A Multimedial Database System

Managing a Virtual Collection of Art and Architectural Works

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Abstract

In 1993, The Faculty of Architecture and Fine Arts, Pontificia Universidad Catlica de Chile, decided to create a virtual collection of art and architectural master pieces, mainly of national and Latin American origin. The faculty does not own the works themselves, but a collection consisting of visual representations of each work, including drawings, video, slides and other audiovisual material.

The initiative of assembling the collection is based on the difficulty of access to these works, spread over the world, as well as in the collection process and preservation of visual information consisting in original documents and architectural drawings, slides, photographs, and other visual media. This has been a difficult task due to the natural deterioration of this kind of media.

The knowledge of masterpieces and work of outstanding artists and architects is a basic theme in the study and research in the Faculty. The access to a virtual collection of patrimonial work in these areas provides a new way of research with great impact in the education of students in our faculty as well as schools and other public institutions.

Nowadays advances in technology make us think of a new way of preservation and retrieval of visual information. High quality images, hypermedia, communications and network technology, allow the retrieval of integrated information in different media including high quality still images, audio, video and text. Moreover, the significant growth observed in Internet and specially in the World Wide Web, constitutes a powerful media to provide worldwide access to multimedial information.

The project, in development process, has the participation of a multidisciplinary team, administrated by the Art and Architecture Faculty. The National Art Museum is

collaborating with production tasks providing information and visual material of the collection and the relevant exhibitions that occur throughout the year. The cataloging process is being done by the university Library System experts. Software engineers from the university "Computing, Information and Communication Service" are in charge of all the technical issues and software development.

The project is conceived in several stages, each of them concerned with technology evaluation and acquisition issues, software development and production tasks for collection and cataloguing of information. The first stage was concentrated in the analysis of the system information and functional requirements, considering the users' characteristics and needs. The design and development process focus in user-interface design aspects, data modeling, and evaluations of technology in image processing, file format standards, multimedial software development tools relational database servers, and client-server technology. A special emphasis has been made to have a graphical oriented, easy to use and intuitive interface to access the data, oriented to the viewing of images and providing flexible access to integrated information in several types of media. The database stores relevant information of art and architectural masterpieces. The user is allowed to search by several criteria and browse the information of the works and authors intuitively through a graphical oriented interface.

This paper describes the design and development process of the multimedial database system built to manage and retrieve the virtual collection of art and architectural works.

Design Considerations

The following sections describe several aspects considered in the design process of the multimedial database system. The design process was done together with an evaluation of technology before the implementation stages began.

User and Environment

User characteristics as well as the environment certainly determine the system design. The study of the audience will provide some indications in the design process. Some of the user characteristics studied include heterogeneity, number of users involved, and their location. [Shwier R., Misanchuk E.].

Researchers, teachers and students of the Architecture and Fine Arts Faculty need to study masterpieces of artists and architects. The information about these works is widespread over the world, therefore, of difficult and sometimes restricted access. The Faculty is building an archive with the purpose to collect and preserve information of outstanding works. A virtual collection constitutes a

powerful mean for research and teaching purposes, giving access to integrated information of the works in several media. On the other hand, the system will allow the access and manage the original sources collected in the archive.

Other users from national and international institutions such as museums, libraries, universities and schools spread over the world will also have access to the virtual collection. The system developed will allow the knowledge of art pieces owned by museums, private institutions and collectionists, as well as outstanding architectural work.

Therefore, the system will be used by a large, heterogeneous and dispersed audience, with little or no experience at all in computer systems. These characteristics lead us to consider the different needs of the audience for the type and focus in content, functionality of the system and user interface design.

The following section describes in detail the information requirements of the multimedial database to represent integrally each of the art and architectural works in the virtual collection.

Information Requirements

The database will store mainly information of art and architecture representations in different media. All media stored should be acquired in a high quality, which demands a great amount in disk storage, fast compression/decompression techniques, scaling facilities, and high transmission rates over the network.

At this time it is difficult to estimate the final volume of information stored, the system is designed to store great amounts of images, with a natural growth considering access to several servers in multiple locations over a network.

