# A Web Environment to Support User Participation in The Development of Apartment Buildings

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## Abstract

In Taiwan, apartments are sold before ever been built. Apartment buyers can customize their units until the construction takes place. This customization process has become a very unique form of user participation in the development of apartment buildings in Taiwan. However, in all customizations, large amount of information has to be documented and exchanged between related agencies for each apartment unit. For an apartment building that contains over 40 units, managing the information can be a daunting task.

We are developing a web environment to support the customization process and enable efficient management and timely exchanges of information. The environment provides three levels of design interaction to encourage user participation in a controlled customization process. This paper describes the framework of this web environment, illustrates its functionality through a running prototype, and discusses technical issues encountered during its implementation.

## Keywords

User participation, controlled customization process, web design environment, Feng-Shui, information exchange, information management.

## Introduction

Most apartment units in Taiwan are sold before they are ever been built. In an area where the cost of land is extremely high, this type of sale enables developers to collect enough capitals so that a building project can be realized. People that are interested in purchasing apartment units make their decisions relying on architectural drawings, perspective renderings, and full-scale models of some prototypical units in a project. Once a purchase is made for an apartment unit, the buyer has options to customize the interior of this unit, for instance by changing finishes, fixtures, or layout arrangements, before the building construction begins. This customization process has become a very unique form of user participation in the development of apartment buildings in Taiwan.

In current practice, an apartment unit buyer can customize her/his unit in two ways:

1. by accepting the original layout arrangement but selecting different finishes for walls, ceilings and floors, and selecting different fixture-hardware-cabinet combinations for kitchen and bathroom(s); or
2. by modifying the layout arrangement through removal or addition of some interior partition walls.

The first type of customization can be as detail as adding a towel hanger of a particular type and material on a bathroom wall. Whereas, the second type of customization requires approvals from the architect, reports to related governmental agency, and notifications to construction-related agencies. In all customizations, large amount of information has to be documented and exchanged between related agencies for each apartment unit. For an apartment building that contains 20 to 40 units, managing the information can be a daunting task.

By working closely with several developers, we have analyzed the activities and information flows in the customization process (Shih and Chien 2000). To facilitate this process, there are four key actors: developers, marketing agents/agencies, architects/consultants, and construction companies/contractors. A buyer's customization request usually comes through a marketing agent. The request then goes to the developer where, if necessary, it is sent to architects/consultants for approval. Developers process customization requests, adjust the cost of an apartment unit accordingly, confirm requests with marketing agent, and inform construction companies to make appropriate modifications. Figure 1 shows the information flow between these four actors.

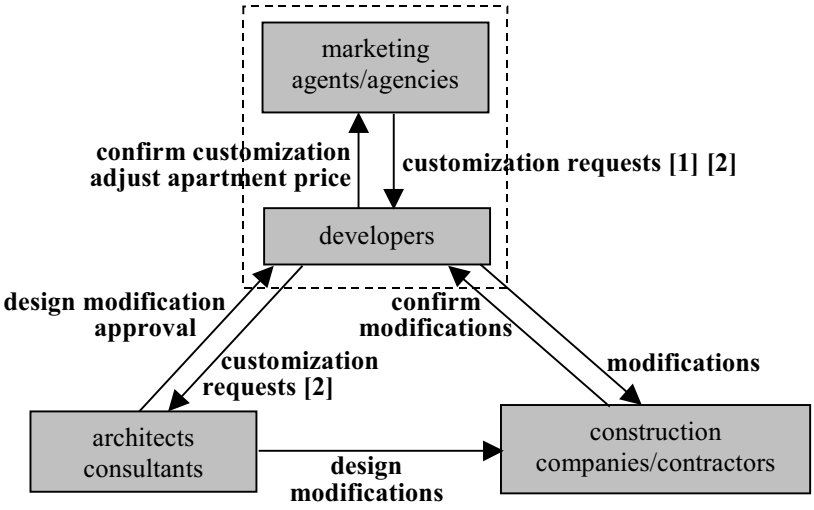


**Figure 1.** Information Flows in the Customization Process.
(Numbers indicate the type of customization request. Some developers operate marketing agents internally; this is illustrated as the rectangle formed by dashed lines.)

