Cognition as a Network of Tasks (COGNET)

Submitted by superadmin on Mon, 10/22/2012 - 14:45
HP Activity Categories:
Assessment of situational awareness [1]
Resource Type:
Method
Abstract:

COGNET (COGNitive NEtwork of Tasks) is a framework for modelling human cognition and decision-making which provides an integrated representation of the knowledge (mental model), procedures (behavioural actions), strategies and problem solving skills (cognitive operations) used in a domain or task situation, yielding the data for a powerful cognitive engineering tool for the design of user interfaces.

Complex domains often involve a dynamic work environment, necessitating a way of representing the fact that the operator must perform multiple, often competing tasks in real-time and must share attention among these tasks. COGNET also addresses these requirements. (Ryder, J.M., Weiland, M.Z., Szczepkowski, M.A., & Zachary, W.W. (1998). Cognitive engineering of a new telephone operator workstation using COGNET. International Journal of Industrial Ergonomics 22, 417-429)

References

Developer and source:


COGNET models may be implemented using iGEN software available at: http://www.chisystems.com/

Year of development / publication, updates etc:
1992
1998
2000
1991

General Description

Purpose:

COGNET is an integrated modelling method used to develop cognitive, rather than psychomotor, models of human-computer interaction in complex, real-time, multi-tasking environments. COGNET assumes that humans perform multiple tasks in parallel. These tasks compete for attention, but ultimately combine to solve a problem. COGNET assumes rapid attention switching with attention focused first on one task and then another depending upon the priority of the task in a given problem context. At any given time, the task with the highest priority becomes the focus of attention. The COGNET architecture consists of a problem context, a perception process, tasks, a trigger evaluation process, an attention focus manager, a task execution process, and an action effector.
Type (e.g. observation, questionnaire, interview, checklist, measurement instrument, etc.):

Information-processing models

**Technical description of method or tool etc**

Description of the content/study:

COGNET - COGnition as a NETwork of Tasks, developed by Wayne W. Zachary, is used for performing cognitive task analyses and building models of human computer interaction in real-time, multitasking environments (Zachary, Ryder, Ross, and Weiland, 1992).

It provides an integrated representation of the knowledge, behavioural actions, strategies and problem solving skills used in a domain or task situation. (Yates K. A., 2007, Towards A Taxonomy Of Cognitive Task Analysis Methods: A Search For Cognition And Task Analysis Interactions)

The goal of cognitive task analysis is to understand and represent the internal knowledge of experts in the domain of interest. The COGNET framework has been developed to provide a practical tool to facilitate the cognitive task analysis in complex, real-world domains.

- COGNET framework contains 4 types of knowledge representations (Zachary, Ryder, & Hicinbothom, 1998):
  - Perceptual Knowledge
  - Declarative Knowledge
  - Procedural Knowledge
  - Action Knowledge

COGNET has an associated development environment iGEN, which is commercially available from CHI Systems (iGEN® is a patented artificial intelligence engine that mimics the way human experts analyze and make decisions in a wide range of situations), it includes editing, debugging and testing tools.

The most recent version of the modelling system is COGNET-P (Zachary, Ryder, and Le Mentec, 2002). The developers contended that previous versions of COGNET modelled human competency. COGNET-P was specifically designed to model performance and included mechanisms for incorporating time and accuracy constraints. The model also included a meta-cognition component that accounts for executive control of cognitive processes and self-awareness of some of the processes.

Technical requirements for using the method, tool, etc:

COGNET input and output is managed through the iGEN? set of software tools.

COGNET and iGEN? were written in C/C++ and can be run on a variety of platforms, including Microsoft Windows, Macintosh, and UNIX-based operating systems.

Detailed descriptions of iGEN? and COGNET available through CHI Systems Web site.

Measure/Response Type:

For each real or simulated scenario, the activities of each subject expert are observed and recorded for subsequent analysis in conjunction with verbal introspective data collected using knowledge elicitation methods. The verbal data, in the form of thinking-aloud protocols and question-answering protocols
(obtained while reviewing the recorded behaviour), are taken immediately after the problem or simulation has been completed.

