KNOWLEDGE BASED DESIGN EDUCATION

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ABSTRACT

What kind of difficulties could a design education professional encounter nowadays? A junior professional could find it difficult to organize a syllabus, and his lectures in the first years will probably not contain a lot of significant information as a result of a lack of experience and knowledge. Also, scientific and technological advances are so frequent that a senior professional often has difficulty updating their syllabus at the same rate.

The aim of the present work is to propose a Knowledge Based System (KBS) in order to organize the knowledge referred to design education. The proposed system begins with the methodology for collecting information, aided with tools such as mind maps. The KBS works with databases where the collected information is organized, and through a system of rules and restrictions that links the input and output information provided for/to the user with the databases of knowledge. The KBS allows the knowledge of the whole group to be available for any particular user at any given time. Even if one professional leaves the group, his knowledge will remain in the group.

The KBS can be applied to more than just syllabi: exams, presentations or papers that can be easily created with this kind of system. In this paper, this proposal is aimed towards eco-design education.

Keywords: Knowledge Based Systems (KBS), design education, eco-design, knowledge.

1 INTRODUCTION

In the field of education, knowledge management can provide solutions to problems that frequently occur. A junior professional could lack useful knowledge and experience for preparing lectures, exams, projects, etc. As a result, the standard of his lectures could be insufficient and the content could vary in the first few years. More experienced professors could be unaware of the most recent innovations in their field, causing their syllabi to be obsolete. As a result, students could encounter great shortcomings in their education upon entering the workforce. Whether it be a junior professor or an experienced one, it is simply impossible for a professional to know all of the aspects of their field. These are just two examples of problems related to knowledge management in the field of education [1-3].

The current need for knowledge management in different industries has resulted in the creation of a series of tools known as Knowledge Based Systems (KBS). These systems are the result of a long process of investigation on Artificial Intelligence. In the seventies, it became evident that the problem solving capacity of a computer program does not only reside in its formal expression or its logical inference schema, but in the knowledge that it possesses. Thus, a knowledge based system is a cluster of computer programs that attempt to imitate, or even surpass, a human expert in a specific area. The aim is not, by any means, to reproduce human thought, simply the expertise of an experienced professional [4-7].

In the field of design, the development of ontologies is being focused on more and more as a possible solution to the deficiencies of KBS [8]. This progress encompasses the sharing of knowledge and the development of a standard engineering language. An ontology can be defined as an explicit specification of a shared conceptualization, which can be taxonomically or axiomatically based. Taxonomies consist of concepts and relationships that are organised hierarchically and whose concepts can be arranged as classes with sub-classes [9]. The application of ontologies has been demonstrated in different studies carried out by Kitamura [10] and Cebrian-Tarrason [11].

Several authors have previously attempted to create aids (methodologies, tools, etc.) for design education [12, 13]. The proposal put forth in this article consists of the creation of a tool based on KBS, which will be capable of classifying and managing knowledge contributed by teaching professionals. It will also be able to provide information to the user such as syllabi, exercises, exams, etc. The best way to create such a tool is by means of a KBS that will interact with different databases through semantic queries, based on an ontology (figure 1).

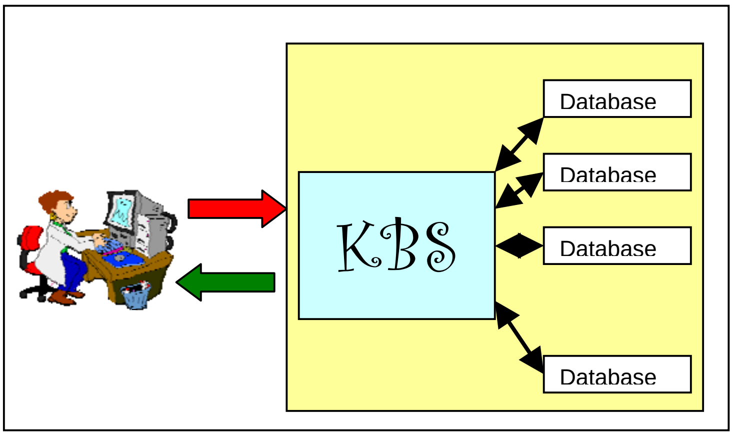

Figure 1 The proposed tool has a set of databases managed by a KBS

2 MATERIALS AND METHODS

To be able to carry out the design and ensure the proper functioning of a KBS to aid design professionals, it is necessary to use and be familiar with a series of specific methodologies. Among these, the most important ones are detailed below.