The study of current practice indicates that developers are the traffic center of all information flows in the customization process. Therefore, we propose an environment with a data processing center managed by developers.

## WIDE: a Web Interactive Design Environment

WIDE is a web environment to support the customization process and enable efficient management and timely exchanges of information. The design of WIDE, therefore, focuses on two aspects: human-computer interaction, and information management.

For usability considerations, we design WIDE with three levels of design interaction to encourage user participation in a controlled customization process. The three levels of design interaction are as follows:

1. Interior finishes/equipment selection: buyers can tryout different options of finishes and kitchen/bathroom equipment; and see the result of selection through computer rendered still images or virtual-reality walkthrough.
2. Layout arrangement selection: buyers can select different types of pre-designed layout arrangements that are suitable for a specific apartment unit and visualize the result. Once a layout arrangement is selected, buyers can also access the previous level "interior finishes/equipment selection" to make further selections.
3. Advanced layout adjustment: buyers can customize interior layout for special needs through an intelligent design aids. For each confirmed change, the system visualizes the result in various ways to help buyers make their decisions.

From the information management standpoint, once buyers confirm the modifications through any of the three interaction levels described, the system has to calculate the cost for modification, to make necessary notifications, and to store data in a central information repository. Figure 2 illustrates the system architecture of WIDE.

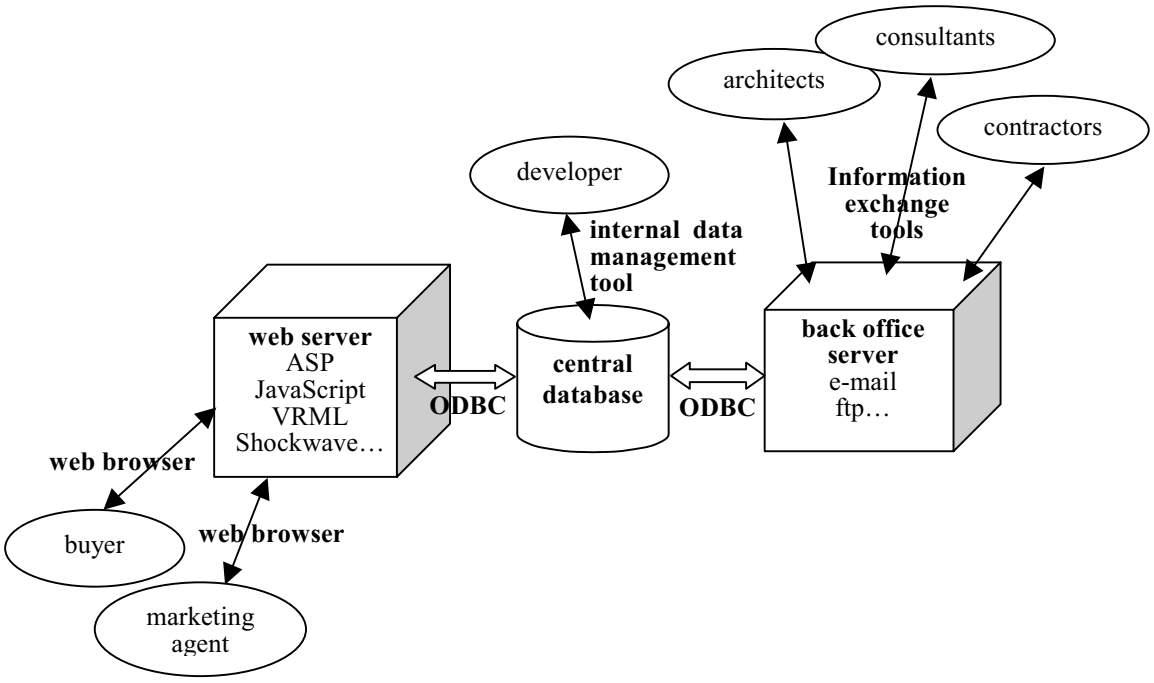


**Figure 2.** System Architecture.

Against current practices where the content of design modifications may transfer directly from architects/consultants to construction companies/contractors (see Figure 1), WIDE

maintains a central database to provide design versions management and eliminate possible version conflicts that could occur in current practices.