Specific verbal probes are often made to clarify these accounts (at which time the replay of the problem is temporarily halted). These primary verbal data are supported by unstructured debriefs by participants, and interviews and critiques by subject matter experts (SMEs) from the domain (especially instructors), particularly during the data-analysis process.

Results obtained and interpretation:

The overall method involves six broad steps:

1. Performing an a priori domain analysis.
2. Defining subjects, settings, and example problems/scenarios.
3. Recording subject performance in real or simulated problem solving, followed as quickly as possible by verbal Question-Answering protocol using problem replay.
4. Analyzing and representing the data, repeating step 3 as necessary.
5. Developing the executable cognitive model, repeating steps 3 and 4 as necessary to achieve the level of detail and quality of elicited expertise required.
6. Validating the CTA result. (Ryder, Zachary, & Hicinbothom, 2000)

**Evaluation**

Advantages:

COGNET has been successfully used to model human computer interaction and problem solving in en-route air traffic control.

Validation studies have shown the model is able to predict more than 90% of the attention shifts of expert operators.

Works for very large and complicated tasks.

Disadvantages:

The parallelism through rapid attention switching theory has not been completely validated.

COGNET does not allow for any learning by the model.

Apparent scientific isolation.

Alternative Methods:

SOARS (State, Operator And Result, http: [www.umich.edu/~bcalab/epic.html](http://www.umich.edu/~bcalab/epic.html) [3])

EPIC (Executive Process Interactive Control, http: [www.umich.edu/~bcalab/epic.html](http://www.umich.edu/~bcalab/epic.html) [3])

**Usability (ease of use, efficiency, effectiveness)**

Ease of use:
medium

Efficiency:
medium

Effectiveness:
medium

Constraints concerning conditions of use:

COGNET can be used in actual environment or a simulated equivalent.

Reliability:

n/a

Validity:

Validation studies have shown the model is able to predict more than 90% of the attention shifts of expert operators.

Required effort (to conduct & to analyse):

Medium to high

**Level of HF expertise needed (required user qualification)**

High: high level of expertise required, only for experts, lots of training required

Other expertise needed (required user qualification):

SMEs

**Cost Information**

Information at: http://www.chisystems.com/

Experiences of use by SESAR partners (including references):

not available

Reported and/or published experiences of use (including references):

Although perceptual and motor functions are represented in COGNET, this model is probably better suited for contemplative, open-ended tasks that are not strongly perceptual-motor in nature. COGNET is particularly well suited to modelling complex time-constrained, multitask situations that require performers to switch the focus of their attention repeatedly. Morrison, J. E. (2003) A Review of Computer-Based Human Behavior Representations and Their Relation to Military Simulations (IDA Paper P-XXXX). Alexandria, VA: Institute for Defense Analyses.

Applicability to lifecycle phase (E-OCVM):

V2, V3

Application Area:
COGNET was applied in a number of complex domains: The original development and application was to a vehicle tracking domain (Zubritzky, Zachary and Ryder, 1989). Then it was applied in air antisubmarine warfare (Zachary et al., 1989); in ATC (Seamster et al., 1993), in naval command and control (Zachary et al., 1993). It was also used to design interfaces for telephone operators (Ryder et al., 1998) and as the basis for an intelligent tutoring system embedded in a shipboard tactical air defense system (Zachary et al., 1999).

Keywords:

Human-computer interaction; decision-making; cognitive modelling; ASW; COGNET; attention; adaptive interface; Cognitive Architectures; cognitive task analysis.

Short Description:

COGNET is a framework for modelling human cognition and decision-making which provides an integrated representation of the knowledge (mental model), procedures, strategies and problem solving skills used in a domain or task situation, yielding the data for a cognitive engineering tool for the design of user interfaces. The goal of cognitive task analysis is to understand and represent the internal knowledge of experts in the domain of interest.

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Links