A Component Class for Design Objects

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Abstract: This paper discusses an architectural design support system. The system is based on a strategy of incremental spatial decomposition of a design object. It provides mechanisms for the application of strategies such as functional decomposition and re-use of design object knowledge. First we discuss two basic strategies used in architectural design, viz. decomposition and application of prototypes. We then discuss the architecture of a design system that supports both strategies. By means of an example, we show how the system actually supports an architectural design process and how the system is used to communicate with external, autonomous design support expert systems. Such systems provide special facilities for drawing, calculating and other tasks performed during a design process, and are interfaced by means of our design system. The last part of the paper contains an evaluation of our work. We propose topics for further research for our project: the IIICAD project. The aim of our system is to provide a sound basis for the tools developed in the IIICAD project and at the same time to be an interface to already existing tools like expert systems for FEM modelers, drawing machines etc.

Keywords: Intelligent CAD, Knowledge Representation, Design Strategy, Object Oriented Programming.

1. Introduction

One of the main problems in knowledge based design support is the representation scheme of a design object description. Such a representation scheme must fulfill a dual purpose. In the first place, it is an integrated description of the design object, constructed during the course of the design. In the second place, it is used in the process of re-using design object knowledge in other designs. Only a representation scheme that can be used for both purposes, forms a strong basis for the construction of a knowledge based design support system.

Both intentions of the above mentioned design object representation scheme lead to different requirements. The identification of these requirements is based on the analysis of

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design. In design we identify two basic strategies. A first strategy is incremental decomposition of the design object. It supports the evolution of a design object description from global to detailed, using stepwise refinement [9]. We call every increment in such a decomposition a design step. A second strategy is the application of existing design object descriptions to support a design step. Such existing design object descriptions are used as prototypes for new designs.

With the above introduced decomposition strategy we capture both the design process itself and the result of a design process. The result is a hierarchical design object description. There are several methodologies for object decomposition. We make a distinction between functional and spatial decomposition. Functional decomposition uses the functional specification of a design problem. It decomposes a design problem into comprehensible sub-problems and accordingly it provides a functional decomposition of a design object [1]. Spatial decomposition aims at building the structure of a design object. With spatial decomposition, a design object is described as an assembly of spaces with sub-spaces.

The application of existing design object descriptions as prototypes, supports the actual declaration of a design object. A prototype provides the user with a previously built spatial decomposition structure, which serves as a template for further declaration. The user can change this template in order to make it fit to a functional specification. A prototype contains in general more information than supplied by a given functional specification for the design object description. Therefore, a prototype can be used to extent the functional specifications.

In this paper we propose a design supporting system based on spatial decomposition of a design object. In the next section we introduce and elaborate the concept of spatial decomposition and the application of existing design object descriptions as prototypes. In §3 the system and its functionality is described. §4 contains an example that illustrates the application of the system. The last section evaluates the system and proposes topics for further research.

2. Architectural Design Strategies

2.1. Functional and spatial decomposition

An architect's design problem is to assign both space to function and function to space. In both cases he applies a strategy based on decomposition. We define functional decomposition as assignment of space to function, and spatial decomposition as an assignment of function to space. A special case of spatial decomposition is called material decomposition, which is a known strategy in assembly based design [2].

Functional decomposition results in a functional specification of different parts of a design object model. A functional decomposition is associated with a specific field of interest. The concept of functional decomposition for architectural design is discussed in detail by Alexander [1]. He solves a design problem by sub-dividing it into different sub-problems, corresponding to different sub-functions. Each of these problems is tackled by an independent sub-system. The design solution is found by integrating the results from each of the sub-systems. Straight on application of a strategy based on functional decomposition, results in a number of aspect models of a design object. These aspect models exist independently from each other. The major disadvantage of the application of functional decomposition, is that it generates a problem of integrating different aspect models into a single, coherent design object model.