INTEGRATING SCENARIO-BASED DESIGN AND CASE-BASED DESIGN FOR USER PARTICIPATION IN APARTMENT PLAN DESIGN PROCESS

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Abstract. It has been an ubiquitous problem that users generally do not participate in housing design process. In Taiwan, however, apartment buyers have a chance to customize their plan until the construction takes place. This paper attempts to solve the problem about user participation in apartment plan design by integrating scenario-based design and case-based design approaches. We build an interactive computational tool for designers to support user participation in the apartment plan design process and to prove our concepts by some concrete examples.

1. Introduction

Regardless of putting stress on the importance of user participation in building design by several prominent researchers, it has been an ubiquitous problem that users generally do not participate in housing design process. In Taiwan, however, apartment buyers have a chance to customize their plans until the construction takes place, because most apartments in Taiwan are sold before they have been built (Chien and Shih, 2000). When clients want to customize their plans, some people make a decision by themselves, but others discuss with sales agents, consult apartment builders, or hire interior designers (Zhu, 2000; Li, 1991). However, sometimes clients may not clearly explain what they want with designers because the process is not quite structuralized. Besides, since clients do their customization in several ways, we need a method for describing the design moves. In order to meet the challenges facing the problems, we take an approach based on scenario-based design (SBD) technique. Compared with other approaches, SBD uses narratives for envisioning real situations with interactions.

For a standard situation, expert apartment designers/architects usually refer to a collection of standard solutions with, perhaps, some variations. Case-based design (CBD), which is an application of case-based reasoning (CBR) to design, is a paradigm for re-using past experience in design domain.

Currently, there are several existing problems in the apartment plan customization process. First, most home buyers do not know where to find design

professionals when they want to do customization. Second, instead of directly communicating with designers, home buyers have to meet apartment sales agents who may not have enough information to guide home buyers to do the customization. Third, because of the fragmented market situation, there may be information missing or misunderstanding caused by communication problems (Zhu, 1997; Li, 1991). The problems can partially be solved by including a generative system within a CBD system, which supports interactive editing and expansion of the problem specification and components for exploration and generation, and a persistent case base.

In this paper, we build an interactive computational tool for designers to solve the client participation problems in the apartment plan design process by integrating SBD and CBD approaches.

2. Background

2.1. THE APARTMENT INDUSTRY AND PLAN IN TAIWAN

In order to understand the Taiwanese pre-sale system procedures, literature reviews and interviews with sales agents are conducted. Once a certain amount of land is obtained by a developer, he/she starts to contact a sales agency. The sales agency investigates the market survey for potential clients and makes a proposal for the developer. After that, the sales agency contacts a designer to design the apartment based on the proposal concept. When the designer finishes the apartment design, the sales agency starts to sell each apartment unit one by one, and finally, the apartment is constructed.

During the apartment plan design, designers consider the relationships between individual rooms. The relations between living-room (L), dining-room (D) and kitchen (K) are among the most important connections in the apartment plan. The connectivity can be classified as follows: (i) one space (LDK); (ii) kitchen independent (LD-K); (iii) living-room independent (L-DK); (iv) totally separated (L-D-K). The requirements for each room or area depend on the number of inhabitants and the residential profile. The number of bedrooms and bathrooms is a major consideration and often directly reflected in the classification of a home (Lee, 2002).

The number of rooms and the LDK configuration are essential parts in apartment layout because it reflects clients' needs and lifestyle. However, most clients may only explain what they want or need using adjectives words during the customization process. In designer's perspective, the clients' requirements have to be shown in graphical way. Therefore, an interactive computational layout system to show the results instantly and systematically is needed.

2.2. USING SCENARIO-BASED DESIGN TO DESCRIBE DESIGN PROCESS

The design process is evasive. Besides, as mentioned in Chapter 1, apartment pre-sale system in Taiwan involves many parties. To deal with those ill-defined and complexity problems, we take an SBD approach. SBD manages the complexity of design problem solving by concretization and use scenarios describing situations at many levels of detail from different perspectives (Rosson and Carroll, 2002). This feature of SBD makes ambiguous and dynamic situations easy to evoke reflection in design process by embodying concrete design actions.

Note that most clients are not professionals in layout design domain. A lot of clients may not easily describe or communicate their ideas or may not realize all the different aspects of a situation that they have to consider when they make a decision for customization. Scenarios can describe the complex interactions during customization with sequences of actors and events. One advantage of using scenarios is that they enable rapid communication about usage possibilities and concerns among many different stakeholders so that designers can easily get feedback and continue to refine their ideas.

2.3. DESIGN CASE ADAPTATION FOR APARTMENT CUSTOMIZATION PROCESS IN CBD

2.3.1. Overview of Design Case Adaptation

Case-based Reasoning (CBR) is, at its core, a problem solving process. In *design*, the problem is generally a functional specification that includes goals and a set of requirements to be satisfied. The solution in design is a description of an artifact to solve a design problem. CBD includes three main phases: creating design case, indexing and retrieving design case and adapting design case. Since we are interested in the apartment plan customization process, we focus on the *case adaptation* phase according to client's requirements.