The information collected for Art and Architectural masterpieces is the following.

Arts

The faculty decided to collect at least one slide for each work, biography of the author and a list of bibliographic references. When needed (decided by an art expert) and if possible, a set of slides showing details of the work where provided for a complete study of it. or the study of each work, the faculty collected the following information:

- A set of 35 mm. slides of 4 pictures (average). This set includes 1 full view and 3 or 4 details for each work, as they were needed. In the future, a short video sequence will be provided for the study of the sculptures.

- A biography of the artist.
- A list of bibliographic references of the work.

Architecture

The faculty provided a set of architectural drawings in different sizes (A0 the biggest), paper kinds and qualities. Usually, these drawings correspond to a deteriorated copy of the original available. A magnetic copy of the drawings will avoid further deterioration and give access to the information through a print-out copy for study and research purposes. For the study of each work, the faculty provided the following:

- A set of 20 images average for each work including exterior, interior views, as well as construction details. (35 mm. slides).
- 10 drawings (average), including originals, copies and reproductions made by researchers and students.
- Biography of author, description of the work and a list of references of the work.

All this media was provided by researchers from the university, library and national art museum. This source material will be organized, library experts are working in this task. The information provided will be stored both in digital copy and original source. The system will provide access to the originals stored in the library, as well as a multimedial integrated retrieval of the information of the works, artists and architects.

World Wide Access - Internet

The significant growth observed in Internet and specially in the World Wide Web, constitutes a powerful media to provide worldwide access to multimedial information. Longtime ago, Internet was a physical network with historical ties to research education and national defense. Nowadays, information services over Internet have millions of users, increasing considerably each day. Internet has been characterized as the Information Super-Highway, it has come to represent what the future looks like today, and to suggest what is possible when people can communicate with each other around the world. [Dugugherty,Koma, Ferguson]

This fact was considered in the design process. To provide world wide access, the system design should consider technical decisions in order to make possible world wide publication and future services that can be provided through Internet, that appears to be the main distributed information system.

Technical research was done in client-server and network technology to provide multi-platform access to the virtual collection. The evaluation of technology included file format standards and image capture options, between others. The next section describes the technical issues studied prior to the implementation stages of the project.

Technical Issues

Parallel to the design process, an evaluation was made to ensure technical feasibility, considering future changes and standards to guarantee project success and evolution. Mainly, the following technical issues where included during the process of technical evaluation.

- Image capture options available for each media and quality required.
- File format standards to ensure cross-platform compatibility and world wide access, as well as good compression rates for huge volumes of graphical information.
- Development tools for multimedial systems and relational database management systems to manage and retrieve the several media mentioned in the information requirements section.

Image Capture Options

The evaluation of the technology in image capture and processing was done with original sources for each kind of media. Image capture options were evaluated considering type and volume of media as well as quality requirements.

The view of artworks in the screen computer, requires high quality scanning and edition process of the images that represent the works. The technology chosen had to be good enough to represent these works with as much fidelity as possible, capturing details, textures, materials, colors and style.

The art objects belonging to the museum collection could not be exposed to any process that cause any damage to them due to certain light exposure, transportation or other. To avoid this, we worked with representations of the objects in 35 mm. slide, we are also planning to have short video sequences for the sculpture objects.

On the other hand, originals and copies of architectural drawings of famous buildings, were scanned to store a full size digital copy of them for further print-out copies in several sizes as needed by students and researchers.

For the first set of slides included about 1000 images. Scanning was adopted as capture option for the images. Studies from the Getty Museum had shown that 50.000 images could take about 3.6 person years (Getty 1988), what makes think of evaluating other methods to increase productivity, such as Kodak Photo CD. The image scanner evaluation considered the following:

Media Type. As mentioned, representations of the works came in 35 mm. slides, pictures and drawings in A0 format. The evaluation considered reflective/transparency media scanners for the images and large document scanning systems for the A0 format drawings.

Colors. For images (buildings and artwork), full color was needed, 32 bit system. Line-art was adopted for architectural drawings.