KBS and KBE (Knowledge-based Engineering) are considered AI (Artificial Intelligence), like Expert Systems or Rule-based Systems. KBS is applied to systems that carry out tasks by applying rules based on symbolic representations of knowledge, instead of using algorithms or statistical methods. The key to KBS is that it defines a differentiation between the knowledge itself and the control aspects. Despite the fact that the development of a KBS is based on KBE techniques, its actual definition depends on languages used to model engineering software. The development process of a KBS is the same as that of almost any other system (figure 2), consisting of the phases of definition of requirements, system analysis, design of the system and implementation. The steps taken to define a KBS are: company modelling, conceptual modelling, knowledge capture, knowledge-system design and implementation. Given that there is no standard procedure for defining a KBS it is necessary to use the modelling technique used by standard engineering software. Most techniques make use of a mix of annotations derived from different programming languages, such as UML (Unified Modelling Language), IDEF (Integrated Definition), SADT (Structured Analysis and Design Technique) and others. This tendency is evident in the creation of several methodologies for defining KBE, such as CommonKADS or MOKA (Methodology and tools Oriented to Knowledge-based engineering Applications).

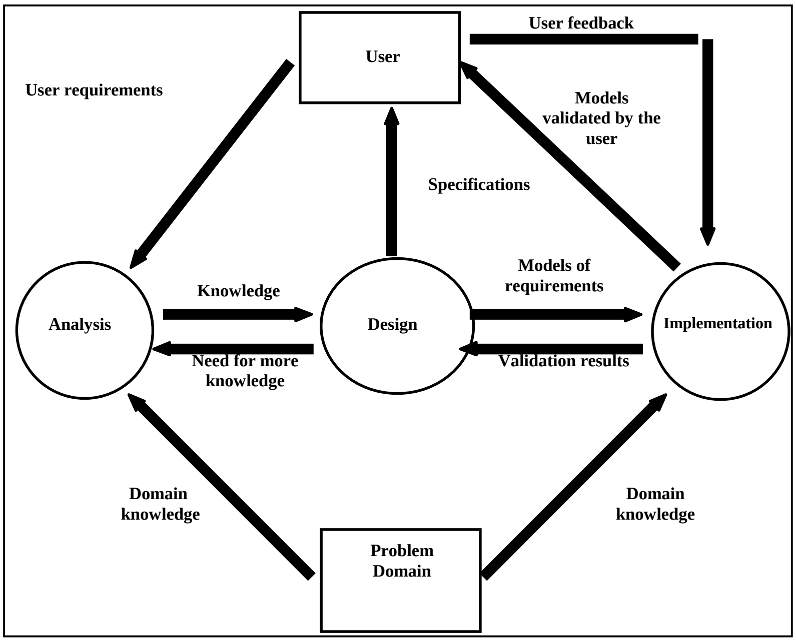

Figure 2 General diagram of system development

UML is a graphic language for visualizing, specifying and documenting each of the parts that make up software development. UML is a general purpose language for modelling objects, whether they are conceptual such as business negotiations and system functions, or concrete such as schemes of databases or reusable software components. Promoted by the Object Management Group (OMG, www.omg.org), the UML language combines notations originating from modelling of objects, data, components and workflows.

A development process should offer a series of models that allow for the representation of a product from all of the relevant perspectives. A model captures a view of a real world system and it is a description of a system (or a part of it), described with a well-defined language. A well-defined language is one with precise syntaxes and semantics that can be interpreted and manipulated by a computer. UML establishes four models for representing systems (classes, states, cases and deployment). A diagram is defined as a graphic representation of a collection of modelling elements, frequently depicted as a graph with vertices connected by arcs. UML standardizes nine types of diagrams for graphic representation of a system from different points of view (classes, objects, interaction-sequence, interaction-communication, use, state, activities, components and display).

MOKA consists of an intermediate phase between knowledge and the applications that will be used to manage it. In the MOKA methodology there are different figures or roles implied in the process, definition and use of a modelling language: experts on the subject, knowledge engineers, computer engineers and final users.

In the process, the experts transmit their knowledge to the knowledge engineers, so that they can transcribe it to MOKA, by means of the ‘informal’ software tool ICARE, to transfer it to formal MML (Multiple Method Language) or others . This transcription is initially carried out to create an informal model (table 1), that is later transcribed to a formal model, which the computer engineers can understand and use to develop applications. By means of a generation code, and alter a series of iterations, the KBS application is obtained and personalized for the final user. It is worth noting that in the knowledge acquisition process for the modelling carried out by the knowledge engineer, the engineer is in contact both with the knowledge experts and the final user. This is to ensure that the creation of the informal/formal model includes both the knowledge of the experts as well as the final user’s requirements. The final users can also use the informal/formal model as a reference tool and as a base for possible adaptations or modifications.

