ARCHITECTURE IN REAL TIME
The Interdisciplinary Use of Film, Video and Computer Graphics For Representing Architecture

by
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Submitted to the Department of Architecture on August 9, 1985 in partial fulfillment of the requirements for the Degree of Master of Science in Visual Studies.

ABSTRACT

This thesis examines the interdisciplinary application of film, video and computer graphics to architecture. Three projects provide the basis of research:

1) An "interactive" videodisc of the design and construction of the Sagrada Familia Temple in Barcelona.
2) A videotape sketch of an urban space, "Trinity Church", December 1982.
3) Slow scan transmission of video images between Copley Square and the computer graphics lab of the Visible Language Workshop, M.I.T., April 1982.

They investigate the potential of a media technology that is non-traditional for architects to:

1) Document the Design and Construction of contemporary building. (Projects 1 and 2)
2) Be used to assess the social and environmental impact of architecture and urban design. (Projects 2 and 3)
3) Communicate the pathos, cultural qualities, observable symbols and images of architecture and urban design. (Projects 1 and 2)
4) Document or creatively express architecture through:
   (a) Computer 3-D Animation. (Project 1)
   (b) Computer Painting. (Projects 1 & 3)
   (c) Film Animation. (Projects 1 & 2)
   (d) Film Production. (Projects 1 & 2)
   (e) Slow Scan Transmission. (Project 3)
   (f) Sound Recording. (Projects 1 & 2)
   (g) Video Production. (Project 1)
   (h) Interactive Videodisc. (Project 1)

A comparison with more traditional media (e.g. pencil on paper) will be used to assess the relative strengths and weaknesses of the new media tools. The pedagogical role of media for architects focuses the assessment.

The approach within this document is more topical than technical. Technical materials developed for the above projects, such as source code by this thesis candidate, are for the most part immaterial to the nature of these findings with one exception. The design of a relational and hierarchial database for making videodisc technology an integrative medium is summarized.

Thesis Supervisior: Richard Leacock
Title: Professor of Cinema

TABLE OF CONTENTS

"The whole life of the average house, it seems, is a sort of indigestion."

Frank Lloyd Wright

INTRODUCTION

New Tools with New Conventions, Strengths and Weaknesses:

This document is itself a communications vehicle with unique attibutes that determine its capacity to transmit information to the reader and its capacity to serve as a pedagogical aid for the writer. It is a static medium. Once a book is written, it is revised only with the production of a new edition. Its characters and drawings can not be rearranged by the reader. Its organization is fixed.

Its communications potential may also be limited by its conventions. Variance with those conventions may be the artistic license of poets and graphic artists, but the mainstream writer will observe the basic rules of style to the degree that the reader's normal expectations will be satisfied:

> "Chapter titles should be similar in tone, if not in length. Each title should given a reasonable clue to what is in the chapter; whimsical titles in a serious book, for example, can be misleading. Many potential readers scan a table of contents to determine if a book is worth their time (and money). Relatively short titles are preferable to long, ungainly ones, both for appearance on the page and for use in running heads."[1]

Similar conventions have been written about architectural drawings. The American Institute of Architects' book on Architectural

Graphic Standards has established drawing conventions for almost everything that an architect may put in a contractural drawing. Limiting an architect's liability in legal disputes, these conventions are necessary often to reduce ambiguity in a drawing. But as a pedagogical vehicle for exploring design alternatives, these definitive standards are usually abandoned in the design studio in favor of more free-handed drawing techniques that are intended to foster ambiguity. Although the use of these techniques tend to vary widely, the approaches that are encouraged reveal forms to the designer that are less encumbered by predefined concepts. To the extent that these methods can be articulated by studio masters, they represent a loosely defined set of conventions.

A new set of electronic media tools are being released into the commercial marketplace for architects. The conventions for using these tools and expectations upon them are to large degree based on the standards that exist for the use of more traditional media. However, there are few counterparts in the traditional studio for working with the capabilities of three-dimensional real time animation, computer graphic solid modeling, live video, and synthetic sound. At the same time, there is much hesitation in accepting new media that do not support the same degree of fluidity and subtlety in sketching as some of the more traditional drawing mediums. If the new media tools are going to make it in the studio environment, there is a need to establish new expectations based on a different set of conventions, strengths and weaknesses than the more traditional media.

Relevence to Practice/Background Summary:

The uses of film, video and computer graphics can be examined separately in terms of current applications to architecture. Film and video media have been used as an alternative to presentation boards. The Architect's Collaborative (TAC) have incorporated several of their presentations onto videotape, such as a proposal for a Kuwaiti News Agency.[2] At TAC, the designing architect may sketch out the movie's shotboard, a script writer and a narrator are hired, and a video company is contracted to handle production (Videocom Inc. in the case of the Kuwaiti News Agency). The videotape is used to intensify reality through the merging of site models, simulated pathways and sound.

The use of video as a vehicle for design professionals and clients recording their interests was demonstrated at a seminar of the "A/E Systems 84 Conference" in Baltimore, Maryland (August 1984). Several tapes were played that depicted architects and planners discussing their design methods, and clients articulating their concerns. This use of film/video suggests a more active role for the media, before the design process is complete, and allowing interested parties to make intelligent decisions on a given set of proposals.

A further use of film/video is advocated by Boston architect David Lee.[3] He proposes the use of "town media parlours" as a means of engaging people in a participatory planning process. A visual analog is shown to inform people what a design may look like. The "media parlours" are connected by telecommunications links to the architect/design team, and a diverse audience of users has the opportunity to help define objectives and voice community interests. The value of design input that originates from this setting, however, needs to be carefully examined (see Remote Transmission from Copley Square Project).

The rising interest in film and video is reflected by the involvement of grant disseminating institutions and architects in movies that concern architectural themes. These institutions include the Association of Collegiate Schools of Architecture that supported a grants program recognizing "film/video as a medium that could force the architect to abandon the static images of traditional graphic representation."[4] Larry Rosenblum, independent filmmaker and architect, sums up his transition to film by stating, "I left architecture because I was more interested in the personality of the building than whether it leaked or not."[5] His interest in the theatre of architecture is reflected by his observation that, "There are textural, visual and dramatic effects that you can achieve in film that are impossible with any other medium, including architecture."

While moviemaking has achieved some legitimacy as a medium for presenting architectural concepts, greater attention has been focused on the role of computer graphics. Marketing efforts targeted at practicing architects established a $275 million dollar industry in 1984, with expected revenues of $1 billion by 1987.[6] The role of computers is gaining acceptance, although their use has yet to embraced by the profession as a whole.[7] In most instances, it is serving the architect in applications that are a few steps removed from the creative design process, and through "low end" products (inexpensive and based on micro computers). Its introduction has occured in tasks that are most repetitive, where the speed of the computer can be used to process information very efficiently in a "boiler plate" manner.

The "low end" products have helped architects to track accounts, maintain budgets, fees and personal schedules. Micros have been used for structural design computations, energy consumption analysis, building life-cycle projections, and for facilities management and space planning. Specification writing has attained much penetration, with one prediction that 70 percent of all firms will be doing some specification writing on computers by 1989.[8] It is, however, in the creative design tasks where there seems to be some footdraging by architects in the acceptance of the computer.