Resolution. After the evaluation, the least resolution needed for each media was:

- 35 mm. slides: Scanning resolution of 600 dpi was the least required for the processing, edition process and scaling needs. The final images were stored with a resolution of 72 dpi., enough for computer screen visualization (640 x 480 pixels). Professional printing quality of slides (300 dpi or more) will not be allowed by the system.

- Architectural Drawings: Evaluation with 20 representative examples, show that 300 dpi was enough to capture most of the information of architectural A0 format drawings. Due to the quality of the original source a highest resolution in scanning process did not make much difference, increasing document size and scanning speed time without having considerably better results. Final drawings were saved with 300 dpi full size source size to obtain further print-out copies of each.

Scan speed. The average processing time required for each media considering colors and resolution mentioned above was the following:

Media: 35 mm. slides
Colors: Millions
Scanning time: 2,5 min. average.

Scanner: flatbed with transparency module
DPI: 600

Additional processing time for simple edition, color and brightness adjustment, sharpening, cropping, resizing, saving to disk increased slides processing time from 5 to 10 minutes, using image processing software.

Media: A0 drawings
Colors: Line Art
Scanning time: 1,5 min.

Scanner: Large scale scanner
DPI: 300

Additional 5 minutes were required for editing process.

File Formats. Images require considerably more storage space than text, while audio and video demand even more of data storage. Not only is a huge storage required but the data rates for the communication of continuos media are also significant. The following examples illustrate some storage requirements for still color images and video [Steinmets. 1994].

In very simple color display modes, a single pixel of a bitmap can be represented by 256 different colors. Therefore 1byte per pixel is needed (8 bits- 28=256 colors).

The storage required for screen is:

640 x 480 x 8 bits = 307.200 = 300 KB. (1 KB= 1024 bytes)
For full color (24 bits) standard 640 x 480 pixels images, 3 bytes per pixel are needed. (24 bits - 224=16.000.000 colors).

Therefore, one standard 640 x 480, 24 bits image will need:

640x480x24 bits = 921.600 bytes=900 KB
For a video sequence of 640 x480 pixels resolution images, considering 25 images per second (PAL).
640 x 480 x 25 x 3 bytes/sec.= 23.040.000 bytes / sec.=22.500 KB

The use of appropriate compression techniques considerably reduces the data transfer rates. Compression in multimedia systems is subject to certain constraints. The quality of the coded, and later on decoded data should be as good as possible, in order to make a cost-effective implementation possible, the complexity of the technique used should be minimal. The processing of the algorithm must not exceed certain time spans.[Steinmets. 1994].

During the last years, research and development in this area have improved, today there are many different compression techniques available for different media. JPEG (Joint Photographic Expert Group) for still images and MPEG (Motion Pictures Experts Group) for video and audio. These techniques are often mentioned in literature and seem to be the standards adopted today.

The following standards were chosen for full color still images and line-art drawings.

Full - Color Still Images. JPEG (Joint Photographic Expert Group) is a standard jointly developed by ISO/EIC JJC1/SC2/WG10 and ITU-IS. JPEG was the format chosen for full color images for the following reasons:

- Is considered as the future standard for coding still images. Today JPEG is available both as software and hardware solution. JPEG is often used in multimedia applications that require high quality.

- Very general format, supported in several platforms, with a good compression ratio. JPEG can compress still images 10:1 and 50:1 without visibly affecting image quality. [Nicolas D. Georganas. 1995]

- Standard adopted by network client-server applications such as Netscape and Mosaic, used in World Wide Web publications in Internet.

An evaluation was done using a set of 300 images of artworks 640 x 480 aprox., 24 bit full color. The average size without applying compression was of 700 KB. After JPEG compression, the average storage needed was of 60 KB., without visible loosing quality.

