Currently, there is a debate among architectural educators regarding the use of computers in the curricula. At present, computers are used for design purposes, and there is limited use in other areas of the curricula. This paper explores an instructional tool developed specifically for teaching and learning of architectural history and theory, and since these courses are main components of any architectural curricula, using this tool can have a great impact on architectural education in general. The tool, called ArchiWAIS, is a multimedia-based architectural information system that utilizes emerging computer technologies such as multimedia, hypermedia, and telecommunications.

As a multimedia system ArchiWAIS provides effective ways of handling various architectural media—text, images, architectural drawings and diagrams, three-dimensional models, animation and sound. ArchiWAIS as a distributed hypermedia system also provides multiple ways to search multimedia databases and browse through multimedia. ArchiWAIS is a WAIS (Wide-Area Information Server) client and has access to architectural databases specially constructed for this experimental project as well as general WAIS databases.

ArchiWAIS is one of two subsystems of ArchiTOUR, an educational system currently under development. While ArchiWAIS searches and collects a variety of architectural information, HyperTOUR, the other subsystem of ArchiTOUR, can be used for presenting and learning a specific subject in architectural history and theory. A future extension of ArchiTOUR will be the integration of other curricula into the system, in essence, creating a common ground among architectural courses.

Introduction

The use of computer technology in architectural education is not new. Since the 1960’s, computers have been used as drafting tools, and have increased the cost efficiency of architectural design [Radford and Stevens, 1987]. The use of computers as design tools is relatively new, but is gaining in popularity [Yessios, 1986]. However, few systems have been developed especially for the teaching and learning of architectural curricula, even though there is an increasing need for this [Kensek and Noble, 1992].

For these reasons, it is crucial to investigate new forms of computer-aided inquiry. Some research has been done to address the limitations of current CAAD systems, but few solve the problems unique to architectural history and theory courses. For example, current CAAD systems rarely deal with architectural database management. Those systems mainly focus on managing a single project, but cannot access finished projects that might be reusable for various purposes. Seebohm [1992] proposed the creation of such architectural databases and explored their usefulness for teaching architectural history. Millet et al [1991] developed a prototype system called ArchiMedia, an interactive encyclopedia of architecture which attempts to provide architectural information categorized by several headings—architects, formal analysis, building types, structure etc. Additionally, the Form Processing Workshop at MIT [Miller, 1990] utilized the Design
Reference Management System, a hypermedia prototype system for collecting, storing, managing and displaying design information. This research has been helpful, but does not utilize a distributed system and therefore cannot handle large amounts of information. Consequently, these systems are not powerful enough to meet the needs of architectural history and theory courses.

Another problem is that existing CAAD programs also lack the ability to integrate various forms of architectural information—text, images, drawings, three-dimensional models, and even animation on one unified platform. Some hybrid systems of hypermedia and CAD have been explored to handle the integration of such architectural information [McCall, 1990; Skauge, 1993; McCullough, 1993; Fox, 1993]. Again, this research is useful, but is not specifically geared towards the specialized concerns of architectural history and theory.

For these reasons, I am proposing a system focused specifically on the needs of architectural history and theory. In these courses, students must digest a considerable amount of information within a limited time. Another problem is the lack of accessibility to certain information due to geographic location, time and cost. The last and most critical limitation is architectural history and theory’s reliance on traditional media—often limited to two-dimensional black-and-white images; instructors cannot present students with three-dimensional models [Seebohm, 1988; Pelt and Seebohm, 1990; Seebohm, 1990; Seebohm, 1992]. It is clear that in order to improve the quality of instruction, a more intelligent and systematic approach to information management is needed, as well as new pedagogical approaches that utilize computer technologies.

A Theoretical Overview of ArchiWais

In order to provide an information-rich teaching and learning environment, ArchiTOUR (Figure 1) will concentrate on three areas: searching information (for teaching and learning), presenting (for teaching and learning), and learning (for individual learning). ArchiWAIS is mainly focused on the searching capabilities.

ArchlWAIS Media Space: An Information-Rich Virtual Environment

Media space is “the information environment connecting real and imaginary places, objects, and the people within them. [It is] the context in which people can use representations to work with artificial reality” [Wodke, 1993, p. 21]. ArchiWAIS provides ArchiWAIS media space, an information-rich environment (Figure 2). As a learning and teaching environment, it creates a virtual electronic classroom that allows students to travel through space and time. Through this system, students can “visit” a historic city in order to learn a specific architecture. They can leap from sixteenth-century Florence to nineteenth-century London, bringing one historic building from

![Figure 1: The Overview of ArchiTOUR](image1)

![Figure 2: Media Space in ArchiWAIS](image2)
a different era and location to compare it with another building. The media space is a virtual environment where the users have more flexibility in handling architectural information.

