

# ***LOCATE* Intelligent Systems Demonstration: Adapting Help to the Cognitive Styles of Users**

**Jack L. Edwards and Greg Scott**

AI Management and Development Corporation  
206 Keewatin Avenue  
Toronto, Ontario, Canada M4P 1Z8  
jle@aimdc.ca

## **Abstract**

*LOCATE* is workspace layout design software that also serves as a testbed for developing and refining principles of adaptive aiding. This demonstration illustrates *LOCATE*'s ability to determine user cognitive styles and provide help matched to those styles. Users are assessed along a Wholist-Analytic dimension and a Verbal-Imagery-Kinesthetic "trimension" and that information is stored in a User Model maintained by *LOCATE*. Help options provided to users for selecting alternative forms of help permit the system to track those selections and allow for system adaptation to the user's preferred style of help.

## **Background**

*LOCATE* is a full-featured software application that supports design, analysis and optimization of workspace layouts. It plays an important role in Defence Research and Development Canada's (DRDC's) ongoing efforts to develop, test and refine principles of adaptive aiding within an extensive and robust intelligent help system. *LOCATE* currently is in transition from a mature application, emerging from a testbed for studying adaptive aiding, to a commercial system, expected by the end of the year.

*LOCATE*'s infrastructure tracks user actions, goals and plans and uses that information to provide intelligent aiding. It includes a plan recognition component, based in part on the COLLAGEN work of Rich, Lesh and Sidner (1999), using plan trees dynamically assembled from a library of pre-scripted plan recipes. Other elements incorporate various theoretical and practical approaches.

Among *LOCATE*'s Explicit Models (Edwards and Hendy, 2000) is the *User Model*, which contains knowledge of a user's capabilities, needs and preferences and plays a particularly important role through information keyed to individual users and maintained across sessions.

Using the action, goal and plan tracking mechanism, *LOCATE* interprets the results in terms that can signal a need for help. Help is indicated when any user activity violates one or more of five *help criteria*: 1) Safety; 2) Correctness; 3) Completeness; 4) Efficiency; and, 5) Consistency.

Factors suggesting a need for help arise from a *Task x Criteria Analysis*, a design tool for system developers to examine major software tasks, determine ways in which users might violate each of the five help criteria and specify strategies for correcting them.

Users are offered help from a variety of *LOCATE*'s help resources: 1) A Quick Start User Manual; 2) Wizards and contextually-based wizard fragments; 3) A Tutorial and contextually-based tutorial fragments; 4) Hypertext help; 5) System-initiated, contextually-based help.

Finally, recent testbed work, built around the *LOCATE* tool, used a variety of theoretical approaches to help construct a comprehensive, integrated framework for the design and implementation of intelligent, adaptive, agent-based help systems. The methodology consists of top-level models populated in the process of designing and implementing intelligent adaptive systems (see Scott and Edwards, 2005).

## **Technical Basis for the *LOCATE* Demonstration**

The demonstration of the *LOCATE* system presents some of the foundational elements of adaptive aiding and concentrates on recent work that re-engineered the entire set of help resources to accommodate individual differences in cognitive styles. The most recent addition to the testbed work in general, and the *LOCATE* workspace design tool in particular, is a module that matches the kind of help offered to users with their identified cognitive styles, that is, with their preferred ways of learning and processing information.

Designing and implementing that module involved three challenges:

- determine the range of cognitive styles to measure;
- find a way to measure the styles of *LOCATE* users, both upon initial exposure to *LOCATE* and subsequent feedback as the user interacts with the software tool;
- re-engineer *LOCATE*'s help resources so the same help provided to one user, with one preferred style of learning, can be provided in different forms to users with other preferred styles.

Efforts to address those challenges involved a review of the recent cognitive styles literature and examined a wide variety of methods both within the cognitive styles area and from related disciplines, such as learning theories, decision-making, intelligent tutoring and cognitive biases. The goal was to seek commonality in constructs and draw upon elements that have gained widespread acceptance.

The result was a new, integrated approach to classifying the cognitive styles of *LOCATE* users that could help form an accurate and complete profile of user styles. At its foundation is a classification scheme, known as Cognitive Styles Analysis (CSA), which integrates a number of the most common concepts from the cognitive styles literature into a single two-dimensional scale (Riding & Cheema, 1991). One dimension is a Verbal-Imagery scale that describes a person's tendency to process information either through language or through visual representations. The second dimension is a Wholist-Analytic scale that classifies people as to whether they organize information into wholes or parts. An addition was made to the first of these scales to accommodate users with a Kinesthetic style, that is, those who tend to prefer "learning by doing."

The second challenge of measuring cognitive styles was problematic since most approaches involved answering a considerable number of questions. Luckily, work at the University of Saskatchewan on an iHelp system that matches students with compatible tutors (Bull and McCalla, 2002) had incorporated cognitive style as one component of a user profile. The cognitive style component was determined on the basis of answers to a short questionnaire. Adapting that to *LOCATE* involved re-wording some of the original questions and adding others to accommodate the Kinesthetic style. The result was five statements that *LOCATE* users are asked to use to describe how they prefer to learn new material. Answers provide *LOCATE* with a preliminary identification of a new user's cognitive style and tracking subsequent preferences for different types of *LOCATE* help provides the basis for refinements to that preliminary judgment.

The final challenge was to re-engineer the range of *LOCATE* help resources to accommodate the different ways users learn and process material about the application. An examination of those resources revealed that most, but not all, could be re-engineered. The one exception was *LOCATE* wizards: highly stylized procedures for taking a user through complex processes. In general, wizards are biased to the accommodation of a Verbal-Analytic style, since they are primarily text-based and take a user through a series of well-defined steps.

Other help materials were re-engineered according to a set of guidelines established to address the needs and preferences associated with the individual styles. One example is the help provided on the various features of *LOCATE*. Over one hundred such features exist and there now are over 600 forms of help available for them to accommodate users with any one of six different styles of

learning. Imagery users receive predominantly graphical help, in the form of either still images or animated demonstrations. Material for Verbal users is textual with minimal use of graphical content. Kinesthetic users are provided with a short description of a feature and then given the opportunity to practice the feature on their own under the guidance of the help system. Help for Analytic users focuses on providing a sequence of instructions for carrying out a particular task. Wholist users receive not only information about a specific feature, but also an overview providing context for that feature, such as how it contributes to the overall process of workspace design.

## Generalizing *LOCATE*'s Cognitive Styles

Since *LOCATE* is part of a testbed for the study of adaptive aiding, it is important to understand how principles embedded in the work on cognitive styles might generalize to other domains and applications. Following evidence for the usefulness of customizing help to an individual's cognitive style, help resources in any application could be re-engineered using the guidelines followed in *LOCATE*. Organizing cognitive style information within an application's User Model would aid in decisions about what help information to provide and when and facilitate its co-ordination with other related user information.

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