Line Art Drawings. Line art big size (A0) drawings were scanned using specialized equipment. This task is in evaluation progress. Up to now, a full size 300 dpi raster version of the drawings is stored. The file format chosen is TIFF (Tagged Information File Format), a standard used by raster programs, by some image processing and desktop publishing applications. The compression method chosen is Hauffan, giving good compression ratios, considering the large size of the files. Hauffan algorithm is a standard in various platforms (IBM and Macintosh). Examples during evaluation process show that a set of examples of 15 MB average file size, without compression, were reduced using Hauffan compression algorithm to 1 MB average size files.

Alternative file format standards are in study as requirements appear in the following stages of evaluation. Future requirements include full compatibility with CAD software for several platforms for further vectoring and plotting in several sizes as needed.

The next stages of evaluation will concentrate on file formats for audio and video sequences. Literature indicates that MPEG and MPEGII are the standards for video and audio sequences used in multimedia. [Nicolas D. Georganas. 1995], [Steinmets. 1994].

Client-Server Technology

Several services on the Internet are based on Client-Server Technology, where there is a server software on one computer that manages the information and provides access to it. The client program on another computer manages the users interactions with the information. Through this technology, multiple clients can interact with a single server or many different servers.

Examples of these information services in Internet are FTP (File Transfer Protocol) and Gopher, each providing different ways to access the information. Today, the World Wide Web appears as a new information service, providing hypertext links, images and video and audio on a single document, users can navigate transparently through multimedial documents located in multiple servers over the network. This technology provides access to information to multiple users, no matter if they are Macintosh, Windows or X-Windows. They all can access simultaneously the same information located on the server.

Considering these technical issues, the database was design separately from the user interface. The database contains mainly text information about the works and file links including name and type of the other stored medias. Up to now, images' and drawings' file information is stored in text fields of the database. To include other medias such as audio and video, new fields will need to be added to the data-model in the future.

As large image files need to be transmitted over the network, two versions of the images were stored. A thumbnail version for browse and identification purposes and a full resolution for a detailed visualization of the work. The full size version of architectural drawings considered resolution requirements for further printing.

The next sections describe the implementation stages of the project. The first stage is described in detail, showing the user interface design and the retrieve facilities provided by the system. This design is the basis for the next stages of development.

Implementation Stages

This section describes the implementation stages followed in the project. The first stage was concentrated in data-modeling using the relational database approach, retrieve facilities and user interface design, according to functional requirements and user needs identified in the previous analysis. A first prototype was built on a Macintosh system using a relational database manager software. The next stage was to migrate the software to a client-server based system, providing world wide access. For this purpose, a second version of the system was implemented on World Wide Web using html (hypertext mark-up language). The user is allowed to browse through information about the artists, the works of art, architecture and art crafts. The next stage, consists in adding retrieve facilities to the WWW version of the system, adding communication to a relational database server using procedural language to retrieve data from the database server and build the html pages on the fly as the user accesses the information.

RDBMS Prototype

The first prototype was built on a Macintosh platform, the design considered data independence from the interface providing future access to the database located in one or more powerful servers that could be access from other platforms such as Windows.

The prototype built, includes information of art pieces belonging to our National Art Museum Collection, including 332 images for 130 works. For the architecture collection, the faculty provided information about a set of famous 20st century religious buildings. This information included 132 architectural drawings, 310 slides and information of the buildings.

The user interface was designed to be extremely user-friendly, considering characteristics of simplicity, feedback, consistency, and standards defined for systems to which the user is familiar.

A strong effort was made in orienting the interface to the images, rather than to the text. For example, the user is allowed to browse a set of thumbnails of the works and through simple "point and click" access additional information about the work and the artist. A full size image corresponding to the thumbnails is also available.

The following sections describe the search and retrieval facilities as well as the user interface design of the prototype in development.

Search and Retrieval Facilities

The different kinds of data retrieval were defined with the participation of a multidisciplinary group, including the software engineers, the projects director, the museum and Art faculty director, and a library system experts. The next step is to validate this with students faculty researchers.

Art Database

The user can search information by the following pre-defined criteria :

a. Search one Artist by Name. The user indicates name and/or first name of the author in a search window.

b. Search Artists by Subject. The user chooses, one or more, from the following: country, period (century or date range), discipline and technique in the search window. This query answers, the following:

Artists for a country.
Artists for a country in one period.

