

## **Behind the Image: Representing Design Concepts**

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### **Introduction: Design Concepts as Design Representations**

In this paper we report on research in which the Internet is considered an environment for the storage and retrieval of design knowledge. The nature of the net as a medium for the representation, storage and accessing of design knowledge is reviewed and the attributes of the medium are analyzed. We elaborate on the appropriateness of certain attributes of the technology as providing means for representing not only the physical representations of design, but also their conceptual content. Furthermore the research demonstrates that the embedding of design conceptual content in web-based representations provides a powerful advantage for strengthening and expediting the processes of search and retrieval in design knowledge bases.

Current problems of search and retrieval in net-based resources are considered. The need to develop and refine advanced search mechanisms is postulated as a prerequisite for web-based design knowledge bases. One approach to improving and expediting search is that of intelligent search agents. This is exemplified by new products such as Surfbot and Webcompass which can extract information from sites and deliver a personalized report, or search and extract information without dependence on explicit requests by the user. Our approach considers the strengthening of the conceptual content and structure of the representation of design knowledge as a key to the expedition of search. Information structure, the way information is displayed and organized, has implications for functionality in navigation, browsing and search. Furthermore, if we are interested in the collaborative development of shared sources of knowledge, we require accepted structures and models behind the organization and presentation of design information.

### **Structuring Design Concepts**

We report on research into the implementation of representations of conceptual structures which incorporate prototypes, metaphors and analogies into the representational structure. This expanded representation of design concepts enables the development of a structure (semantic nets of concepts) which are domain specific, that is, particularly relevant to particular interest groups or design tasks.

Prototypes form a basis for such conceptual structures. We categorize things in terms of prototypes. A prototypical chair has a back, seat, legs etc. Properties relevant to our comprehension of chairs will include perceptual properties, functional properties and purposive properties. We demonstrate the exploitation of prototypes in the creation of a conceptual structure of design knowledge related to chair design.

Metaphors and analogies can expand the basic structure of concepts created by prototypes and enhance concept expansion. Metaphors according to Lakoff and Johnson, "are capable of giving us a new understanding. ....Because so many of the concepts that are important to us are either abstract or not clearly delineated in our experience we need to get a grasp on them by means of other concepts that we understand in clearer terms.

This need to metaphoric definitions exists in our conceptual system ". We demonstrate how people understand normal concepts in terms of systematic metaphors. Analogies can further expand this functionality. Koestler has proposed that creative thinking depends on the interlocking of two domains of knowledge previously seen as unrelated or incompatible. Analogies make it possible to understand one situation in terms of another. Analogy is guided by a pressure to identify consistent structural parallels between roles in the source and the target domain.

We demonstrate that "structured conceptual representations" have, beyond the improvement of functionality, potential for supporting the conceptual linkages, or concept expansion, which is characteristic of creative thought in design. Furthermore, such enhanced conceptual representations of design concepts can also support search through design ideas in an associative manner as well as concept formation in creative design. Metaphors and analogies embedded in conceptual representations are demonstrated to promote functionality of associative search in design knowledge bases. Prototypes, metaphors, and analogies are three types of conceptual structures which can be integrated.

**Conceptual Structures in Design Knowledge Bases** We report on experimentation with three classes of conceptual structures (prototypes, metaphors, analogies) in a knowledge base which has been implemented. The knowledge base is intended to provide a design resource for chair design. The knowledge base called, "The Modern Chair" contains a set of known design precedents of modern chairs. The representations include various forms of graphic content, textural material, related examples and design precedents. In addition to these forms of content there is a superimposed structure of design issues and concepts which enhance linkages and associative search through the knowledge base. We describe the system operation and analyze the functionality gained by the embedded conceptual structure.

The knowledge base was developed collaboratively in a classroom simulation of an "open web site" in which such a design knowledge base could be collaboratively constructed. The paper reports on the educational experiment, the findings relevant to the requirements for collaboratively constructed knowledge bases, and the learning experience of the students. The pedagogical content represents a research- oriented approach to computational design studies.

The conceptually enhanced graphic knowledge base was edited and implemented in Oracle by the author.