The closer that computer applications move towards the artistic domain of the architect, the greater the level of resistance. There is some skepticism that the automation of the design tasks would force a blind and uniform interpretation of function to form. Architects claim that the "intimate-hand-pencil connection is the irreplaceable pipeline communicating their humaneness to the very stones of the buildings they design."[9] Reflecting on early computer aided design efforts at the architecture machine group, Nicholas Negroponte wrote, "The clumsiness of computer graphics architecture is surrounded with technical difficulties, its resolution will not yield the same textural feeling as graphics on paper."[10]

CAD is an acronym for computer aided design. It is a label generally applied to all uses of computers by architects, including, but not limited to, the use of computer graphics as a design tool. Most products commercially available within the architectural CAD market, however, support the integration of computers into the drawing production process only and are intended to improve drafting productivity. The computer is used to automate working drawings production, but it is less well adapted to rapid sketching and visual ideation. Negroponte writes that "No matter how fancy and sophisticated the computer graphics, it is only a glorified background or piece of paper, that is, until it overtly talks back and participates in the dialogue."[11]

Architects engage in a limited dialogue through an iterative use of drawing media. Insights will often occur in the fleeting and spontaneous moments of a rapid sketch that can not be captured within a deliberate or finished drawing. This phenomenon is recognized in Negroponte's statement that "Computer graphics displays will force a new doodle vernacular if they are to capture those original ideas that initially reside on paper."[12]

It was noted before that the acceptance of film/video and computer graphics has mainly been for presentation and drawing production purposes. These activities are said to occur at the back end of the design, occuring after the creative stage has concluded. However, much "cutting edge" research has been directed towards the front end or creative part of the design process. Experimentation with computer aided design has been conducted in artificial intelligence applications, including projects Urban 5 and Machine Vision. The development of Urban 5 involved a machine intelligence that would "search for idiosyncracies in design habit" so that a man-machine partnership could adapt to the methods of a particular designer.[13] The Machine Vision project centered on an effort to develop a three dimensional model based on the reading of two dimensional images/sketches input to create a video image through a drawing interface device.

Research at Cornell University, under the direction of Donald Greenberg, has emphasized methods of environmental modeling and of achieving photographic quality in computer graphics images. The computer graphic images, although computationally expensive, can offer a high level of resolution and textural feeling that adheres to Nicholas Negroponte's criteria for image quality.[14] Additional research at Cornell is intended to provide tools that parallel the architect's design process. This has been described as a five-staged iterative loop, encompassing 1)Problem Definition, 2)Strategy Formulation, 3)Temporary Solutions, 4)Preliminary Design and 5)Analysis. At M.I.T., the design process has been characterized as having greater ambiguity than suggested by this five staged model. Computer applications have been developed on the basis of a model allowing for greater ambiguity, however, the pioneers of this approach believe that much research lies ahead before a successful prototype is developed.[15]

The capability to synthesize information potentially poses the greatest challenge to computer graphics modeling of architecture. As a design partner, the computer can aid the architect by discerning patterns, visualizing the result of design strategies, and monitoring the adherence to design constraints. Computer graphics modeling supported by the use of an intelligent database can help to synthesize

concurrent design activities, reconcile conflicts where possible, and flag those conflicts that can not be reconciled without compromise. Within such a paradigm, the computer can add a qualitative check to a proposed design, and present a visual overview more encompassing than otherwise apparent to the designer.

When evaluated separately, computer graphics and film/video have each added new mediums that have the power to provide a visually realistic and compelling presentation of a proposed design. As design tools, each medium has the capacity to elevate an architect's understanding of a design problem by creating a three dimensional display that can convey motion, light, texture and sound. Provided that a spontaneous method of interaction can be supported, this dynamic modeling capability can have a pedagogical value similar to sketching, and impart unique representational qualities. The study of design elements such as motion, sound and moving shadows could set the stage for a more complete approach to architectural design than that afforded by drawing a two dimensional medium. This thesis explores the uses of film/video and computer graphics separately, and the potential for their combined use within the interactive videodisc.

THE SAGRADA FAMILIA PROJECT

Description:

The Sagrada Familia Temple in Barcelona represents the artistic and philosophical views of Antonio Gaudi and his close associates who were leading proponents of the Catalan Renaixensa. The Renaixensa was a cultural renaissance that found expression in poetry, painting, and sculpture as well as the design of the Sagrada Familia Temple. Today, the Temple remains active as an architectural laboratory for experimentation in structural and geometrical form. These activities are performed by the current architect and modelmakers.

The Temple is still under construction and now spans the work of several generations of craftsmen. It's organic architecture, structural innovations, and complex three-dimensional forms can not be easily described within a conventional drawing, or with a combination of traditional architectural drawings (e.g. plans, sections, and elevations). Because it is difficult to draw by conventional methods, the Sagrada Familia Temple poses a challenge to any new rendering technique and medium for expressing architectural design. In particular, it provides an opportunity to experiment with modeling through the interdisciplinary use of film, video and computer graphics.

The Tools:

A "randomly interactive" videodisc was produced that consists of several architectural rendering mediums. The "random interaction" refers to the capability to view sequences of personal preference on the videodisc at random locations and not according to a predetermined order. The mediums recorded within the videodisc are film, video, and computer graphics. The techniques used in working with the diffenent mediums include observational cinema, time-lapse photography, computer graphics geometrical modeling, computer image processing, and computer graphics painting.

The videodisc is played by means of a computer graphics menu. The viewing system's hardware configuration includes an IBM Personal Computer(The IBM PC-AT or IBM PC-XT) and Color Graphics Monitor, an Interactive Graphics Cursor Controller (a Mouse), a Videodisc Player (SONY LDP1000A) and a Color Television Monitor. (A detailed description of the software environment is provided later).

An Interdisciplinary Approach to Rendering the Geometry of a Column:

