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## AUGMENTING DESIGNERS MEMORY - REVISAL OF THE CASE- BASED REASONING PARADIGM IN ARCHITECTURAL EDUCATION AND DESIGN

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**Abstract.** *This research focuses on the Case-based Reasoning paradigm in architectural design (CBD) and education. Initial point for further exploring this only seemingly comprehensive investigated field of research constitutes the finding that promising looking concepts exist but that they do not play a role in daily routine of designing architects or in university education. In search of reasons for this limited success a critical review of the CBR approach to architectural education and design was performed. The aim was to identify gaps in the CBD research and to discover potential fields of research within CBR research in architectural education and design to improve acceptance and practical suitability. Two major shortcomings could be identified. In the first place the way retrieval mechanisms of systems under investigation relate to the needs of architectural designers and students. At second: Successful CBD systems rely on the work of third-parties in sharing their experiences with others and filling the databases with relevant cases. Therefore two questions remain unanswered: The question of which projects become part of the database and how get existing projects not only described but evaluated. This is an essential task and prerequisite to meet the requirements of the underlying theory of CBR.*

## 1 INTRODUCTION

The starting point for this research endeavor constitutes observations made and experiences gained with the supervision of an interdisciplinary teaching project at Bauhaus-Universität Weimar, Germany. Graduate students participating in this project are asked to analyze contemporary as well as historical housing projects regarding 52 predefined criteria in 8 categories. These criteria serve as basis of the analysis, as means of organizing the data in the database and as search patterns. The database currently contains over 600 housing projects incl. 1200 analyzed criteria and is frequently and enthusiastically used by students and professionals.

Investigations made deal with the use of architectural precedent collections in design education.

## 2 CASE-BASED REASONING IN ARCHITECTURE

Based on the notion that architects frequently make use of existing designs – architectural precedents – to solve current design problems concepts and systems have been developed to support this strategy by means of computer technology since the beginning of the 90's [1]. These systems are based on the AI concept of Case-based Reasoning (CBR), a paradigm for reusing past experiences to generate new solutions of current problems. For design supporting systems the term Case-based-Design Systems (CBD-Systems) has evolved. In this research systems providing a resource of previous experiences to support a designer - design aiding system - in contrast to design automation systems [2] are in focus.

## 3 DEFICIT ANALYSIS

A comprehensive analysis of seven CBD systems (Archi-II, CADRE, FABEL, IDIOM, PRECEDENTS, SEED and WEBPAD), which are a representative selection based on the distinctive approaches and the potential to demonstrate a wide range of directions in CBD research in architecture, was conducted in 2000 by Heylighen and Heylighen and Neuckermans [1,3] The outcome of this extensive research undertaking can be summarized as follows:

- Abstraction of content  
„Design cases are extracted from context and reduced to abstract computer-readable formalisms.” [1, p. 151]
- Danger stemming from the view of the design process as a mere problem-solving process
- Lack of dynamics
- Problem of CBD in design education: Fear of design fixation and prejudices
- Retrieving relevant cases  
„Underlying most CBD research is the assumption that relevance equals similarity, in other words, that the most relevant case is the one having the most features in common with the new design.” [1, p. 146]

The proceeding examination of CBD systems and concepts through literature review and the exemplary trial of corresponding prototypes and their deficit analysis in focus of this paper has the ability to confirm these findings. Since retrieving relevant cases is considered as being crucial for successfully applying CBD systems in architectural education and design it will be discussed in more detail. Beside the above mentioned problems an additional highly

delicate problem of CBD systems in architecture has been extracted and will be illustrated as well.

### **3.1 Retrieval**

To solve problems based on experiences made in past situations it is necessary to recall a suitable situation or past experience in the given (new) situation. It is thereby essential to correctly assess the situation at present to successfully use this human problem solving strategy.