Table 1 Concepts of the informal model

Representation	Concepts
Entities	Objects that describe the product
Illustrations	To register historical cases, anecdotal information
Constraints	Physical or geometrical restrictions, etc. of objects or of object attributes.
Activities	Elements of the design process
Rules	Knowledge that directs decision making in activities

Ontologies can be categorized according to their conceptualization [8], in the following types: metaontologies, domain ontologies, task ontologies and application ontologies. Domain ontologies can be reused within a specific domain (engineering, manufacture, or design). This type of ontologies provide vocabularies about concepts within a domain and their relationships, the activities taking place in that domain, and the theories and elementary principles governing that domain.

Based on the methodologies discussed so far, the proposed procedure for developing the KBS tool, taking as example a subject about Ecodesign, is detailed below.

Using the scheme of a KBS (figure 1) as a basis, the ontology will serve as a link between the different databases that will be added on to the system. The aim is to interconnect the information and make it available on different levels to the final users.

When it comes to collecting the necessary information for the system, a tool will allow for addition and consultation of information. This tool will obtain the formalized information in the form of an ICARE template that has been optimized for this purpose.

Upon organizing the system information, the hierarchic semantics of the ontology would be taken advantage of in order to distribute the different material provided and utilized by the users. In this way, the distribution could be established as demonstrated in figure 3. Thus, the system would be structured in such a way that it could link directly the database with the area that needed to be accessed.

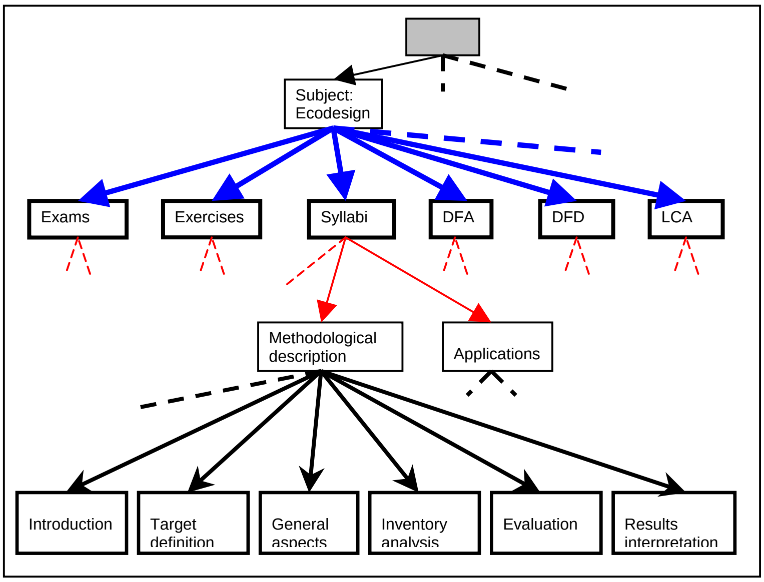

Figure 3 Proposed ontology of the KBS

Also, UML could be taken advantage of in order to organize the roles of the system users, and thus establish a distribution of tasks and permissions according to levels. As a result of the organization of user roles, restrictions could be established to limit certain actions within the system.

If a junior professor wanted to access the system to prepare some course syllabi, an application with a template would allow him to indicate the necessary information. At this point, the ontology would provide information in the form of class notes and presentations.

The method for updating the system would be closely linked with the information being added and the number of users participating. Thus, as new information would be added to the system, the database would be automatically updated.

3 DISCUSSION & CONCLUSIONS

The use of a KBS in the field of design education gives us the advantage of having the knowledge related to courses structured in an efficient manner. This results in greater efficiency upon creating syllabi, exercises and other aspects of a course, which allows for a higher standard of teaching. This, in turn, ensures that students, irregardless of a teacher's previous experience, receive the same level of teaching. Also, information is continuously updated, and the system can use logical rules in order to inform of lacks of information in any place.

Another advantage is the reduction of the amount of time employed by a professor in preparing class notes, presentations and exercises. This can increase the time that professors have both for researching and for improving teaching training.

The main obstacle to reaching this level is that a large amount of cooperation on behalf of the teaching staff is necessary, since some may think that others will be taking advantage of their work. This can be overcome through training to explain the many advantages of the system, for teaching staff as well as students.

In brief, the present article that a KBS tool for design education is feasible, since problems perceived are at a personal level and not at technological level. Most of the showed advantages point the KBS as a propitious tool for groups and departments. A future upper level is an inter-university KBS, which will insure higher and communal teaching quality level.

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