

# Design Knowledge Capture Using Cmaps

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## Abstract

This research project deals with the integration of knowledge management and case-based reasoning (CBR) in the capture of knowledge in the design process. The project uses, as a prototype, design problems from courses to implement a database of solved design problems for capturing design knowledge and allowing to use these solutions in solving future problems. Concept Maps (CMaps) software is used to capture the design problems and their solution. CMaps provide a framework for capturing experts' knowledge and making it explicit in a visual form that can be easily examined and shared. The set of problems archived in the database is used to solve other problems and to share and save the experts' knowledge in the field. The method can be extended to solve real and complex design problems in computer sciences and engineering such as robots, expert systems, programming, logic circuits, and many other applications.

## 1. Introduction

This research project deals with the integration of knowledge management and case-based reasoning (CBR) in the knowledge capture of the design process. Knowledge management, a new technology in the field of artificial intelligence, promotes an integrated approach to identifying, capturing, retrieving, sharing, and evaluating information such as

databases, documents, policies, and procedures as well as the uncaptured tactic expertise and experience stored in individual designers' head. Case-based reasoning (CBR) uses cases to reason and solve problems similar to the way human's reason. CBR uses past experience in solving new problems by storing previous experience or cases in a case base or database of cases.

This project uses, as a prototype, design problems from courses to implement a database of solved design problems for capturing design knowledge and allowing to use these solutions in solving future problems. Concept Maps (CMaps) software is used to capture the design problems and their solution. Concept mapping is a simple and intuitive methods of representing knowledge in a clear and natural form than is possible with other forms such as pure text and predicate logic. CMaps are made of nodes that represent concepts. Nodes are connected by arcs and represent the relationship between the concepts. Usually, both, nodes and arcs are labeled showing the concept and their relationship. Concept maps can be used for decision making, design, description, planning, and modeling. Concept maps can be used to collect designer's knowledge and cognitive skills not available to others. This is the kind of knowledge and design experiences not found in books and other written sources.

The information contained in a concept map could be retrieved automatically by a computer program (Kremer 1994) if a “syntax” is created to formalize the semantics associated with the maps. The automated agent could be used for decision support and knowledge-based inference such as design.

## 2. Background

Case-Based Reasoning is a new technology that helps to solve problems by storing, retrieving and adapting past situations or cases. In case-based systems a “case” is usually a specific problem that has been previously encountered and solved. Like most humans, when faced with a new problem, a case-based system compares the current problem with cases encountered in the past to determine if one of the earlier experiences can provide a solution. If a similar case exists, the solution to complex problems is found in matter of seconds. If the system retrieves a case that is similar but not entirely appropriate to the current problem, the case-base system will provide a new solution from known cases. This new case will be added to the case base for future use. CBR works well even in domains that are poorly understood because the case-based system does not need to know why a solution worked in the past. CBR is a technology that allows finding analogies between a current working situation and past experiences (these are the reference cases). Case-based reasoning makes direct use of past experiences to solve a new problem by recognizing its similarity with a specific known problem and by applying its solution to find a solution for the current situation. In contrast, induction first needs to construct a decision which is the save for all problem solving episodes. This approach is sometime too rigid and nearest neighbor overcomes some limitations of induction technology.

Knowledge management, a new technology in the field of artificial intelligence, has been defined in as many different ways as there are people defining it. Gartner Group ([www.gartner.com](http://www.gartner.com)) defines it as: “Knowledge management promotes an integrated approach to identifying, capturing, retrieving, sharing, and evaluating an enterprise’s information assets. According to the Gartner Group, these assets include databases, documents, policies, and procedures as well as the uncaptured tactic expertise and experience stored in individual workers’ head. However, it is not certain how this will impact the future company organization and how it will be used.