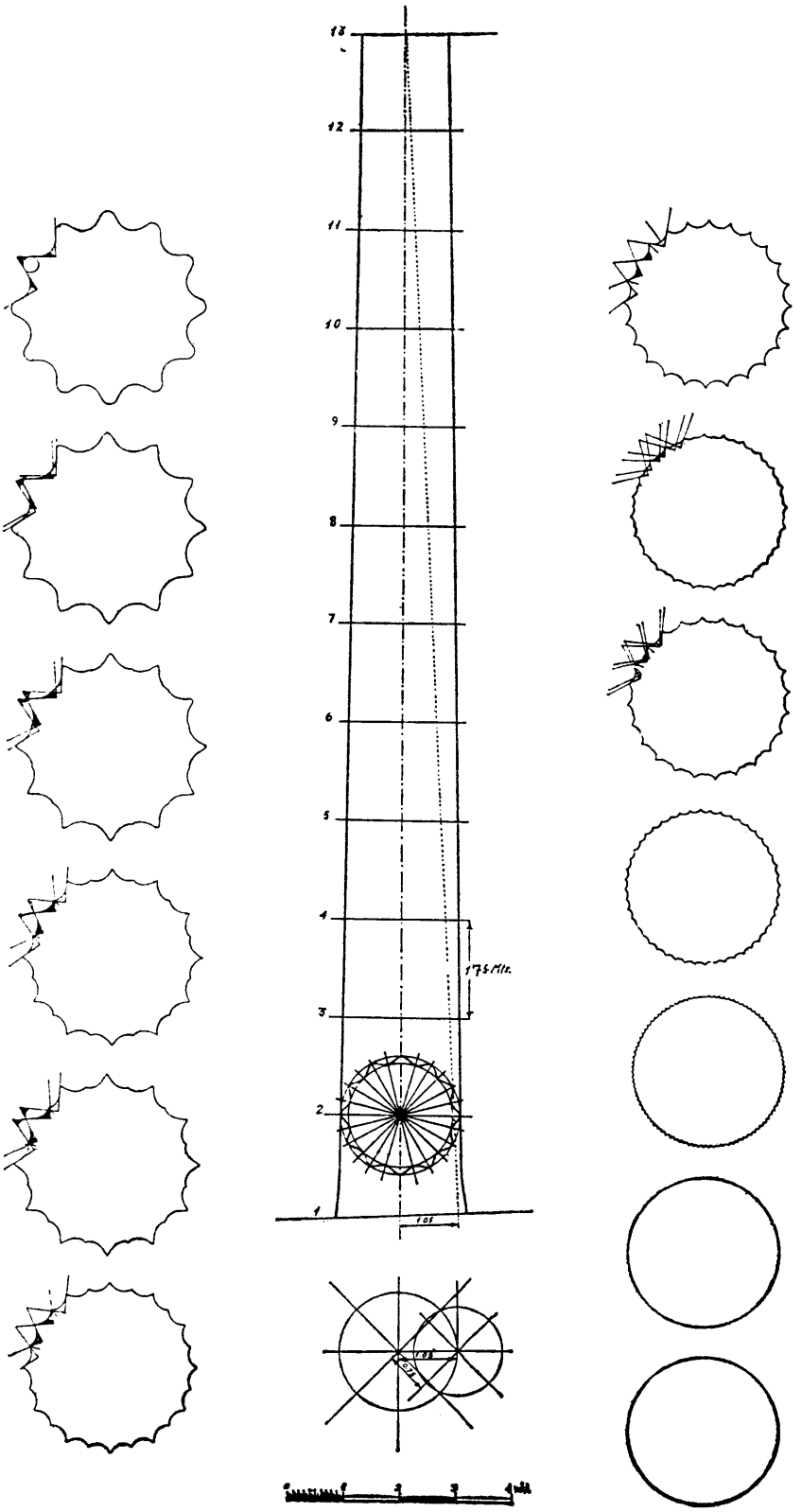
Three weeks of on-location videotaping and filming focused on the work of the modelmakers within the crypt of the Sagrada Familia. The modelmakers relied upon a projective geometry in the interpretation of

architectural drawings. The same geometrical technique was used to build computer graphics models. As an example, one of the projective geometries used to transcribe a plan into a three dimensional model is based on drawing 1 (next page).

As described by the current architect of the Sagrada Familia, and further clarified by Professor George Collins at Columbia University, the geometical scheme begins with the base level plan of twelve points shown in the upper left hand corner of drawing 1. The base level plan of twelve points is superimposed upon itself and rotated so that twelve new interstitial points are created (level 2). The rotation progresses gradually through the next five levels of the column so that eventually 24 points of equal character are formed (level 7).

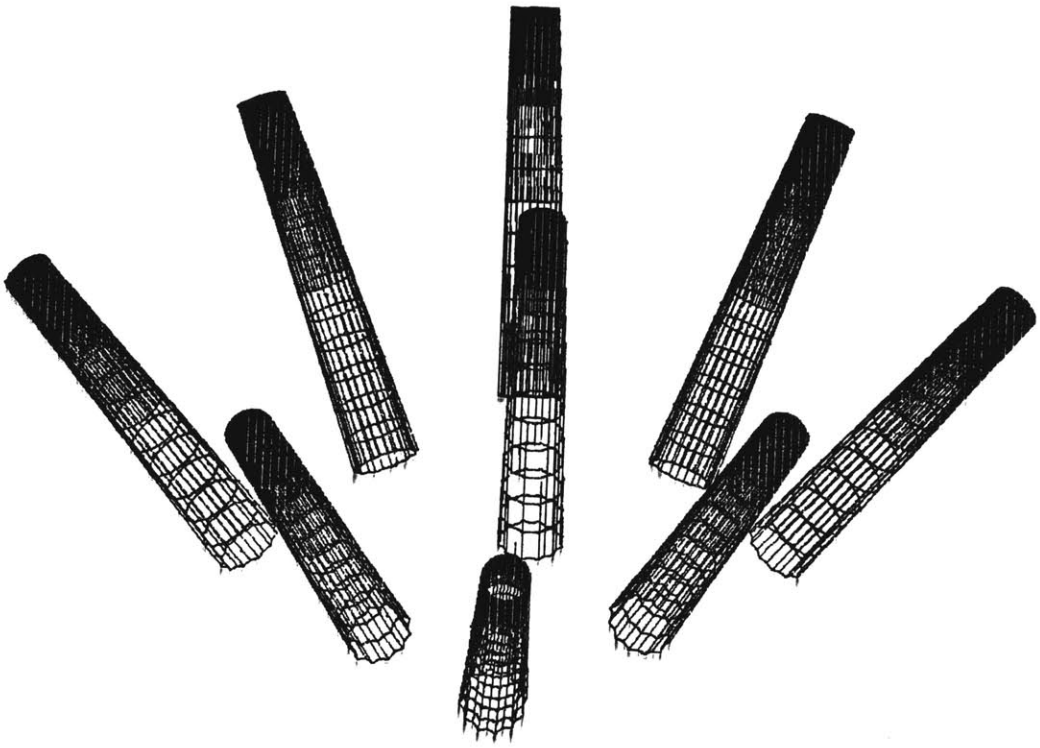
The process is then repeated so that eventually 48 points of equal character are formed at level 10. The pattern of superimposition, rotation and doubling is repeated upward through the remaining levels of the column. After level 10, the complete doubling process occurs at every level. That is, 48 points of equal character at level 10 give way to 96 points of equal character at level 11, 192 points at level 12, and so on. This doubling of points can be described exponentially in terms of 2 to the nth power where the exponent n is incremented by one at each new level of the column. As the top of column is approached, the doubling of points has accrued exponentially to the degree that they approximate a smooth circle.

