

*This paper describes the conceptual design and prototype implementation of the "Knowledge Board"—a set of hypertext "templates" which integrate a body of texts (whose knowledge footprint and interconnections have been made explicit through hypertext) and a set of cognitive-support tools for composing an issues-oriented, analytical text which either codifies, extends, or mediates among various source texts.*

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### **Weaving Webs**

Hypertext has been variously characterized as non-linear prose, interactive print, or dynamic text. The basic elements are *nodes* (chunks of text or graphics) and *links* (connections indicating a relationship). Both contribute to hypertext's ability to fashion knowledge from information. *Nodes* deconstruct the linear sequence of printed materials, making possible dynamic recombinations. *Links* indicate the relationship among nodes (through types and attributes), creating a conceptual graph, similar to a semantic network.

Problem-solving platforms implemented in "intelligent" hypertext support early, unstructured thinking on a problem. Similar to storyboarding, these systems encourage the "problem-solver" to emulate the heuristics of an expert by providing "templates" which encourage guided-inductive exploration of the problem space. Similar to task simulation (a seasoned concept in computer-based training), these systems reify obscure or opaque mental processes. (To "reify" a concept is to transform the unobservable into objects that can be examined and inspected.) Because hypertext provides "objects" for obscure mental actions, the process of thinking can be examined and managed (in real time) by the thinker.

### **The Knowledge Board as an Interactive Problem Space**

*The Task:* The rhetoric task modeled by this software involves a type of writing familiar to managers, investigative reporters, engineers, and researchers—to name just a few. In issue-based writing, source documents become the raw materials in composing a position paper, an evaluative summary, an interpretive response, or the like. The *Knowledge Board* is a prototype of a comprehensive, integrated writing environment providing cognitive support for professionals who create complex documents as part of their job. It differs from many other computer-aided writing tools in that it is an end-to-end development tool. It assists the writer throughout the process, from generation of ideas to production of connected prose.

*Cognitive Models:* Reasoning with language requires not only ingesting information but also understanding content well enough to draw inferences and to apply concepts in different contexts. These critical skills, augmented by domain-specific knowledge, are the foundation of mature learning strategies and expert behavior patterns for reading and writing. Several major cognitive studies in the past decade have examined how verbal reasoning happens (Anderson 1983, Bereiter and Scardamalia 1987, Flower and Hayes 1980). This project uses a problem-solving paradigm to explain writing and emphasizes the power of representation or reification in helping the writer to move gracefully through the activity spaces of the task (Neuwirth and Kaufer 1989).

*Software Components:* As indicated by Figure 1, the complete *Knowledge Board* uses Bereiter & Scardamalia's (1987) notion of a *content space* (essentially, summarizing, analyzing, and synthesizing

## **Using Hypertext as an "Intelligent" Workspace for Writing Issues-Based Prose**

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information about the topic) and a *rhetoric space* (essentially, planning and organizing the domain information into a logically and stylistically appropriate formal artifact). Six distinct cognition enhancers help with sequencing the tasks and managing the mental load. Each element is more fully explained in the next segment.

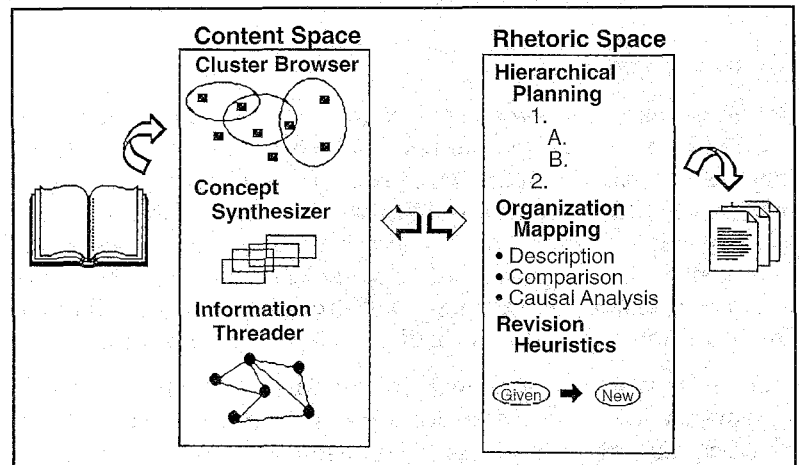


Figure 1. System overview of the Knowledge Board.

