# AN AR-BASED NAVIGATION INTERFACE

*Does navigational process influence the learning effect of passive learners?*

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**Abstract.** In order to improve the learning effect of the navigation interfaces in current museums, the architectural exhibition in museum exhibition hall is taken as an example in this study. An instant interactive navigation interface which is different from those used before is developed to guide the visitors to learn exactly the designing styles of architects. Two results are reached in this experiment: 1) a model of knowledge acquirement which is most possibly related to the learning process based on the exhibition of learning topics; 2) the influences of operating movements on specific topics that emphasize knowledge domains.

**Keywords.** Learning effect: Learning behaviour; Augmented Reality; Information Navigation, Database Query.

## 1. Introduction

In recent years, many interactive multimedia operating platforms have been installed based on the experiences of visitors to combine the information with forms of multimedia games for the purpose of education (Marlia, 2006). However, it is found through the interviews that most of the visitors eventually only remember the special effects of these platforms and neglect the precious information inside (Museum and Information Technology: Past and Trend1, 2001). Falk and Dierkin have mentioned that the interpretations in most museums could less connect with the visitors, therefore, most of the visitors are not interested in reading those interpretations (The Museum Experience, 2002). In accordance with this aspect, the architectural exhibition is used as an example in this study to guide visitors to learn exactly the designing styles of

architects and to investigate the possibility of developing a different interactive navigation interface. The operating method of this interface is through using different boards as searching tools, which allows visitors to puzzle out the corresponding results with representative elements, through which to connect the visitors with the information.

According to the purposes above and in order to agitate the desire of active learning, three steps are used in this experiment: 1) the analysis of building elements: to isolate specific element from architecture and design corresponding board; 2) the construction of hardware interface: using augmented reality system as the subject of the hardware construction and analyzing the difficulty of operating and whether the boards are recognized properly; 3) the experimental observation and analysis: experiment on subjects to compare the effectiveness of traditional learning with the experimental prototype and to evaluate two questions: 1) How does this learning subject contribute to the learning process and possible modes of acquiring knowledge? 2) How do operation movements contribute to emphasize certain topics in the field of knowledge?

## 2. What kind of navigation interface could arouse learning motive?

Research reports indicate that one of the elements to make learning effective are the connections between learners and learning contents. Therefore, some museums will arrange exhibitions and introductions in accordance with school lectures. However, this method is not suitable for all visitors. The key point to make this system successful is to relate the learning content to the learners. Consistent with this key point, many concepts are proposed that can be agitated through navigation behavior. The purpose of relating learners to learning contents is achieved through the process of designing suitable navigation behaviors.

## 3. Could this kind of navigation device achieve effective learning?

The main purpose of learning in museums is not to convey important information but is to inspire and encourage people to learn. Lord et al. suggested that the learning of informal education is the most successful learning in that it helps improve the attitude and arouse the interests of visitors (Lord & Lord, 1997). It can be concluded that the visitors using condition of navigation system influence their experiences of participating and their desire for a second visit.

To make a comprehensive survey of digital learning mechanisms in current museums, the most often used one is navigation systems. The purpose of constructing navigation systems is to interpret and illustrate the contents in

museums. The father of interpretation, Freeman Tilden (1883-1980), defined six principles of interpretation (Tilden, 1957) which are viewed as criteria by people engaged in interpretation around the world. Based on these six principles, the current digital navigation systems in museums are surveyed and two major defects are found in current navigation systems: First, there is no strong connection between navigation contents and visitors. Second, the information in museums is in great quantity, hence visitors could not absorb critical information when they are dazzled by navigation systems. Another navigation method is proposed to investigate the possibility of solving these two major defects mentioned above.

## 4. Learning behavior and construction of thought

Ernst von Glasersfeld adopted Piaget's viewpoints on cognitive development and proposed his personal constructivism theory, in which he thinks that learners' growth of knowledge is developed through learners' interaction with environment, assimilation, and the adjustment of their original cognitive structures (schemes). It can be inferred from his viewpoints that the growth of knowledge can be developed and it is not fixed. It can also be inferred that the growth of new knowledge is not only based on original knowledge but also restricted by original knowledge.

The action of piecing puzzle pieces together is a constructive behavior. In order to come up with the desired shape, users have to judge that what this object really is through their original knowledge. When each piece of puzzle is connected with one another continually into a specific image, users also have to adjust their original knowledge. The construction of thought is developed through these series of actions. This is also the reason why using architectural puzzling behavior as an experimental tool to investigate learning behavior in this study.

A preliminary experiment is done in this chapter to observe learning behavior. Observing both users of traditional media and multimedia to find the differences between them, and try to find the critical point that influences learning effectiveness. Interviews are also done to those subjects to get the information of their thinking process as materials for analyzing learning behavior.