Drawing 1 Two Dimensional Drawing of The Column [16]

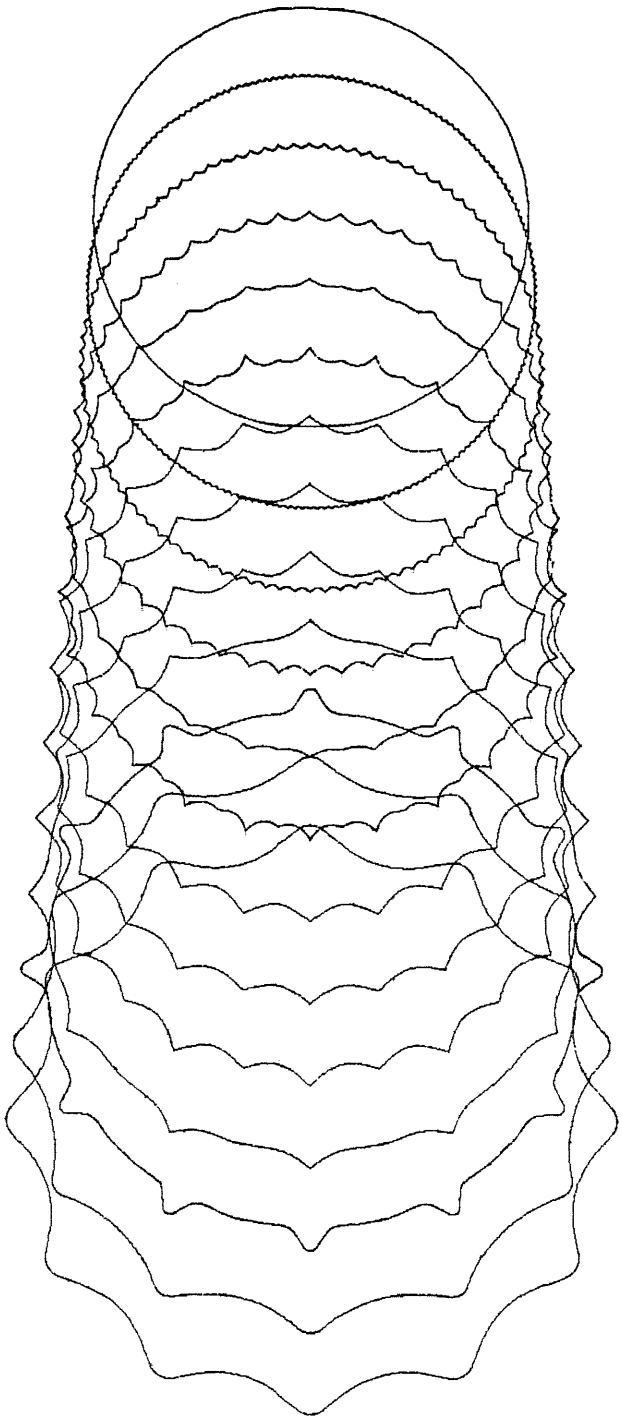


Barcellona - Tempio espiatorio della *Sagrada Familia*. Generazione geometrica delle scanalature e della rastremazione di una colonna, mediante un movimento elicoidale alternativamente destrorso e sinistrorso. Il raddoppiamento degli spigoli è sincrono al progressivo ridursi del diametro, per cui il movimento elicoidale determina anche la rastremazione del fusto.

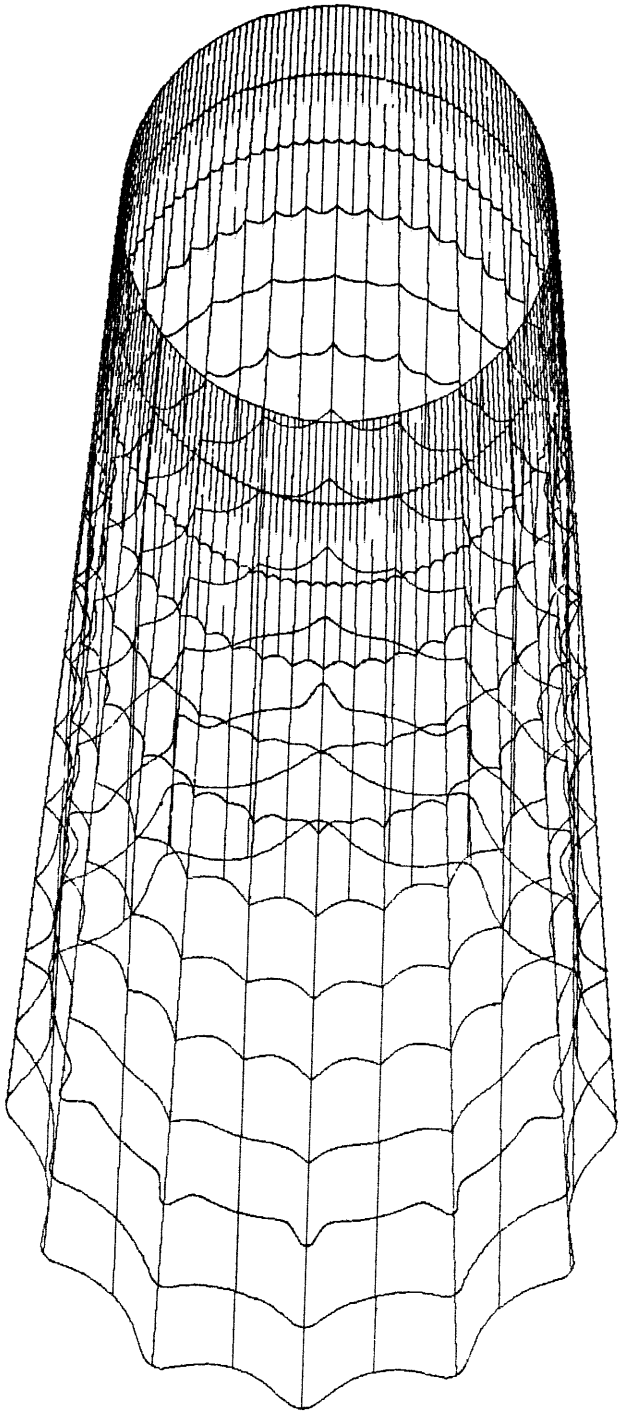
Drawing 2 Rotated Views Of the Column
Drawing was created on a Computervision Cadds4X CAD system.



Drawing 3 Plan Geometry of Column at Each Elevation
Foreshortening due to angle chosen. Drawing was created on a Computervision Cadds4X CAD system.