In order to achieve apartment customization process in CBD, we need a generative system, which is an efficient way for representing geometries of apartment plan components and their relationships. The system must first be able to represent and generate rapidly the geometry and hierarchical structure of *known* standard solutions and save in the case base. Because a retrieved case from the case base may not completely fit the client's needs, the generative system must be able to do interactive editing of each component such as add, delete or resize a room instantly for design case adaptation.

2.3.2. Generative System for Design Exploration by Direct Manipulation

The process of layout design is often characterized by its exploratory nature. Given a set of design requirements and constraints, the designer searches through a number of possibilities, seeking the *best* solutions. An interesting idea is found in Harada

(1997): one is discrete, that the designer looks for different structural arrangements or combinations of constituting elements (topological), the other is continuous, that the designer is more concerned with dimensional variation, such as size and proportion (geometric). Furthermore, she suggests a concept of direct manipulation that is a physical-based theory for simulating interactions between elements in the real world (Figure 1).

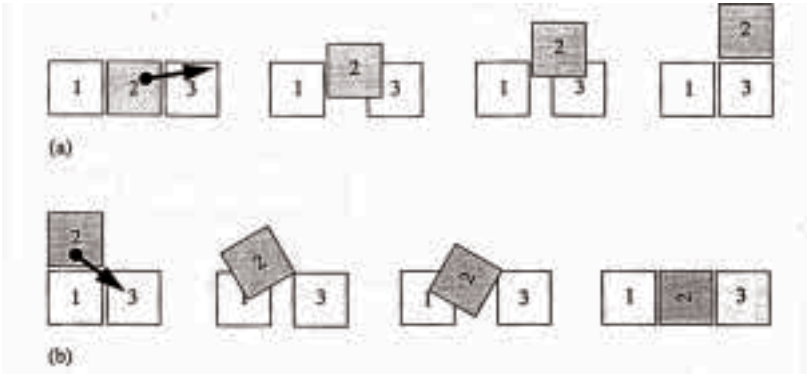

Figure 1. Animated transitions between two states (from Harada, 1997)

3. An Integrated Framework for Plan Customization Process

In Figure 2, we see a framework for customization scenarios in parallel and match the customization scenarios with the building blocks that can be assisted by the main steps of CBD.

The top of Figure 2 illustrates the decomposition of customization scenarios. Each plan customization process can be captured by a sufficient number of *design scenarios*. A design scenario, in turn, can be expanded into more detailed *sub-scenarios*, each of which has a set of associated *design moves* that the respective process should accomplish.

The bottom left column shows a 'dynamic' customization scenario. We call it dynamic because the hierarchical tree generates a lot of alternatives and a customization scenario is decided by depending on the client situation. Each hierarchical step represents a corresponding sub-scenario, which is selected from a set of sub-scenarios shown in the top of Figure 2, according to the customization situation. Therefore, the whole procedure from an initial state (step 0) to a final result (step n) generates a dynamic customization scenario.

This dynamic decision tree is mapped with the CBD main steps, retrieval and adaptation, to realize the sub-scenario with 2D graphical representation, which includes topological relations and geometric adjustments.