Several results are found after interviews as below:

1. Subjects tend to remember special objects (How to describe objects in most memorable way and how does this image relate to important information?)
2. Subjects tend to be impressed by colors.

3. When doing puzzles, a single piece of puzzle has no meaning to subjects and subjects could not think about the questions about the puzzle image when they are doing their puzzles. After finishing puzzles, the explanations that subjects describe their puzzle image are too much and complicated. The benefit of doing puzzles is that it offers actions of construction. If subjects can puzzle out something recognizable during their process of doing puzzles, it is helpful to them to memorize it.
4. The atmosphere generated from images arouses the learning motive. However, as for extended learning, most of people care about "where to learn" rather than the architects and their styles.

The information listed above will be used as guidelines for the construction of hardware navigation interface in this research.

Most visitors come to museums not for finding out the answers to certain questions but to look around casually with relaxed attitude. Under this circumstance, visitors usually do not spend too much time on reading interpretations; hence it is important to relate the exhibition contents with visitors. The purpose of this study is to solve this problem through using the retrieval forms extended from puzzle concepts.

1. To guide visitors to generate questions about exhibition contents and to find the answers on their own. Both meaning and knowledge are constructed in this process.
2. To increase the abundance, mobility, diversity, flexibility, and interaction of information contents, which enables navigation systems to become a learner's centralized, self-orientating, exploring, and active learning environment.

## 5. Architectural Puzzle-Retrieval form to support multimedia learning

The reason that architecture is chosen as information contents is that visitors can experience the styles and fashion through observing modern architect masters' masterpieces in the 20$^{th}$ century. And visitors may also understand what those masters had done when they confronted with the conflicts between classical tradition and modern living needs. Architecture includes not only culture and time but also includes complicated philosophy. Through understanding these masterpieces, visitors are guided to think about the history before and the environment at present.

### 5.1. THE ANALYSIS OF STYLE FACTOR

The case study uses masterpieces of a famous architect in the 20th century, Alvar Aalto (1898-1976), as the contents of the navigation interface. Aalto advocated the idea of free architectural style. He emphasized the correlation between humanity, nature, and free style and he stood against any means of restraint, restriction, and settled expression. He wrote in an article in 1938, "Any means of restraint, no matter deep rooted traditional patterns or those standard patterns aroused owning to the misunderstanding to the new architecture, impede the fusion between architecture and peoples' efforts to survive, hence reduce the meaning and possibility of architecture."

Masterpieces of form by Aalto tended to break the restrictions of meshes and templates. The volume and space of his architectures usually were randomly distributed. Sometimes those architectures were distributed in large and obvious distance while sometimes they were distributed with only small deviation. He tended to add curves, curved surfaces, quarter rounds, bowstrings, fans, and swinging curves in integral shapes. He thought that simple cubes and rectangles could not express the diversified and complicated feelings and emotions of people.

Typical elements of form with Aalto's architecture:

TABLE 1. Style and technique.

| Style | Technique |
|---|---|
| The harmony between architecture and nature | Topography/ lower altitude |
| Free style | The combination of lattices and upside down lattices/ randomly distributed volume and space/ the change of geometry |
| Interweaving curves | Strong decorations |
| The meaning of bays | Introverting space |
| The meaning of trees | Perpendicular linear division on wall surfaces or indoors |

TABLE 2. Factors and elements that influence style.

| Factors that influence style | Elements |
|---|---|
| Environment (culture, technique) | White concrete, red bricks, wood |
| Natural environment | Divisions on wall surfaces |
| Area (climate) | The orientation of roof |
| Designing objectives | Curves on roofs and indoors |
| Personal preference | Introverting yards |

## 5.2. HARDWARE DEVICES

When visitors puts media (parameter X) with element meaning on corresponding position (parameter Y) of sensing board, the sensing board will search for objects with the corresponding description in a database based on the meaning of media and the position where visitors put and it will show an image on the screen in accordance with where media are put. It can be shown that when visitors put the next parameter on sensing board, the next image showed on the screen might be different. When visitors are sure about their retrieval parameters, the images will be clearer. Through this method visitors can see what will change when they put parameters on the sensing board.

On a board with nine chequers, visitors may randomly put some geometrical patterns. These geometrical patterns represent different element meaning and there are also illustrations explaining corresponding style elements. The board with nine chequers can be divided into three parts, which represents roof, wall surface, and site respectively. A sentence of description about a certain part of the building can be showed when visitors put these geometrical patterns on the sensing board. (Figure 1.)

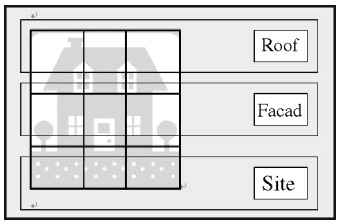



*Figure 1.* Sensing board.