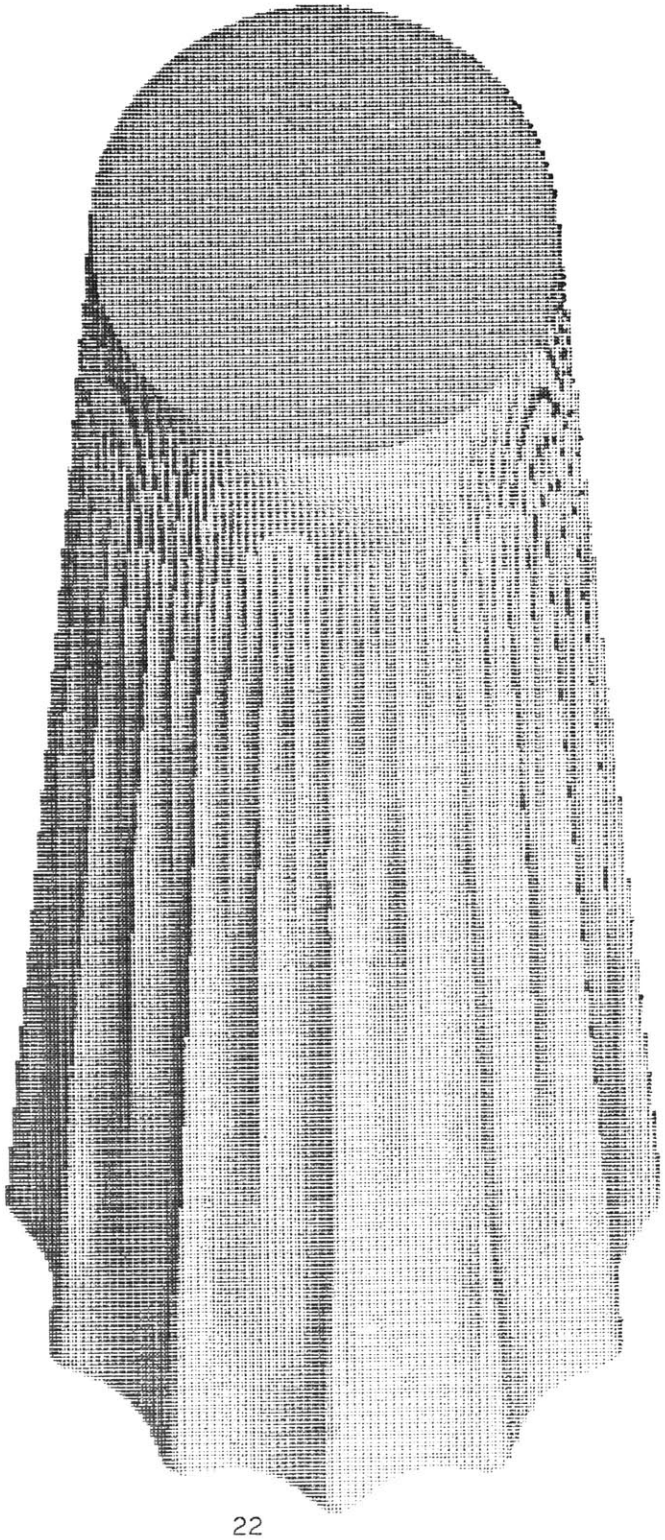


Drawing 4 The Ridges of The Column
Foreshortening due to angle chosen. Drawing was created on a Computervision Cadds4X CAD system.



Drawing 5 The Surfaces of the Column

The column contains over 1,200 surfaces, of which approximately 100 are unique. Foreshortening due to angle chosen. Drawing was created on a Computervision Cadds4X CAD system.



The series of doubling points on the column are connected vertically by ridges. The ridges outline the colunn's fluting. The number of flutes double in correspondence to the number of points. As the points multipy to approximate a circle at the top of the column, the fluting multiplies to approximate a cylinder. Finally, since the number of flutes is doubling, the shape of each individual flute is constantly changing as it rises from the base of the column.

In this example, several ways of describing the column have just been given. A verbal description of the column's geometry only provides a vague description of its form. A conventional drawing is coupled with the verbal description, and yet they alone do not produce a tangible image. At the Temple, a more graspable depiction of the column is communicated through the use of a small scale plaster model. A primary use for the plaster model is to clarify the design of the column within a medium that can be readily understood by the stonecutters at the construction site.

The modelmaker begins by pouring plaster into a simple mold that is large enough to encompass the geometry of the column. With the aid of compasses and other measuring tools, the modelmaker takes exact measurements from a set of working drawings and carves the geometrical framework of the column into the mold. This geometrical framework serves as the basis for a more interpretative carving of the column's

highly variated fluting. In this manner, the modelmaker's technique includes a combination of precise measurements and more free-handed carving, as though following exactly the measurements and beats and more interpretively playing the notes of a piece of music.

The process of constructing the column with computer graphics is similar to making the plaster model. The constructive technique is based upon the use of primitive geometrical entities, such as circles, arcs, and lines. These entities are used to set up the precise geometrical framework of the column. This framework establishes a three-dimensional skeleton for inserting more complex geometies, such as b-slines and surface poles.(A surface pole is a type of surface built up from b-splines). At any time during its construction, the computer graphics model can be rotated and viewed from any angle (see drawing 2).

Unlike the plaster model, the computer model can be transformed to any scale. It can be exploded so that the framework of its underlying geometry is more recognizable. It can be filtered through a overlay system that displays varying levels of detail. For example, the complex geometry of the column can be filtered into more understandable component geometries. The "points" can be described on one layer (see drawing 3), the ridges can be described on a second layer (see drawing 4), and the surface of the fluting can be described on a third layer (see drawing 5). This use of the CAD system for

viewing this column offers special vantage points not available within more traditional media. Rotating the model on a computer in "real time" reveals the complexity of its geometry more coherently than does a static image.

The Computer Model as a Communications Vehicle:

The computer graphics model provides a precise mathematical description. Its constituent elements can be readily scaled, translated or rotated by the use of transformation matices. Within a true three dimensional CAD system, any computer graphics drawing is obtained by a direct projection of the model upon a two dimensional plane, as in the taking of a photograph. Since a computer graphics drawing is only a projection of the model, it is a secondary representation of the information held within the model's database. On the other hand, a traditional drawing is not projected from a three dimensional model sitting within a database. It is the primary source of information for documenting the three dimensional entity that it describes. Unlike the construction process used with the computer, the coordination of traditional drawings is directly essential to the formulation of the model.

A model that is based on a computer database can be communicated without the use of drawings. For example, if a computer aided

manufacturing (CAM) component is added to the CAD system, then the model translates directly into a set of machine instructions required to build the architectural components. All professionals that are involved in a design project may potentially share the same database. Extracts of that database would be filtered according to the specialized needs of each profession and may include graphic and/or non-graphic information.

The use of model's 3-D computer database as the primary communications vehicle for architects has some disadvantages. Whereas architectural drawings are a direct visualization of the model, they are more likely to be universally understood. In contrast, computer databases must first be processed by a machine before they can be interpreted. The databases exist within a wide variety of formats that are not necessarily compatable with all machines. There has been advocacy of standardized databases, such as IGES; however, standardized databases can not always accomodate the unique requirements of specialized applications. According to the National Reaserch Council's Advisory Board on the Built Environment, the creation of a database that is translatable accross islands of specialization within the construction industry may be one of the most significant goals for CAD/CAM.[17]

The Capacity of the Medium to Support Creative Expression:

Of special importance to architectural design is the capacity of a modeling medium to accomodate spontaneous expression and record the free flow of changing ideas. The computer database model offers a high degree of responsiveness with regard to geometrical amplification and reduction. The geometries of many elements can be quickly characterized and manipulated with a single instruction to the computer. Networks of architectural space can be rearranged by the alteration of a single parameter (as in Space Planning applications software). These examples illustrate that there is no longer a one-to-one relationship between an architects action with a drawing instrument and the number of graphic entities that can be created or modified. The computer modeling system supports a one-to-many dialogue where any number of coincident results may occur in response to one input.

Building a model on the CAD system, however, is restricted by the requirement of a precise mathematical description for each of its many geometical forms. This was evident when working with the unique surfaces forming the flutes of the column depicted in drawing 5. The column's flutes change as they rise from the base, and take on a progression of varied concave surfaces. In the plaster model, each unique surface is individually sculpted to match adjacent surfaces.