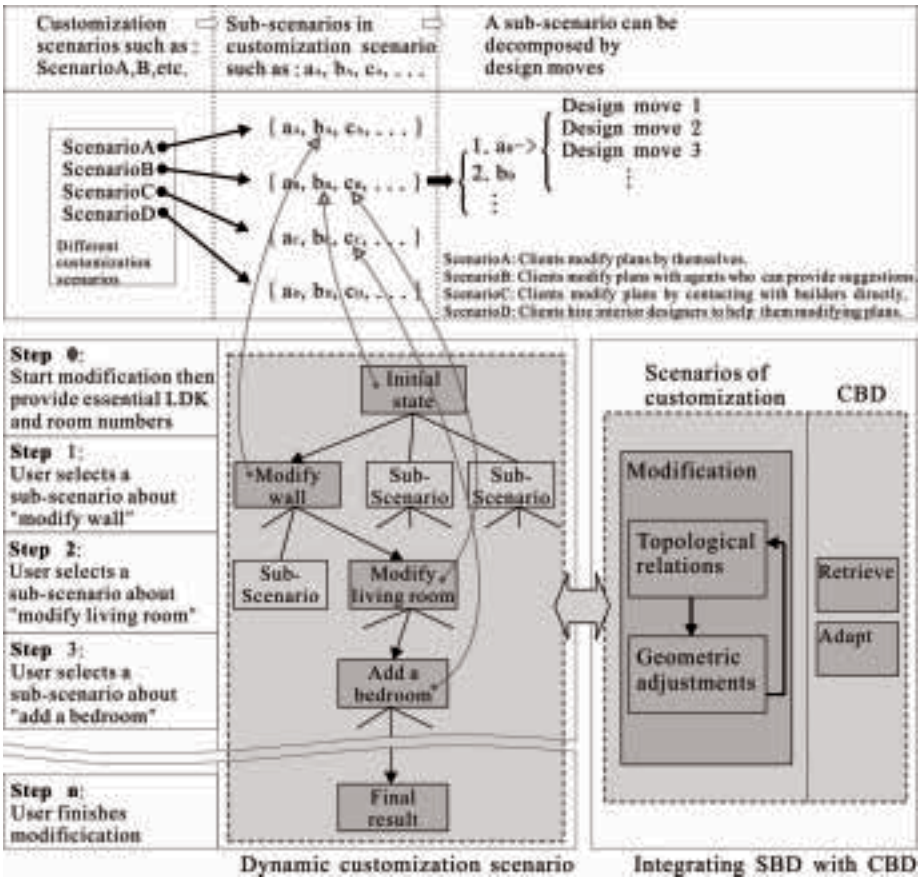

Figure 2. Integrating CBD with decomposed scenarios in customization process.

4. Implementation

4.1. SYSTEM ARCHITECTURE

The first prototype is implemented using various components: classification knowledge base for the classificatory types that gives to a research prototype an efficient indexing and retrieval mechanism; a case base for storing apartment plan cases; a layout generator, which is implemented on the top of AutoCAD as a GUI, to customize it, to seamlessly connect it to the case base, and to provide an efficient mechanism to communicate between user and system. Figure 3 shows the architecture of our system.

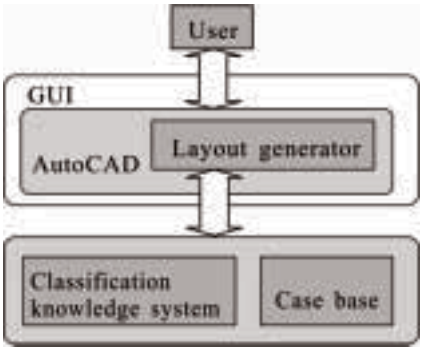

Figure 3. System architecture.

4.2. PROTOTYPE IMPLEMENTATION

According to a client profile and requirements, our system retrieves the alternatives (Figure 4) and the client selects one of the retrieved alternatives.

When a user wants to customize the apartment, (s)he uses a dynamic scenario to compose his/her own customization. The scenario includes selecting L-D-K configuration and the number of rooms, and moving interior walls. In this process, each customized result is shown in the previous window.

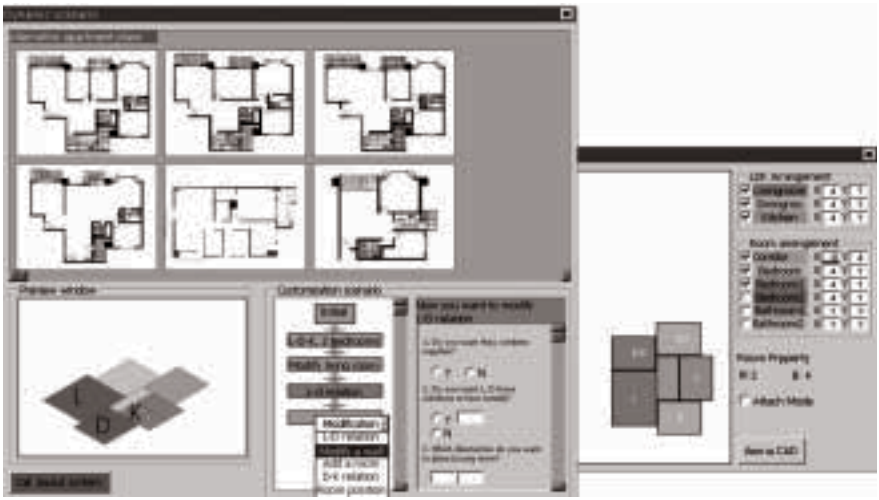

Figure 4. A snapshot of our interface.

After structuring the overall layout, a layout modification tool is opened to offer detailed and further modifications for topological relations and geometric adjustments. If the client is satisfied with the plan, our system draws the result into AutoCAD.

5. Conclusion

This paper presents a new approach for the apartment plan customization process by integrating SBD and CBD paradigms and illustrates its extensibility using architectural CAD software. By using the sub-scenarios analyzed from customization scenarios, a client easily makes decisions for a whole customization process and acquires his/her own scenario dynamically. The SBD approach can be more powerfully supported by a CBD system with a layout generative system, which shows similar alternatives simultaneously and adapts the topological relations and geometric adjustments instantly.

For user participation in apartment plan design process, this research can solve the complex communication problem in customization process and the client can be easily guided by the extensive usage of scenarios.

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