Artists for a discipline in one period.

For example:

20st Chilean watercolor painters.
19th century Mexican sculptors.

c. Search one Work by Title. The user chooses "start with", "contains" or "is" and types the title text in the search window.

d. Search Works by Subject. The user chooses, one or more, from the following: country, discipline and technique in the search window. This query answers, the following:

Works of artists for a country.
Works of a specific discipline and technique of artists of a country.

For example:

Sculptures in Chile.
Oil painting in Chile.

The following figures show examples of retrieval functions available and the user interface design. To search a specific artist, the user types first name and/or name in the search window.

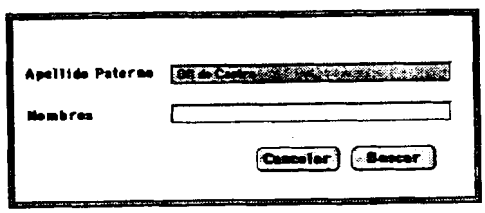

Figure 1.Search by Name

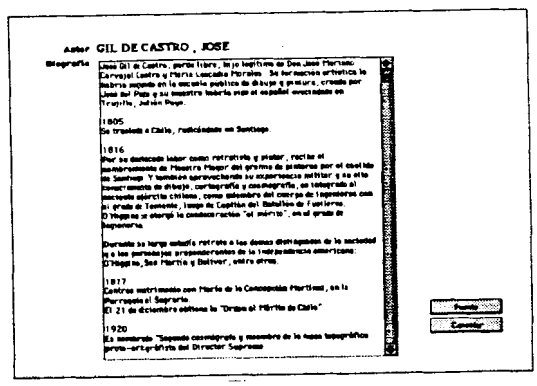

Figure 2. Artist Biography

A list is displayed with the names of authors found. Once the user selects the author of interest, the following information is available.

The artist biography
The set of works available of the artist
A list of bibliographic references.

The list of references where to find more information about the artist is available through this window. The collection of works of the artist can be browse by a set of thumbnails ordered by title.

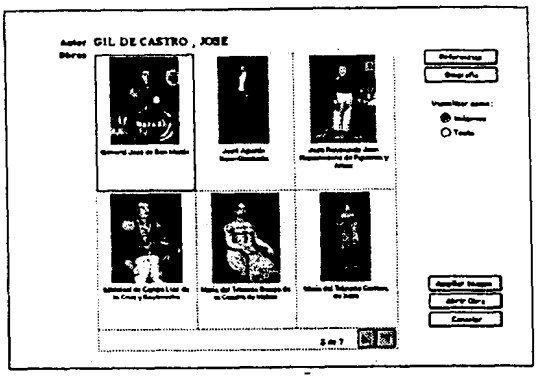

Figure 3. Author's Collection of Works. Thumbnails.

The user also can browse the works through a list of titles. As the user selects one work in the list , a thumbnail of the of it is shown at the right for easier identification of the work. This is very useful when the user knows the title of the work of interest, or when there is a large amount of works. The title list allows to browse faster the complete set of thumbnails.

All images can be seen in full size 24 bit, 640 x 480 pixels.

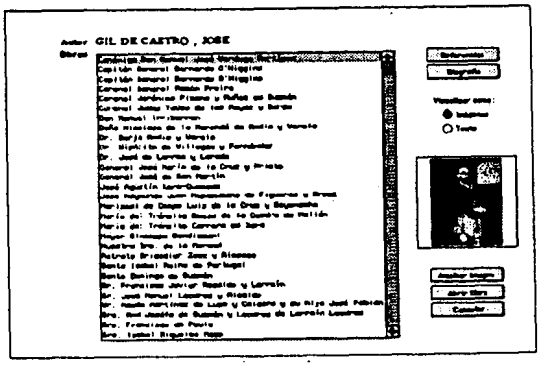

Figure 4. Author's Collection of Works. List and Thumbnail.