Two adjacent surfaces with dissimilarities in curvature are joined by intuitively sculpting the edges of each one until the connecting symmetry is obtained. Within the CAD system, each individual surface has to conform to two restrictions. It must be definable in precise mathematical terms. And, its joins with adjacent surfaces must match in precise mathematical terms (b-spline surfaces). For Gaudi, these variating surfaces embedded within the more regular geometry of the column's ridges (Drawing 3) provides the coherency of its design. "If necessary," he said, "we will seek unity in variety".[18]

Each action of the craftsman has a singular inpact on the model, a one-to-one mode of input. The one-to-one relationship of the craftsman's action to a each physical change in the plaster model provides an immediate sensory experience. The plaster modelmaker slowly works the material and uses many senses in creating the desired shape. The plaster is cool and light. It possesses physical attributes and changes of state that influence how it is sculpted. As it dries, its ductility changes, and accordingly, pouring the plaster is succeeded by carving it. By comparison, the computer graphics modelmaker relies exclusively on sight for sensory contact with the model, and is deprived of more direct physical stimulus.

Selecting the Best From Alternative Mediums:

The combined use of media techniques can be used to overcome limitations and recognize advantages inherent in the use of each constituent media. The distinctly unique media are grouped together on the Sagrada Familia videodisc to provide a more complete view of a particular subject. For example, computer graphics modeling, time-lapse photograhy and film were brought together in the study of light. The computer graphics were generated to simulate the motion, lighting and shading of a column. The film was shot to record a light source moving over a plaster model of the same column. The time lapse photography reveals the movement of the sun over similar columns built into completed portions of the Temple.

A comparison of traditional and computer generated rendering techniques at a conference on Gaudi in Barcelona produced formal criticism of the limitations of the old and the new techniques.[19] The use of electronic media and film does not substitute for studies of light made in charcoal or pencil. Traditional hand rendering techniques provide sensory feedback that contribute to a personalized visual exploration of the object being drawn The process of drawing a shadow lends itself to a more painstakingly careful study of it than viewing it drawn automatically. Yet, a computer can animate a shadow moving over a surface and provide a time related observation that would not be as perceptible with hand rendering techniques.

Introducing new media and there attendant methodologies into the practice of architecture may provide vantage points that have a radical influence on design. The eclectic use of these media may provide architects with a hybrid modeling medium that can respond to a wider range of imput. The use of such media may also provide the opportunity to formulate design solutions that can not be expressed with the use of more traditional modeling techniques. At the same time, the established methodologies of each medium may also change within the context of their new application.

Observational Cinema in a Context Without Closure:

A personalized video record of the design process used in building a column is associated on the videodisc with the computer graphics study of the column's abstract geometry. The video images of the Sagrada Familia Temple and its environs resulted from two weeks of on-location shooting. A focus for the videotape is the collaborative design process that attaches importance to each craftsman making a contribution of high aesthetic quality to the whole work. In the construction of a column, drawings are translated into plaster models, and the plaster models are translated into stone, within a traditional design process dating back to Gaudi's time.

Gaudi inherited the project to construct the Sagrada Familia Temple from another architect in 1893. The Temple was originally designed in a purist neo-Gothic style. Using a stuctural innovation based on the catenary curve, Gaudi redesigned the Sagrada Familia Temple to be the tallest religous building in the world. However, the Nativity Facade was not completed until 1930, after Gaudi's death. The major balance of construction activity, including the central vaulting, is still to be accomplished. There is a half-joking commentary suggesting that the Sagrada Familia will never be finished for there will be no religion four hundred years from now.[20] These circumstances lacking completeness in the current time-frame seemed unacommodating to the definitive filmmaker looking for a story.

One of the risks of shooting a non-scripted documentary is that the events that are captured are not cyclical during the course of making the movie and may not lead to a meaningful conclusion. In this case, the building and even the model under construction were both approximately one hundred years old. The few complete cycles that could be observed were those of individual's daily routines, and the activity of intitiating and completing a piece of the model. The longest and most important cycle, the process of initiating and completing the construction of the Temple, extends beyond the lifetime of any of its collaborators and is not very perceptible within a few weeks of shooting.

On the one hand, focusing on the shorter cycles that were evident while videotaping at the construction site does not deliver a true perspective of the overall process. On the other hand, forcing the grand vision or big picture to be depicted in the more narrowly focused time-frame of shooting the movie trivializes the significance of the small events observed. The richness of the Temple's construction effort can be in part attributed to the meticulous and unhurried quality of work evident in each of the daily construction routines. That the larger frame of reference is not immediately apparent in those activities adds to their interest.

A narrative can offer definitive information on a the first efforts that characterized the construction effort of the Sagrada Familia. Photographic records can add convincing evidence. However, providing the viewer with the option to view these alternative sources of documentation can undercut the rhythm of a story. The viewer is permitted to watch events in an immediate and intimate manner. These events are delicately paced to impart the lyrical quality intended by the moviemaker. But the viewer gets bored and invokes the privaledge of turning to an alternative pathway through the videodisc. The rhythm and pacing are easily disrupted and the moviemaker has less ability to control the unraveling of sequences and create the desired tension.

Working with the Interactive Videodisc:

The interactive videodisc brings together the previously disjointed capabilities of image processing, computer graphics, text and television. The first uses of the new tool have been based on the known capabilities of its constituent technologies.[21] Yet, it is incumbent upon the applications researcher to discover the ways in which the interactive videodisc can be greater than the sum of its component media. A possible outcome of applying the technology to old problems is to "burn holes" within the mind of the user;[22] that is, familiarity with the technology leads to more creative insight into its potential.

The interactive videodisc is applied to a problem encountered in the making of documentary movies. The problem is to provide a historical and future frame of reference for a motion picture medium that is best at responding to and capturing the present. In the solution to this problem, computer graphics analysis, narration, and historical text are juxtaposed in such a way so as to compliment and expand upon the contemporary footage. This approach recognizes the limitations of its component media and does not impose upon them functions that are not in accordance with their true capabilities. But combining these media within a common vehicle requires the creation of a new set of aesthetic guidelines that can provide coherency and structural integrity to the whole work.

In 1982, an NBC documentary called "Say Goodby" showed men in a hellicopter shooting at a mother polar bear.[23] The commentator spoke sorrowfully of the polar bears, "for them, life is good. At home in a hostile climate, the polar bear has taken for granted its freedom in the Artic. But no more...Grieve for them and for us." Not apparent in the edited footage, however, was the fact that the polar bear had been taged by the men for research purposes. The polar bear later jumped to its feet and walked off. Because of the given combination of sound and imagery, the truthfulness of the event depicted was compromised. In the same way, the videodisc's creditability is challenged by the difficulty of presenting alternative sources of information in a thorough manner. Relying upon the juxtaposition of media formats to tell a story and then permitting the user to jump around the videodisc increases the risk of providing incomplete information.

As another example, a mathematical statement is used to describe the invisible structure of the golden rectangle (i.e. A/B = A/(A+B) where A is less than B). A visual depiction is more revealing of the sculptural qualities of this geometrical pheonomenon (i.e. the spirals of a conch shell). The juxtaposition of these two characterizations provide two vantage points that may be of equal importance to anyone attempting to understand the golden rectangle, but the success of combining the two media may rely upon the completeness of each separate description.

