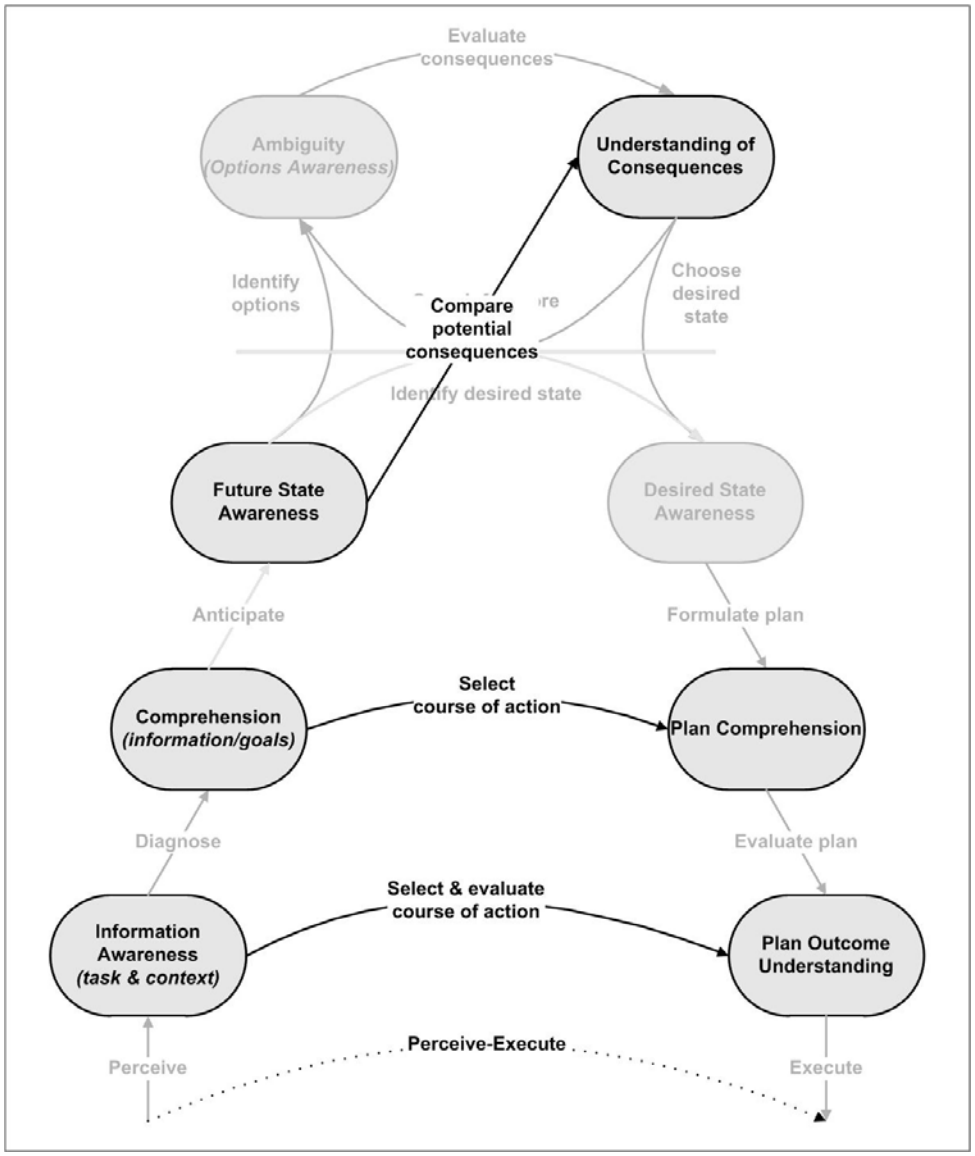

Figure 2: Processes do not need to follow the perimeter of the ladder

Other workers at different levels of experience may follow other trajectories and the same worker may opportunistically follow different trajectories at different times for the same task. An expert is likely to visit fewer cognitive states and to employ fewer cognitive processes than a novice but might also chose different trajectories at different times. That is not to say that anything is possible; the chosen trajectory must reflect the needs of the work task. Why workers (either novice or expert) might chose a different

trajectory at a different time will often be an interesting issue to explore; one that might have ramifications for the design of a cognitive support tool.

Design Implications

Enhanced cognitive support might come through one of or some combination of technological redesign, work process redesign, or training focused on the specific cognitive states or processes that offer a challenge in execution of a work task. Every cognitive state and every cognitive process involved in execution of a work task is a candidate for assistance with some form of technological, process or training support. Figure 3 offers a sample of potential design interventions that could support work tasks. Whether any form of support is desirable for any specific cognitive state or process will depend largely on whether that state or process offers a particular cognitive challenge that could be eased by the form of support being proposed.