For information about one of the works, the user selects the work of interest and clicks the "open button" available in both windows shown above. A new window is displayed showing the information of the work. This information includes a set of images showing the work and relevant details, and information about the technique, size, year and original location of the work.

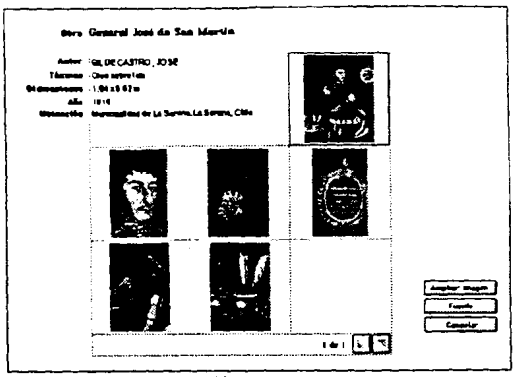

Figure 5 Information about one work

The next example shows the search by subject window. The user is allowed to choose from a list one or more of the following: country, discipline and technique. ("And" query)

Work search results can be viewed as a set of thumbnails of the works, or as list and thumbnail, ordered by title or author name. Information of the work (figure 5) and artist (figures 2-4) is available from both search results windows. The following figure shows the works search result thumbnail window (list and thumbnail version is also available).

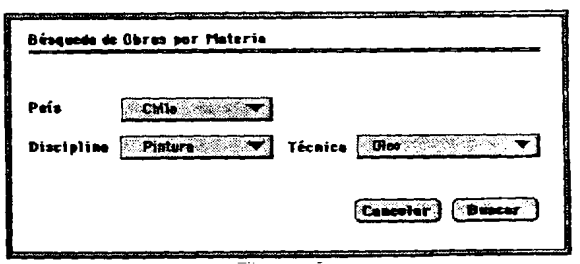

Figure 6. Search of Works by Subject

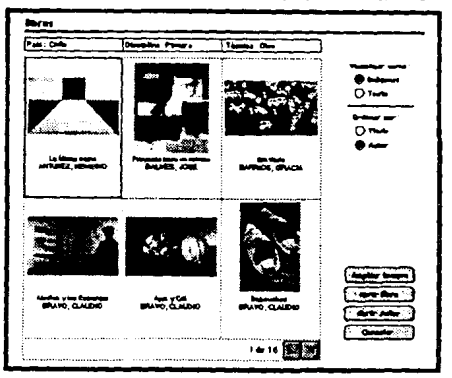

Figure 7. Search results. Thumbnail View

Architecture

The user can search information by the following pre-defined criteria:

a. Search one Architect by Name. The user indicates name and/or first name of the architect in a search window.

b. Search one Project by Title. The user chooses "start with", "contains" or "is" and types the title text in the search window.

c. Search Projects by Subject. The user chooses, one or more, from the following: country, city, type of project, period (date range) in the search window.

This query answers, the following:

Projects in a country.
Projects of one type for one period in a country.

For example: 19 century religious buildings in Chile.

The following figures show examples of the retrieval functions available and the user interface design for the architecture database. To search a specific type of project, for instance, chapels in Chile, (building type classification lists are provided by faculty researchers and library experts) the user indicates the query in figure 8. The user then browses the search results alphabetically in a title list, as shown in figure9.