If obstacles are apparent in the use of any singular medium (radio, print, television), then the notion that an integrated technology would make communications easier may be wishful thinking. Unless each constituent medium carries its own weight, the cumulative result could be fragmented to an even greater degree than the sum of its parts. Arising from these difficulties is the requirement for someone to be well aquainted with the aesthetic criteria of each media in order to know how to combine them effectively. It may therefore be worthwile to consider what aesthetic foundation can lead to a holistic conceptual framework for the new hybrid medium.

Nicholas Negroponte has formulated questions that serve to relate the aesthetics of books with that of computer media[24]:

> "Are there similar chunks? What purposes do they serve? What use does the sense of place serve? What are the meaningful gestaults?"

Taken from Nicholas Negroponte, the term "randomly interactive movie" refers to how the videodisc composite of these aesthetic elements is used. A book, according to Negroponte, is the perfect medium for random access retrieval. The optical videodisc can be perused in the same way; however, the computer interface provides an opportunity for "intelligent" random access. The software interface to the videodisc is an intelligent directory. It has the potential to gather

knowledge about its use, discern patterns, correlate selected topics, interrogate the user, and on the basis of this information act as a partner in information retrieval.

The merging of a computer's memory search and sorting capabilities with a particular user's interests can transform the software interface so that new families of information are identified for future users. The process of finding associated families can also be stored. This feature allows us to compare alternative pathways through the videodisc's contents, juxtapose subjects, and find those connections, parallels and insights which may add richness to their interpretation.

This concept of the videodisc envisages less of a division of roles between the videodisc maker and the videodisc viewer. The "chunks" or associated groupings of information are subject to some interpretation. The curious viewer can re-assemble the groupings of information and perhaps reverse the bias inherent in their original organization.

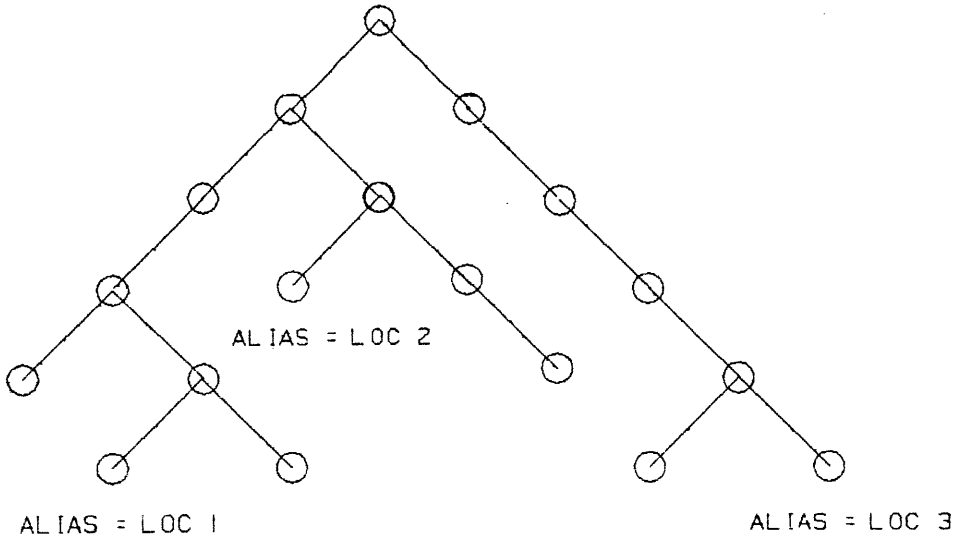
Further investigation of how the videodisc's contents may be shaped and re-shaped is assisted by the identification of its "building block" elements. In the organization of the Sagrada Familia Videodisc, these fundumental elements may consist of anything that is

visible or tangible in form, and is stable enough in location to be retrieved. These fundumental elements are called "objects", as accounted for in the terminology of object oriented programming. According to this conceptual model, a grouping of objects can form a greater object (a sound, an image, a sequence, a story). The accural of all the objects on a videodisc can also be thought of as an object.

To assist random interaction with the Sagrada Familia Videodisc, it is convenient to relate objects (1) hierarchially and to establish (2) varying contextural environments for objects. For example, each object within a hierarchial schema may constitute an event that is one in a series of chronologically ordered events. In this case, the first event may exist at the top of the hierarchy. Alternatively, an object within a hierarchial schema can represent one of several subtopics organized within a broader topic. Here, the broader topic sits at the apex of this hierarchial ordering, and the subtopic is grouped within set a thematically similar subtopics. As an example of varying contextural environments, an object that is grouped within a set a thematically similar subtopics may also be associated within other sets of thematically similar subtopics. In particular, a poem may contexturally be related to literature, the biography of the poet, the study of a language, or some other grouping.

The Database of the Sagrada Familia Videodisc:

In order to keep track of the hierarchial and contextural relationships of objects within the Sagrada Familia Videodisc, they are stored within a hierarchial and a relational database. Each object may sit within the tree of one or several hierarchies, and at more than one level of a given hierarchy. The same object can exist at other positions within different hierarchies. In order for an object to retain a unique address at each place where it may exist within the database, it is assigned an "alias" for each distinct location.

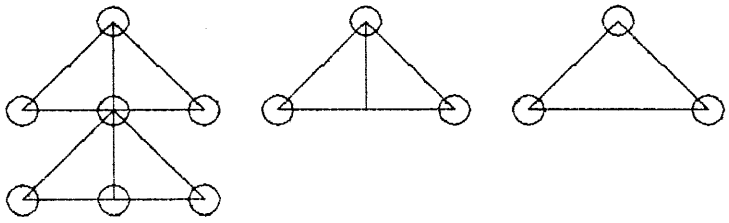


SCHEMATIC DIAGRAM
DATABASE CAN NOT REALLY BE REPRESENTED IN 2-D

An object contains information about who its neighbors are at any given location within a hierarchial tree. The composition of a tree can be determined by traversing and interrogating each object. Due to this feature, the composition of a tree does not need to be stored as a monolithic record in the database. Avoidence of a monolithic database record for a tree gives this database schema its modularity. It also minimizes the need to store large arrays of data that can slow down the videodisc system.

The modularity of the database makes it possible to easily add, remove or relocate objects. If an object is removed or added to a tree, then it will correspondingly acquire or loose an alias identification. When an object is removed from a tree, the pointers within the object's neighbors are reset so as to bridge the hole left behind. When an object is added to the tree, then the pointers of the objects new neighbors are reset so as to include the object.

<- - - - - OBJECT ADDED



OBJECT DELETED - - - - - >

SCHEMATIC DIAGRAM
DATABASE CAN NOT REALLY BE REPRESENTED IN 2-D

A small modification of the existing software for the Sagrada Familia Videodisc would permit the placement and removal of objects to be performed by the system user. The ongoing process of revising the database would be completely transparent to the user. Thus, a user can associate an object with other objects within a hierarchial tree or set an object within different context of objects. While the user is engaged in reconstucting events, images, sequences, and other such objects, the software "worries" about maintaining relational and alias subrecords within the database.

It is possible to associate and re-structure objects within a read only videodisc. However, the original layout of the disk determines how quickly a given sequence of objects can be played. Two objects may be physically located too far apart on the videodisc to be viewed sequentially without some pause or interruption. However, as the technology advances, the advent of read-write discs would permit the user (though some software interface) to relocate objects both physically on the disc and within the database. As the technology further advances, its seems desirable to merge the database records with the physical locations of objects on the disc so as to bring about a truly fast and efficiently designed system.