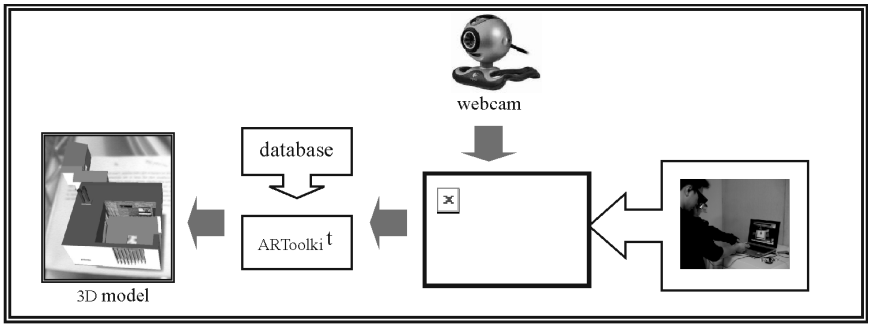


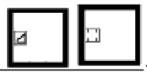

*Figure 2.* Operation procedure.

1. The classification of element geometrical patterns.
2. There are three aspect of description about every piece of work: The description elements of roof are showing about forms and dormers; and

the description elements of façade are about Materials, the orientation of façade and the order forms; The description elements of site, are about forms of site; shapes, bases and forms.

3. Patterns correspond with architectures: These patterns are made according to the characteristics of elements and images are showed on representative patterns base on the sentences, which describe elements. There is a set of example below:

TABLE 3. Patterns of corresponding elements to architectures

| Architecture/ Location | year | Pattern of corresponding style |
|---|---|---|
| Maison Carre/ France  | 1956-1959 | Roof: oblique roof without dormer  <br>Facade: Concrete、 using material as order form  <br>Site: Rectangle without yard  |

## 6. Experimental Evaluation

### 6.1. TEST

Subjects are invited to take a test in which its contents are designed to let visitors tell whether certain buildings are designed from Aalto or not and then subjects are interviewed. The purpose of interviews is to acquire the information below:

- To make sure that what parts of buildings do subjects recognize and to understand what visitors have learned about the building elements.
- To check if the operating forms of this navigation interface is effective in helping learning.
- To acquire the advantages and disadvantages of this device from subjects' responses and to review those advantages and disadvantages.

### 6.2. SUMMARIZING CONCLUSIONS FROM EXPERIMENTAL RESULTS

Through observing live interviews, and listening to the opinions of subjects to understand more about their behaviors of doing puzzles, five observations can be made. Together with the analyzed results in previous chapter, it can be concluded that every participant has increased his ability of recognizing

buildings, which means that the device is positively effective in increasing learning effectiveness.

Secondly, originally, there is difference between everyone's learning ability in professional knowledge; however, after the education of similar puzzles, this difference is shortened. Third, this puzzle device simplifies the building elements into geometrical figures, which makes it easier for visitors to recognize building characteristics more clearly and it also helps in memorizing. Fourth, learning architectural style by doing puzzles helps to observe and to learn single element more exquisitely. And fifth, most people are very interested in assembling objects on their own; this device enables users to learn more about architecture through users' interests in creating.

To summarize the five results above, this puzzle game brings many positive meanings to users not only through amusement but also through the practice process of learning in which users may explore their imagination, apply geometrical concepts, and acquire more confidence and satisfaction.

## 7. Conclusion

The basic concept of this device is to transform abstract descriptions into real media and to combine media with corresponding sentences which describe the intact architecture and eventually transform into three-D images. It helps a lot in thinking about the relationship between building element and architecture.

To learn about architecture style by using a form, like a puzzle, does show some benefits in the experiment, which point out that simple figures are easier to be recognized and easier for people to tell the differences then photos of architecture; moreover, human intent to pre-interpret an unidentified figure as something which they are familiar with. By doing so, the key point of the interface in this study is not only representing a new simple game to show architecture styles, but also helping visitors thinking style features from this interface.

Moreover, two aspects could be improved in future studies. The first is the content of forming an architecture style. For learning a particular style, it is not enough only recognizing some style features; on contrary, the relationships among different style features are also the important factors to determine the forming of an architecture style. The interface would be improved if it shows the relationships of all factors which could inference the forming of a style.

Secondly, some visitors mentioned that they hope to see the internal parts of the building. According to this, if sensors are added on the laterals of the "three-D" patterns, this effect can be achieved by using two cameras at each side to read the patterns when the building is turned over to its lateral with a

window or a glass door and the feelings of seeing through a window from outside to inside can be mimicked by touching the position of the window.

Both physical and fictitious worlds can be mimicked through using multimedia interactive techniques. As an educational tool, an unreachable educational effect is achieved by the correlation between two environments, which can not be achieved through only one of them.

## Acknowledgements

I gratefully acknowledge financial support from my family, and Professor Yinghsiu Huang who provided equipments and suggestions. Special thanks to everyone in the laboratory who are continually involved with my experiments.

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