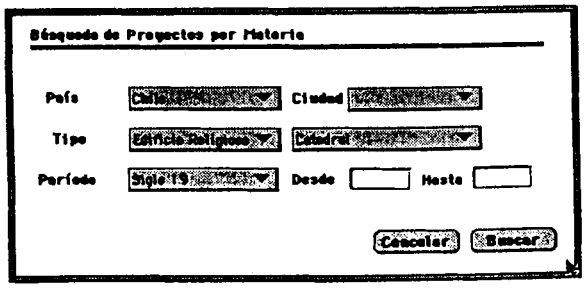

Figure 8 Search of Projects by Subject

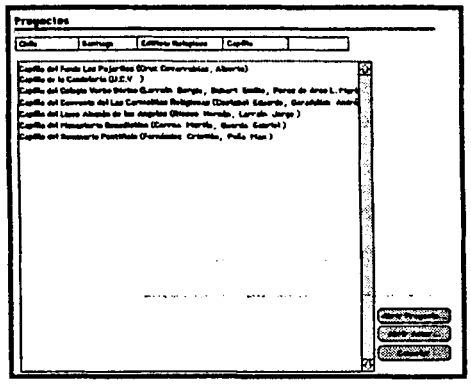

Figure 9.Query by Subject Results

By selecting one project, the user can have access to information about the architects (similar to the artist information) including biographical data, list of projects done by the architect) and to information about the project.

The project information includes :

Name, architects, location, project and building dates and a short summary.
A list of bibliographic references.
A set of slides.
A set of architectural drawings.

The following figure shows the project's information window.

The user can browse a set of slides of the building through a set of thumbnails. All images are available in full size 640 x480 24 bit images. Filters on slide type are available (exterior, interior or both, and slides of drawings). The figure shows an example of the project slide window.

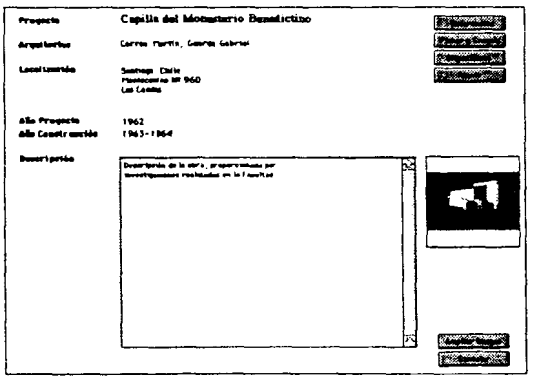

Figure 10. Project Information

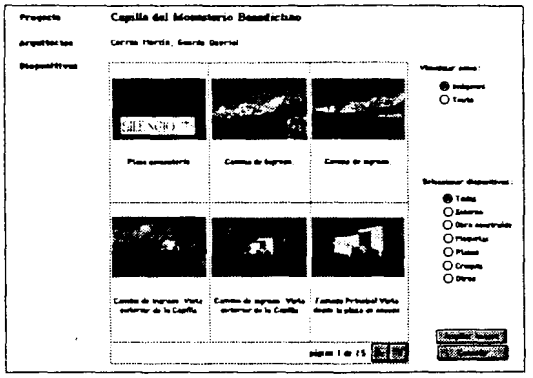

Figure 11. Project's Slides

A list and thumbnail view of the slides is also available.The list of original drawings and copies of the project can be seen as a text list including title, scale and real dimensions of the drawing. A full size scanned file is available in the library for plotting. For better identification, a scaled version of the drawings (640 x 480) has been scanned for screen visualization. This feature is in evaluation process.

The following figures show the drawing visualization window. Filter is available to see which drawings correspond to architect originals, to copies of originals, and copies done by faculty researchers.

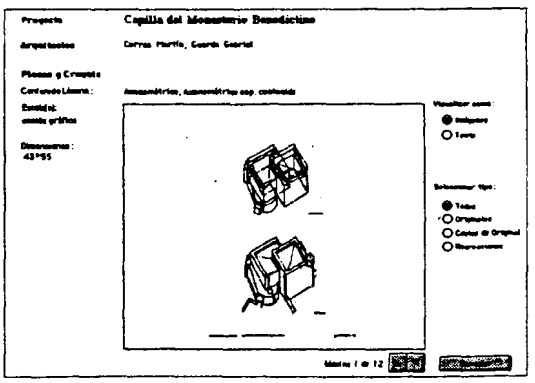

Figure 12. Project's Drawings

Text list version of this window is also available.All the information shown above, both collections for the art and the architecture database are being catalogued by library experts. This media is available in original sources. The users have access to the slides and drawings and in the future to video and other media collected. The next development stages include design process to organize these media, and link the virtual collection to the original sources available in the University library.