One can understand CBR-based design aiding systems as digital collections of past experiences. To use these systems successfully it is indispensable to extract the right case at the right time. Especially in early design phases architects are often unable to formulate what they would need to look for using a CBR-based system successfully since problems are not recognized or not yet definitely defined. Consequently it is not possible for them to categorize problems as would be necessary to use systems under investigation.

Frequently especially novices are not able to recognize present design problems [1]. To them it remains unclear, which, mostly keyword based queries they would have to formulate or to use to retain cases from a database to draw from in order to enrich their current design process.

The investigation on how architects and novices search for relevant material -architectural precedents- using traditional media seems to be a promising approach to gain a better insight into this weak point of the CBR-based design aiding systems.

In addition design is not to be seen as a problem oriented rather than a solution oriented process [4]. This clearly emphasizes the weakness of the way current approaches of CBD systems in architecture support retrieval.

### **3.2 Free Associational Searching**

To slightly change the perspective of CBD in architecture one can understand the potential of collections of architectural precedents, be it cases or projects (see also 3.3), as a powerful medium to trigger memory processes of the user, in the way that the human case-based reasoning process gets activated and solutions can be found based on own experiences. This is what is widely called but not yet satisfyingly defined as “getting inspirations”. This view of CBD integrates aspects of both: human CBR (the cognitive process) and analogy-based reasoning. Thinking of how to successfully support this in terms of indexing and retrieval one has to take into account that “... in design analogies are not expository, and they are discovered rather than searched for. ... A creative search requires a certain amount of randomness by definition.” [5, p. 72] The unintentional way of finding will play a key role in considering this problem.

Current research in CBR in other domains (e.g., E-commerce) [a. o.: 6, 7] emphasizes on the application of soft computing technologies such as Fuzzy Logic, Neural Networks and Generic Algorithms. These research undertakings are based on the notion that “For real complicated world applications, some degree of fuzziness and uncertainty is always encountered; ...” [6, p. 16] and thereby seem to be promising also in regard to CBR in architecture.

### **3.3 Measurement in Architecture**

An important aspect with the conception of a CBR-based system is the question of which cases should be part of the data collection and how they should be represented [8]. Following the underlying theory cases need to consist of three components [9]:

- Description of the problem, situation of the problem,
- Description of the solution
- The outcome, result.

Frequently system developers make do with the mere collection of uncommented and uninterpreted results of a design process - the final project - which is then represented in image and verbal description (projects rather than processes [9]).

The underlying idea of Case-based design aiding systems is to support designers through the provision of a resource of previous experiences while designing and, inseparable, while learning. The strength of this approach comes into play when these experiences are the experiences of others than the users themselves. This implies the necessity that the more experienced share their experiences with less experienced. Architectural design practice is sensed to be “highly secretive in nature” [10, p. 24]. CBD systems rely on the support of third-party, be it students, professionals or academics. The data bases contain projects from “secondhand” in a prevailing number. This points to another dilemma:

Beside the experienced lack of satisfying problem description a major shortcoming of the existing approaches containing projects from secondhand is, following the underlying theory, the lack of evaluation of the stored architectural solutions and thereby the lack of statements on the outcome of the projects.

In CBD literature the not yet satisfied answered question of means of evaluating architectural solutions is discussed [11]. This question is ultimately linked to the question of how to satisfy the predominant demand to only incorporate projects of an “outstanding architectural quality” [8] in CBR-based systems (see also: [12, 13]).

The exploration of this problem implies the investigation and categorization of quantifiable and non quantifiable, subjective, evaluation criteria in architecture.

To satisfyingly answer the questions aroused from this critical review would be a major step towards a better understanding of how to successfully use the CBR-paradigm in the field of IT supported architectural design and education.

#### **4 CONCLUDING REMARKS**

This research is part of a more comprehensive research undertaking aimed at the improvement of acceptance and practical suitability of design support systems making use of the CBR - paradigm. The investigated problem area is thereby narrowed down to the support of housing design.

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