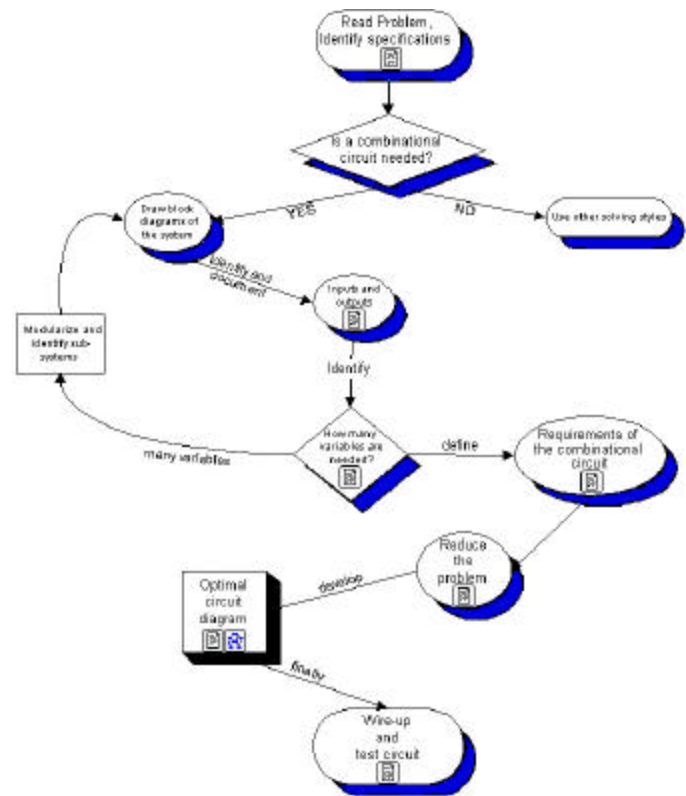


Figure 1. Concept Map

Knowledge is considered to be any form of information that one might be able to manipulate in one’s brain. The word acquisition implies inputting process, but in the computer field, the term implies

manipulation, storage, presentation and many other processes performed on the knowledge. It is this context that the term “knowledge management”, being a broader term, better describes the operation intended to be done by the computer system designed to obtain, manipulate, storage, and more important reuse the obtained knowledge in the same or different situations. Others define the term as a technique to promote an integrated approach to identifying, retrieving, sharing, and evaluating an enterprise’s information assets. These information assets may include databases, documents, policies, and procedures, and the uncultured tactic expertise and experience stored in individual workers’ minds.

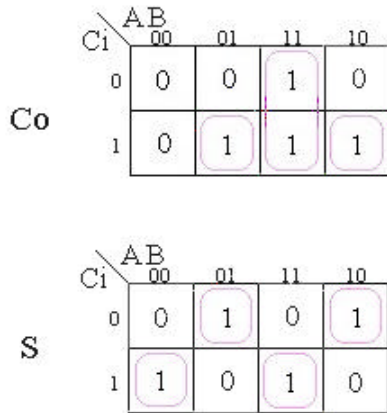


Figure 2. Karnaugh maps used to simplify the Circuit

### 3. C-Maps for Knowledge Capture and Sharing

A design case prototype (Figure 1) has been implemented using CMaps consisting in a full-adder logic machine. The map shows all design steps including: problem specifications, block diagram, circuit requirements, ‘wire-up’, etc. Each of the design steps is associated (Figure 2) with a concept and concepts are connected by arcs that indicate a relationship between them. The final design step includes a test circuit and implemented using an animated drawing

showing the full-adder with three input switches with two positions corresponding to values zero and one (Figure 3). The outputs are the sum (S) and a carry (CO) modeled as lights that will be turned on if the value of the corresponding output becomes one or will be off when the output is zero.

Two software tools were utilized for the CMap prototype: IHMC CMAP Tool from the University of West Florida (Cañas 1999) and Inspiration Version 6 by Inspiration Software Inc. These tools are under consideration and testing for its use in the extension of this research project. Both tools have positive and negative characteristics and the final selection will be based on the versatility and resources that the tool allows to use in the map creation process.

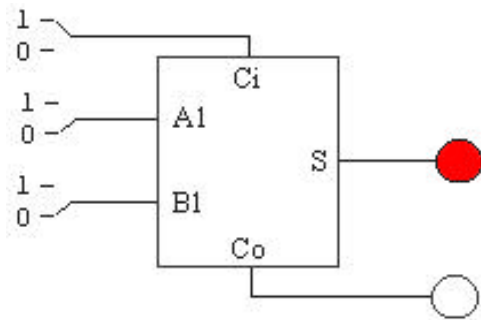


Figure 3. Final Prototype for the Full-Adder Machine

### 4. Conclusions

A design case study using Cmaps has been presented. The Cmap prototype shows design concepts connected by arcs that represent the relationship between design steps. Each concept has additional information about the design that is retrieved by clicking on the concept and another window with details about the concept will be open. More design cases will be added to prepare a fully operational prototype. Other features will be added to the Cmap design representation such as video and audio.

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