Searching Architectural Information: Architectural Databases and Direct Access to Information

Current technological advances in telecommunications allow us direct access to remotely located information as well as more power to communicate, both one-way (e.g., FTP capability) and two-way (e.g., electronic conferencing). Much research has focused on the creation and management of architectural databases that contain multiple forms of media—text, images (pictures and two-dimensional artworks), diagrams and sketches, architectural drawings, three-dimensional computer models, sounds including voices, and computer animation. Even though some current multimedia systems handle some forms of media (text, images, and sounds), none of these systems is yet powerful enough for use in architectural history and theory. Therefore, we need a specialized system that integrates various forms of architectural media.

Since architectural history and theory utilize a vast amount of information, and much of this information comes from geographically diverse places, the databases could be located at more than one physical site or computer. Hence, an alternative approach is to utilize a client/server model in order to have access to remote databases.

Currently, network systems such as WWW (World-Wide Web), Gopher, and WAIS (Wide-Area Information Server) are used in order to share information over the Internet. These systems adopt the client/server model and each has certain advantages. While the World Wide Web provides a distributed hypermedia environment where the user can navigate through webs which may contain a combination of text, images, and sounds, Gopher utilizes a hierarchical structure to allow easy access to FTP sites and supports a limited index search and document retrieval. The strength of WAIS is its searching capabilities. Since the searching capability is crucial in this project, this study adopts the WAIS model to build a specialized tool for searching and retrieving architectural databases.

The WAIS (Wide-Area Information Server) Model

WAIS (Wide-Area Information Server) is a network system where, by asking a question, a user can search and retrieve documents from information sources all over the world [WAIS Inc., 1993, p. 1]. The WAIS network has four main components: the client, the protocol, the server, and the database. The client is a user's front-end for querying the information fronted by servers [ElNees, 1993, p. 7]. The server is a program that services users' requests. The protocol is used to connect WAIS clients and servers and is based on the Z39.50 standard, an information retrieval application protocol produced to facilitate the interconnection of computer systems [Gamier, 1994, p. 4].

Figure 3: ArchiWAIS Client/Server Structure

ArchiWAIS is designed for access to architectural databases specially constructed for this experimental project as well as general WAIS databases. It uses a set of C routines which handle the MacTCP communications and the WAIS protocols from the HyperWAIS Toolkit Release 1.6 [Schienetatte, 1993].

Document retrieval is a highly interactive process [Fowler et al, 1991, p. 142] dealing with large amounts of architectural multimedia information. The document retrieval process in
ArchWAIS involves five steps in general. These steps are shown in Figure 4.

**Figure 4: Document Retrieval Process in ArchWAIS**

Content-Based Retrieval in Multimedia Databases

Another important issue here is how to search multimedia databases. Simply searching by the name of the file is not the solution. More flexible searching capability should be based on the content of the media. The content-based retrieval in multimedia databases has been a hot issue in the multimedia community. The flexible retrieval of multimedia data on the basis of content depends on the ability to model multimedia data effectively [Leeung et al., 1994, p. 24].

ArchWAIS' method of content-based retrieval of multimedia focuses on two concerns: 1) easy management of multimedia databases and 2) flexibility of access to multimedia databases. The ArchWAIS approach uses an associated description file for each multimedia document, which may be a picture, a three-dimensional model, a drawing file etc. This associated description file utilizes the "fielded search" capability in WAIS. The "fielded search" will perform a restricted search based on the value of a field or set of fields. This capability allows the client program to ask the WAIS server to search only certain documents that pertain to a user-specified value from a particular field [WAIS Inc., 1993, p. 37].

The format of a description file is similar to the special text format in ArchWAIS called the RECORD. [For more about RECORD, see section entitled "ArchWAIS Databases and the ArchWAIS RECORD Format"]. Although the RECORD includes all fields, the description file focuses the search on specified fields. The specified fields are concepts that allow the user to search the multimedia data. Suppose you have a picture that shows the architect Frank Lloyd Wright and the owner of Fallingwater, Edgar J. Kaufmann. To support a search of the picture file using only the names of the architect and the client, the description file will contain the following information only.

**Figure 5: Content-Based Retrieval in Multimedia Databases**

Development of Arch WAIS

ArchWAIS Databases and the ArchWAIS RECORD Format

There are eight ArchWAIS databases currently available (Figure 3). Each database represents a different media:

An ArchWAIS RECORD file includes a set of searchable fields that utilize the "fielded search" capability of WAIS. The following is the form of an ArchWAIS RECORD.

The searchable fields are extremely useful for searching specific information. For example, to search all buildings designed by Frank Lloyd Wright, and located in Pennsylvania or California, a query can be generated as follows.

(Architect=Frank Lloyd Wright AND (Location=PA OR Location=CA))
The ArchiWAIS User Interface: Three Layers

Unlike other WAIS client programs, ArchiWAIS intends to handle multimedia data specifically for architectural history and theory. The potential user groups will include architectural educators who teach architectural history and theory and architectural students. Since these user groups do not have extensive computer skills in general, it is crucial, as Brenda Laurel emphasized [Laurel, 1993], to design an interface that is easy to use and provides direct manipulation. At the same time, ArchiWAIS needs to allow advanced users to search and collect very specific information. The interface provides three main layers: a RECORD search window, a RECORD window, and multimedia windows.