At the time of this writing, there are two implementations of WIDE under development. In the following section, we illustrate one of the implementations. It is the very first prototype. This implementation investigates the feasibility of several popular internet technologies to support real-time modifications and visualizing of building models through web browsers.

## WIDE-Kindom: a Prototype to Promote User Participation through WWW

WIDE-Kindom is an implementation specially tailored for an apartment building project, which is under development by Kindom Construction Corporation (a developer). This prototype focuses on supporting the customization process, therefore it does not provide back-end service to architects/consultants and construction companies/contractors. WIDE-Kindom uses Microsoft Access as the central data repository, and has a front-end web server (Microsoft IIS) that provides five basic services: virtual open house, community information, apartment selection guide, buyer customization center, and Feng-Shui recommendations.

"Virtual open house" utilizes virtual reality (VR) technology to introduce public spaces and typical apartment units in this building project. "Community information" is a GIS-like environment that helps visitors understand surroundings (eg, locations of nearby public transportation, supermarkets) of the building project. "Apartment selection guide" allows visitors to identify suitable apartment units in this building project according to their preferences (eg, size, price). "Buyer customization center" and "Feng-Shui recommendations" are provided to allow visitors customize selected apartment units through different means. Since the first three services are not in the scope of this paper, we will only go into the details of the last two services: "buyer customization center" and "Feng-Shui recommendations."

Because the environment is still a prototype, "buyer customization center" opens access to all visitors to encourage participation and comments from visitors. It implements the first two levels of design interaction, "interior finishes/equipment selection" and "layout arrangement selection," described in the previous section. WIDE-Kindom provides "interior finishes/equipment selection" in two ways. For each room of the selected apartment unit, a buyer can make selections from options recommended by designers; for instance, she/he may prefer a classical interior finishes for the living room (see Figure 3a). Besides, a buyer can also make selections for individual interior finishes, such as selecting a different finish for the living room floor (see Figure 3b). WIDE-Kindom interacts with buyers in a web browser through two panels:

- a left panel, displaying perspective view, where buyers can select rooms and identify components of a room for individual adjustment; and
- a right panel, showing designer recommended options, cost estimates, and the customized interior finishes/equipment selections for various rooms in the apartment unit.

a.  b. 

**Figure 3.** Interior finishes/equipment selection interface in WIDE-Kindom.

"Layout arrangement selection" is supported through a similar fashion. The user interface again contains two panels: a left panel for the perspective display, and a right panel for a plan view display and the resulting room sizes. A buyer identifies a room and selects from a set of pre-designed options for possible rearrangement in the left panel. The result of an arrangement is immediately shown in the right panel. For example, Figure 4 demonstrates a layout arrangement that merges the master bedroom and a kid's room (Figure 4a) into one large master bedroom (Figure 4b). After the layout arrangement, a buyer can continue to make "interior finishes/equipment selections."

a.  b. 

**Figure 4.** Layout arrangement selection interface in WIDE-Kindom

After a buyer making these selections, WIDE-Kindom provides various ways, such as VRML, plan view, and rendered perspectives, to visualize the customized apartment unit. The left panel in Figure 5 shows a VRML view of a customized apartment unit. In addition, WIDE-Kindom generates a summary of customizations made to each room and calculates costs (see the right panel of Figure 5). A buyer can review the summary, examine detail customization information, continue the customization, or confirm the customization.

**Figure 5.** Customization Summary

The "buyer customization center" service in WIDE-Kindom is implemented using JavaScript technology (Netscape 1999), as well as Active Service Page and databases (Wang 1998). Buyers obtain instantaneous results when making "interior finishes/equipment selection" and "layout arrangement selection." This is primarily achieved through the layering controls in JavaScript. The data of each different apartment unit is retrieved through ASP technology and database queries. The database contains data for each apartment unit, all customization options, as well as buyer information and confirmed customization results. All database accesses and server requests are handled through ASP.

