Cognitive GOMS for Submarine Experts

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Introduction

Decision making is complicated by a dynamically changing, event-driven environment and ambiguous information. Analyzing the cognitive process under these conditions presents challenges to theory and methodology. We report such an analysis for data obtained from a study of submarine Approach Officers (AOs) using a simulated submarine combat system.

Method and Analysis

The subjects were six expert submarine officers. The task they performed was locating an enemy submarine and deciding how to respond to it. Their information gathering and own ship (OS) maneuvers were mediated by a computer operator (called OS-op), just as they are aboard ship. Two hours of data (two to four scenarios) were collected for each AO.

Scenarios were transcribed and each was encoded by two independent coders. Because of the nature of the problem solving task and the interaction mechanics, only *cognitive* operators were encoded.

Results and Discussion

Inter-rater reliabilities on operator encodings for the task scenarios ranged from Kappa = 0.75, Z = 22 to Kappa = 0.64, Z = 16.5, all highly significant (Cohen's Kappa corrects for chance matches).

Operator	Protocol Example
Information	
query	"let's ...see if we can gain our alpha on narrowband"
receive	"we're minus 12.3 SNR"
derive	"the target maneuvered at some point there"
Actions	
maneuverOS	"and let's come up to 12 knots "
setTracker	"Okay, so I want to track the merchant"
tweakParam	"Can we get down to 15 knots, there we go"
enterSolution	"Why don't you update your solution"

Table 1: Operators and protocol examples

Of the eight encoding operators, 75% were task relevant (Kirschenbaum, Gray, Ehret, & Miller, 1996). These seven relevant operators (see Table 1 for examples) fell into two categories, information-seeking, mean = 90.8%, SD = 3.8 and action-orders (e.g., change course). mean = 9.2%, SD = 3.8.

A shallow goal structure, never more than three deep, accounted for all of the operators. Figure 1 shows levels 1 and 2. The only Level 3 goal, SUPERVISE-OS-op, is not shown.

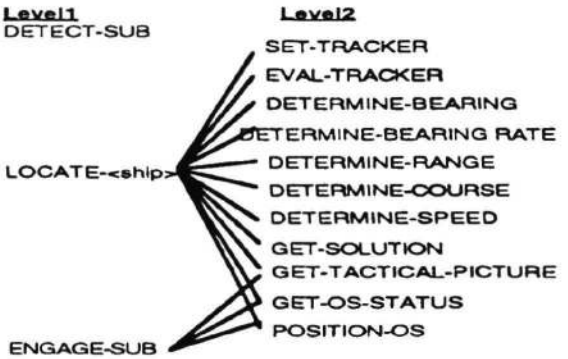

Figure 1: Level 1 and level 2 goals.

We believe that when a goal pops, it returns information to a knowledge schema structure in long-term working memory (Ericsson, & Kintsch, 1995). The schema and/or events determine the next goal.

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