Searching ArchiWAIS Catalog Records

The RECORD search window, shown in Figure 6, contains two main areas: 1) text boxes for constructing a query and, 2) a large text box for showing headlines of resulting documents. The four text boxes with an operator (the “AND” or “OR” function) are used for constructing a query. To search by another field name the user can click the field name (Figure 6). Let’s look at an example. In Figure 6, two strings, “wright” and “falling,” have been specified. When the user is satisfied with the query and clicks the search button to submit the query to the ArchiWAIS RECORD database, the system generates a query, “(architect=wright AND building_name=falling)”. After submitting the query a waiting time follows. Once ArchiWAIS gathers the information, the user can see how many record documents are retrievable for the query. To retrieve a specific RECORD, the user simply clicks the headline.

Dynamic Linking of Multimedia by an Internal Query

The RECORD window, shown in Figure 6, contains a text box which shows a catalog record of a building and may include some hotspots (for ArchiWAIS, a hotspot is an underlined piece of text that provides linkages to other related documents). This RECORD is where the user starts to get multimedia data.

ArchiWAIS provides two ways to get multimedia data. A simple way is to click a hotspot provided on a RECORD content area (underlined red color text). The extension indicates the type of a multimedia database it will search. For example, “.pic” means the database is the image database and “.ani” means the animation database. When the hotspot is selected, the system searches the specific database to retrieve the related documents. It is a dynamic linking process, and thus the result depends on the context of the database.

Searching Multimedia Databases by Automatic External Query Formation

A more flexible way of getting multimedia data is to search multimedia databases by submitting a query constructed by the system automatically. This automatic function will increase the feeling of engagement by reducing the user’s cognitive load. To start the automatic function, the user clicks a field name (underlined blue color text on the RECORD field area). For example, if the user clicks a field name called “Architect,” ArchiWAIS shows a bigger window where the user can search multimedia databases (Figure 6). The user can just click the “Search” button after specifying a multimedia database (the default is the text database). By default, the system automatically generates a query to submit to the remote database. For instance, if the user has selected the field, “Architect” and the content of the field in the RECORD is “Frank Lloyd Wright,” then the system generates a query, “(Architect=Frank AND Architect=Lloyd AND Architect=Wright)”. When the user clicks the search button, the system uses this query to search the database. The user may want to refine the query.

Uniform Ways of Handling Multimedia

One common complaint about current distributed hypermedia/multimedia systems is that they use many utility programs to handle multimedia, and this forces the users to switch systems whenever they want to handle the media. This strategy also prevents the system from integrating multimedia by direct manipulation. In order to avoid this, ArchiWAIS provides uniform ways to handle
Figure 6: Three Layers in ArchWAIS
multimedia while staying within the system. Some standard functions have been implemented to facilitate this, even though their use changes slightly depending on the media being handled.

1. Zoom-In and Zoom-Out
2. Move and Reset
3. Picking (Selecting) Object(s)
4. View Transformation (for 3D models only)

Annotations During Navigation

Each multimedia window includes a text box for annotation (Figure 6). The annotation functions are useful when the user wants to link some textual information to the multimedia document during navigation. The textual information could be text either from other parts of the databases or written by the user.

An advanced feature of the annotation in ArchiWAIS is its capability for spatial referencing. Spatial referencing is crucial for educational disciplines that deal extensively with visual information, and has been recently introduced in other fields. For example, in geography, Laurini [1989] introduced a hypermedia system, HYPERMAPS, that utilizes spatial referencing. HYPERMAPS can retrieve all information dealing with this point or this zone by clicking a point or a region on a map. The unique idea of HYPERMAPS was to extend hypermedia concepts by integrating geographic references.

Spatial referencing can be utilized either between multimedia documents (e.g., a 3D model and a picture) or between a multimedia document and textual information. Annotation in ArchiWAIS makes use of the latter concept. The following is the different annotation capabilities depending on different multimedia documents.

Conclusion and Future Extension

The main goal of ArchiTOUR is to provide an information-rich teaching and learning environment for architectural history and theory courses, as illustrated in Figure 7. As ArchiTOUR as an integrated educational system is currently under development, the main concerns of this paper have focused on two aspects of the ArchiTOUR system: 1) the construction of architectural databases based on the WAIS model; and 2) the development of ArchiWAIS, one of two component subsystems of ArchiTOUR.

The architectural databases, specially designed for this experiment, contain eight multimedia databases. Some important considerations in designing the architectural databases include 1) developing a multimedia database structure that is easily managed, and 2) providing searchable fields needed specially for teaching and learning architectural history and theory.

ArchiWAIS provides an environment for searching and collecting architectural information over the Internet. The system focuses on 1) searching multimedia data by facilitating automatic query generation, focused on a content-based retrieval technique; and 2) manipulating and annotating multimedia data during navigation. The multimedia data collected by ArchiWAIS will be used in HyperTOUR, another subsystem that emphasizes navigating through the multimedia documents.
References