The "Feng-Shui recommendations" service, on the other hand, utilizes an entirely different web technology. Feng-Shui is a set of rules developed by ancient Chinese to relate people and the man-made environment to the natural environment (for further information regarding Feng-Shui, see Walters 1991). In Taiwan and Hong Kong, many people arrange their living and working environment according to Feng-Shui. Main entrance, stove, toilet, and bed are four key elements in Feng-Shui. The "location" and "orientation" of each element in a house asserts energy that contributes to either the harmony or the conflict between a resident and the house. On the other hand, people are not all the same; they belong to one of eight different types according to their birthday and time. WIDE-Kindom provides "Feng-Shui recommendations" as an alternative to help buyers identify suitable apartment units (see Figure 6a), as well as fine-tuning apartment layout to achieve a harmonious living environment (see Figure 6b).

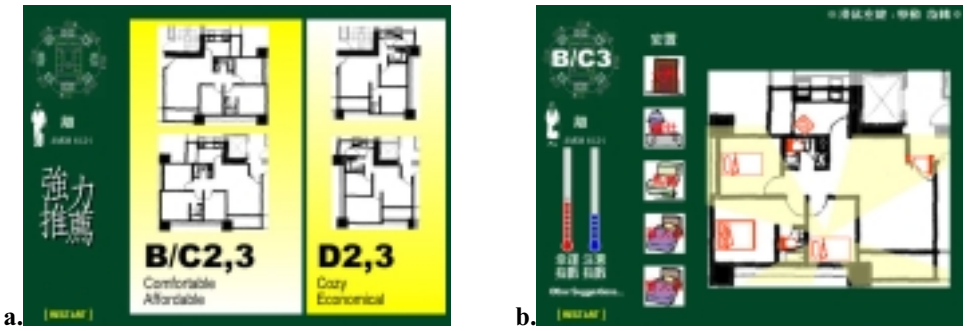


**Figure 6.** Feng-Shui recommendations service in WIDE-Kindom

This service is implemented using Macromedia Director (Roberts and Gross 1999) and converted to a Shockwave movie for web publishing. This technology enables easy integration of various media into a self-contained object. Besides, links to URL can be triggered within the object to relay information to and from a web server.

## Discussion

The WIDE-Kindom implementation demonstrates that a controlled customization process provides a fairly rich set of interaction. The pre-designed options are pre-rendered and stored in a database. Therefore, instead of having to maintain CAD models and rendering them in the run-time, the task is replaced by database queries, which is timely and efficient. Many intermediate customization results are programmed in JavaScript that is downloaded once when the associated web pages are accessed; this also contributes to rapid responses during the customization process. Macromedia Director provides opportunities to design interesting user interaction with programmable controls. Through the Shockwave technology, a Director movie is portable across platforms.

Unfortunately, the controlled customization interface may not scale up when the number pre-design options increases. First, it may require a large amount of preparation work and time. Second, the addition of pre-design options means more JavaScript layers. This may slow down the initial loading time. In the WIDE-Kindom implementation, some web pages need more than 50 layers to support the user interaction. We have encountered instances when over 100 layers are used the web browser simply stops executing JavaScript. WIDE-Kindom provides VRML models for buyers to gain better understanding of the result from her/his customization. However, VRML players usually require large computing power, and can slow down the interface performance significantly.

Having implemented two WIDE prototypes, we find the process to encode pre-designed customization options and related materials can be standardized for all apartment building projects. To scale up the system, however, will need investigations into the content of these pre-designed options and related materials. If we find common characteristics among options of different apartment building projects, an automatic process to encode the information may be possible to replace the manual work. Furthermore, an integration of "Feng-Shui recommendations" into "buyer customization center" in WIDE-Kindom is desirable. Lastly, developing the back office server to support information exchange is the first item in our research agenda for the coming year.

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