### Software Tools and Cognitive Support for Writing

**Cluster Browser.** Analogous to the convention of “view” in a Database management system, this component helps the writer to locate specific concepts in a collection of source texts. (The assumption is that the writer has given the source documents a cursory reading prior to beginning a writing task.) Unlike traditional print technology, the Cluster Browser guides navigation through a textbase by extracting a knowledge footprint for the entire corpus of source materials. The resultant database represents a deconstruction of the source texts: linear sequence is abandoned and boundaries between documents are dissolved.

**Concept Synthesis.** This tool aims to consolidate ideas around central concepts introduced in the source texts. However, the exercise also serves as a *brainstorming session* in that the writer is encouraged to try out various permutations and elaborations on the core concepts. To prod thinking at this point, the writer can request a set of prompts based on known invention heuristics. While these aids foster exploration, they also focus the author’s thinking.

**Information Threader.** After a reasonable period of working with the Cluster Browser and its complement, the Concept Synthesizer, the writer may start to feel overwhelmed by the sheer amount of data and “views” generated. The Information Threader begins the sculpting process for the final text by coaching the writer to see potential structures. Modeling the notion of basic inquiry, this exercise leads the writer to conflate—using the dimensions of similarity and difference (comparison and contrast) as pruning criteria. The result is a collection of possible thesis and/or topic statements.

**Hierarchical Planning.** Writing from sources is a multi-deminsional task. Several models for composition acknowledge this complexity by positing layers of cognitive activities which the writer moves through as she hones the product in different levels of refinement

(Bereiter & Scardamalia 1987, Streitz 1989). The Hierarchical Planner marks a major transition in the process modeled in the *Knowledge Board*. It is a nexus at which the information structures woven in the “thinking and threading” segment must be reconceptualized to meet the requisites of linear text. Smith et al. (1987) discuss this change as a transition from a semantic net (essentially 3-D mental structure) to a hierarchical outline (essentially 2-D concrete representation). This “tool” helps the writer to make this all-important transition from an implicit mental model to an explicit, culturally-defined artifact.

*Organization Mapping.* Similar to the *drafting* stage of writing, Organization Mapping helps the writer to focus more intensely on the requisites of the logical form and the social conventions of text. Rhetoric and discourse studies have produced fairly detailed descriptions of the modes (e.g., causal analysis, classification, comparison, definition, description, and narration, and the like). Organization Mapping instantiates a specific taxonomy developed by whole-text discourse analysis (Meyer 1985, among others).

*Revision Heuristics.* Revision usually refers to substantial changes, such as improving style, adding to or subtracting from the content, rearranging parts, or completely writing. These more global, deep-structured revision activities are associated with higher-order cognitive skills (discerning patterns in bodies of information, exercising judgment, analysis, synthesis, and other metacognitive activities). Heuristic Revision comprises a suite of tools for improving both coherence and expression. These tools are *strategic* (encouraging a re-thinking of high-level issues, such as purpose, point-of-view, audience analysis, voice, focus, and form) and *tactical* (including techniques of elaboration, such as level of detail, examples, support, flow, and balance).

### **“Partnering” with the Writer**

*Models “Expert” Behaviors.* Experts are proficient at deconstruction—that is, partitioning the task into elemental components. The expert works on the pieces for a time, steps back to compare interim results with higher-level goals, consolidates gains, jettisons unrealistic expectations or excess constraints, reorders plans (this might include satisficing), and moves back to working on the pieces again. The cycle takes place over and over during the problem-solving session. The expert excels where the novice fails because of this flexibility, this capacity to move smoothly between top-down and bottom-up strategies.