WWW Version

The Web is an easy and efficient way of distributing any kind of information to a large audience. Data is accessible to people around the world, information can be linked to other pieces of information so that the most important data can be quickly found by the user. It was in the 1960s when this idea was explored further, giving rise to visions of a "docuverse" that people could swim through, revolutionizing all aspects of human-information interaction, particularly in the educational field. The official description describes the World Wide Web (WWW) as a "wide-area hypermedia information retrieval initiative aiming to give universal access to a large universe of documents". What the WWW project has done is provide users on computer networks with a consistent means to access a variety of media in a simplified fashion. [Hughes. 1993]

The Internet has been growing exponentially for the last five years, with the number of machines connected to the network and the amount of network traffic roughly doubling each year. Today, anyone with a Macintosh, PC or Workstation can inexpensively connect to the Internet through a growing number of service providers and range of information and document services available. The emergence of standards for the transfer and storage of data has dramatically increased the ways with which individuals can both access and publish information [Masinter L., Putz S., Robson D. 1994].

Parallel to the first stage of implementation of the project, a considerable amount of information was collected in the production process. One of the project goals was the publishing of this information to make it available to other users spread over the country and world. Today, a world wide web version of the virtual collection is available and users have access to it through the Global University Information System called "Ariadna", available through the url "http://www.puc.cl".

The virtual collection WWW server allows the user to browse information and images of the art, architecture and art craft virtual collection using a graphical interface, using Netscape WWW browser. The next stages of development will provide search and retrieve facilities, joining the database and networking worlds.

WWW and RDBMS

During the last years the networking industry has been doing research in technology and products to construct the Internet world-wide environment. On the other side, database industry has been doing research and developing products to store and manage data to build powerful information systems. Nowadays, networking and database technologies are joining, several products based in relational model and client-server technologies are appearing.

Specifically, in Internet, the World Wide Web has enable global distributed information systems, joining multimedial data browsing and database searching over the network. Important characteristics of the web have made this possible, between them, the use of open standards, a uniform resource locator, modular client and server architecture.

Several tools and products from different database industries are available to have the commercial database servers as backends for World Wide Web. These products make possible to include the power of database technology to the Web applications.

Through SQL (standard query language) powerful operations in the database server can be done, as select, insert, update, delete, sort, commit and rollback. Products provided from database industry will provide interface and gateways to allow the creation of web pages dynamically as retrieval occurs in the database. This will provide up to date information and data integrity.

Specifically, the University Computer Service is using Oracle 7 database server in several projects. During this stage of development, the data model designed in the first stage of implementation will be migrated to the oracle server. Procedures and functions will be developed to integrate the World Wide Web creating multimedial information pages to manage and access the virtual collection of art and architectural works.

Conclusions

A multimedial database to manage a virtual collection of works in Art and Architecture is being developed with the purpose to preserve and widespread valuable information concerning the National and Latin American patrimony.

A virtual collection of outstanding work in these areas constitutes a powerful mean for researchers, teachers and students of the faculty and other institutions, providing information of masterpieces of difficult or restricted access. On the other hand, it will allow the preservation of information in several media.

Nowadays advances in multimedia, networking and database technologies provide new ways of information retrieval and human interaction. Several media including text, still images, audio and video can be presented integrated and transmitted through world wide networks.

The design process, considered user characteristics, information requirements and world wide access. Research in technology issues, image capture options, file format standards, client-server technology and relational database manager systems, was done to ensure project's technical feasibility.

A first prototype was developed with emphasis on functional and information requirements analisys, data-modeling tasks, user interface design and information retrieval facilities. This allowed the evaluation on functional requirements by the several users of the system.

All the information collected is stored and in catalogue process, both in original sources and digital media. Worldwide users can access the virtual multimedial collection through WWW in Internet. This version contains information concerning works of national Art, Architecture and Art craft patrimony.

The next stages of development will focus in adding to the Internet version the power of the database technology, allowing the users to query the information in several ways. A future interchange of information with other institutions such as museums and libraries, as well as new production tasks are expected to increase the amount of works to the virtual collection.

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