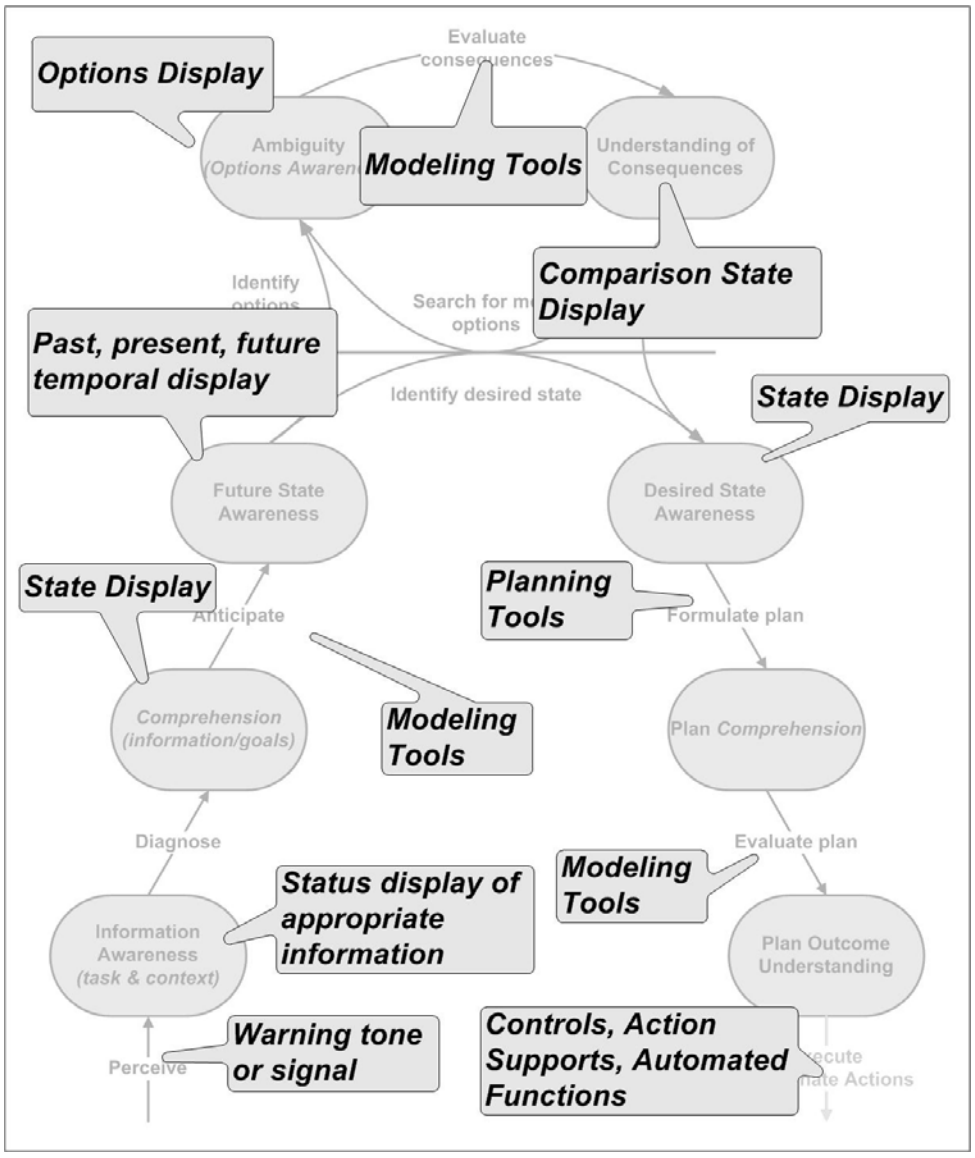

Figure 3: A sample of potential design interventions

Summary

Work task analysis assumes that tasks are accomplished, problems resolved and decisions made via transformations between cognitive states as induced by cognitive processes. A cognitive state is a condition of being (e.g., the state of being alert, the state of being aware of the situation, the state of being certain or uncertain, the state of knowing something) while a cognitive process is an activity (e.g., the process of seeking information, the process of planning). Work task analysis identifies the cognitive states and cognitive processes used within a work task by mapping task trajectories provide by subject matter experts onto a decision ladder.

References

Crandall, Beth; Klein, Gary & Hoffman, Robert R. (2006). *Working Minds: A Practitioner's Guide to Cognitive Task Analysis*. Cambridge, MA: MIT Press, ISBN 10: 0-262-03351-8.

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