In essence, the *Knowledge Board* provides an exploratory world where the writer is helped to discover (and hence to emulate) the empowering strategies of an expert writer. Like a set of “training wheels for the mind” (Carroll 1990), the tools in this integrated environment provide balance and confidence.

*Integrates Knowledge Tools.* Computerized writing environments are still in their infancy and can be represented by the Writing Environment (WE), developed at the University of North Carolina, Chapel Hill, (Smith et al. 1987, Schuler and Smith 1990) and CSILE (Computer-Supported Intentional Learning Environments) developed at the Center for Applied Cognitive Science in Toronto, Ont., Canada (Scardamalia 1991).

Commercial packages offering the user a collection of tools (as the analysis routines in the Writer’s Workbench) have been around for

some time now. Nevertheless, it is important to recognize that these tools are separate entities. While the writer is free to pick and choose among them, the tools are not integrated. In other words, work done with one tool does not translate seamlessly to the "world" of another tool. At a minimum, this is inconvenient. More telling for a worker or a learner, gains in one stage of composing are not easily consolidated and carried forward to the next stage. In fact, the welter of detail generated by some tools or heuristic routines may constitute a step backwards in that the writer has to deal with (1) the cognitive overload of multiple versions or even contradictory instances of the same thoughts and (2) a potentially recurrent *dis*-integration of thoughts constructed while working with different tools or heuristic devices.

On the other hand, a writing environment's suite of tools is integrated into a structured, cognitive model of writing. Figure 2 is a conceptualization of how layering a consistent web structure throughout the *Knowledge Board* gives the writer the opportunity to view her composition—in process—from multiple levels of abstraction. The "layering" nature of hypertext implicitly provides a loose coupling of source text(s) with the writing process. Additionally, the links create a "trace" device or composing trail that can be consulted throughout the writing process (represented as 8 layers in the model).

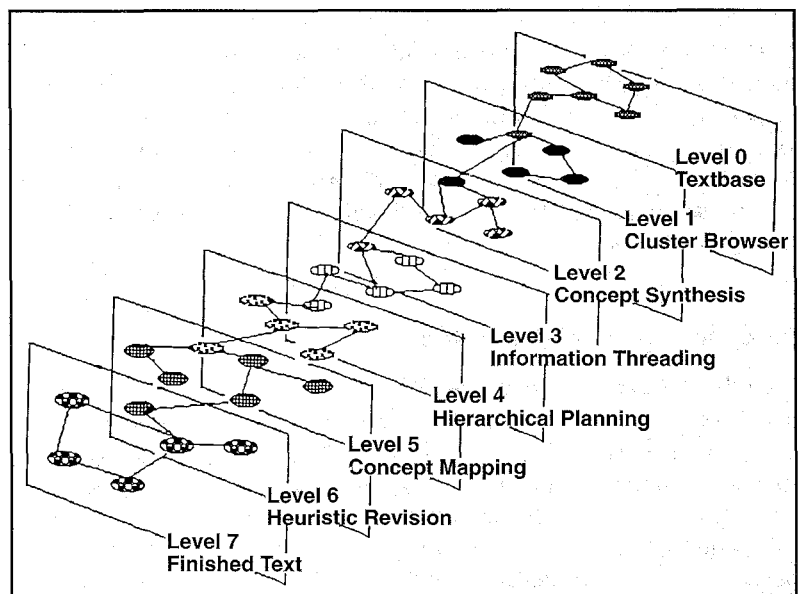


Figure 2. Composite of the process model.

A well-designed environment orchestrates the writing process by emulating stages of thinking. Few existing writing environments include conventional AI applications (e.g., expert systems). Nevertheless, because the whole system supports and guides the activities of thinking, these knowledge-making habitats should be characterized as "intelligent."

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