Abandoning a Linear Movie to Work Within the Aesthetics of a Videodisc Supported by a Database Management System (With My Apologies):*

The previous section defined objects in a database for structuring and relating the contents of the videodisc. An assessment of the merits of this database is based on how well it helps to integrate the contents of the randomly interactive movie. Specifically, does it provide meaningful "chunks" or building blocks of information that can be used to bridge over the differences between the constituent technologies? Does it further the fragmentation that might be expected of such a hybrid medium, detracting from the potential to create a coherent work? Or, is it of secondary importance to shaping the contents of a randomly interactive videodisc.

The database is designed to provide access to the different mediums on the videodisc within a single format or menu. Another important determinant of the database is that the options for viewing the videodisc and the relationships between its segments must be intelligable to the user. A look back on how the Sagrada Familia project evolved from a linear to a randomly interactive movie may help to account for the development of its underlying database.

* for this long, ungainly title

The project began with the premise that a linear movie could be used to describe a building. A movie may involve a progression of images, periodically mixed with heightened drama, and ending for the viewer with a greater comprehension of the entire experience. In comparison, walking through a building accesses a progression of images. There are thresholds along the way that heighten the experience, and that provide a basis for understanding its logic. Making a tour of the building discloses its organizational hierarchy and aesthetic unity. The climax of touring a building may result in obtaining a complete view, its rhythms and plan at last fully revealed.

It is difficult to identify the characteristics of a good movie since it is highly varied form of creative expression. The successful components of one movie may not be appropriate to the theme of another movie. For the convenience of this thesis, it is assumed that each movie is a unique and appropriate solution for communicating a message. It is also assumed that a movie typically consists of a story with motion picture images and sound.

In the case of the Sagrada Familia project, it was found difficult to develop a movie where the principle "actor" is a building. The progression of viewing experiences may ascend towards a climax, but the building does not react in the introspective manner of

a person. It is difficult to associate "thoughts" with an inanimate object. Although some of a building's values and religious affiliations may be evident from its symbolic imagery, they are silently articulated.

A captivating movie that concerned an object in the built environment, "Valley Curtain", may have been successful because it provided an intimate view of people responsible for its construction. The main subject was not the constructed object. The main story was about the design process and the roles of its participants. The design of the "Valley Curtain" was made meaningful because of the opportunity to learn about the environmental artist Christo, his cohorts and his antagonists.

Gaudi, the most important individual to the design of the Sagrada Familia, is long dead and buried, after falling under the wheels of a street car on June 7, 1926.[25] Today, the construction of the Temple is carried on in the spirit of his design process, but the Vision of the Sagrada Familia is best understood in his drawings, activities, models of his abstract geometry, and in the literature of the Catalan Renaixensa. The people currently working on the temple are interesting, but the main story of this movie is buried in books and other historical records of the Sagrada Familia, and with Gaudi.

It was suggested during a review of the Sagrada Familia project that a narration was probably necessary. The narration would relate the modelmaking activities to their underlying design principles. It would establish the historical context. It would describe the important phases of the design process for which there is no documentary footage. At the time, however, this moviemaker was fixed on making a non-narrative linear movie. It was feared that a narration would disrupt the movie's lyrical quality. Later, after many unsatisfying attemps at editing a linear movie, it was conceded that some other format was needed to supply the missing information.

The videodisc provided an opportunity to cross reference the missing facts, computer graphics, and historical context without their direct interposition into the documentary footage. With the aid of a relational database, the pertinant text and illustrative drawings can be retrieved at the discretion of the viewer. By grouping specific videodisc segments together in the database rather than intermixing them contiguously on the videodisc, it was not necessary to pack information into any particular sequence.

However, the ability to build tension and climax within the videodisc is limited. The user determines the pacing and the order of viewing the videodisc. The viewer compares alternative segments on a particular topic and finds the parallels that contribute to a greater

comprehension of their significance. The videodisc maker puts enough information on the videodisc to make it complete and comprehensible, but has limited control over its pacing.

It is also difficult to build the tension of a movie when the rhythms of the documentary footage, computer graphics, and still images are not similar. The documentary footage invites the viewer to sit back and watch. The computer graphics are best viewed by manipulating the image. The still images are best viewed at a much slower rate than the documentary footage and computer graphics. The videodisc was planned so that it could be viewed linearly, but this mode may be ineffective due to the different rhythms of static and motion picture images.

The difficulty of integrating the constituent mediums into a aesthetically consistent whole appears to be restricted only by our perceptions on how to use them and is not necessarily the result of any database limitations. The hierarchial and relational database was unrestrictive in terms of how the videodisc could be organized. Any number of associations are possible for a segment on the videodisc. The rate at which a segment is played can be varied within a wide range of speeds. Any ordering of segments is possible, including the multiple use of one segment.

Sharing control of the pacing and order of segments with the videodisc user poses the most difficult challange to planning a videodisc. Delivering a message through the videodisc is closely related to the amount of control that the videodisc user is willing to give up. In the Sagrada Familia Movie, the randomly interactive videodisc lessens the distinction between videodisc maker and videodisc viewer to the point that structuring a statement and reaching a climatic viewing experience is equally in the hands of both.

TRINITY CHURCH

Description:

A drawing on a two-dimensional static medium may not be able to show the way in which a building can accommodate a range of human activity and changing environmental conditions. If these characteristics are legitimate determinants for design, then the new media tools should be tested for their capacity to communicate them. The videotaping and sound recording of Trinity Church at Copley Square in Boston was intended to capture the dynamic events that convey the theatre of architecture, and to record the symbols and images which signify a buildings philosophical and cultural attributes.

Trinity Church stands on a site that changes character cycically over time. The features that change include light, shadows, sound, colors, wind, and pedestrian activity. The Trinity Church Videotape is a "thumb nail sketch" exercise which records the interplay and transitory nature of these elements. The exercise is specifically oriented to the sketching possibilties available through motion picture and sound. The videotape was produced through repeated recordings at Trinity Church on ten Sundays over the course of approximately three months. The recording techniques used include time-lapse photography, sync-sound motion picture production, and "wild" (as opposed to sync) sound recordings.

Experiencing Architecture by Observing Changes Over Time:

A time dependent observation about architectural space is given by Steen Eiler Rasmussem who describes ball playing at the top of a stairway behind the church of S. Maria Maggiore that sits on one of Rome's seven hills:

> "The many tourists who are brought to the church on sight-seeing tours hardly notice the unique character of the surroundings. They simply check off one of the starred numbers in their guide-books and hasten on to the next one. But they did not experience the place in the way some boys I saw there a few years ago did. ... As I sat in the shade watching them, I sensed the whole three dimensional composition as never before. At a quarter past eleven the boys dashed off, shouting and laughing. The great basilica stood once more in silent grandeur."[26]

The activities occuring on a typical Sunday at the site of Trinity Church have an impact on the character of their surroundings and can be classifed according to the time of day. The morning is dominated by a few habitual dwellers seeking the warmth of the sun. Late morning is marked by parishioners attending and leaving

services. During the early afternoon, children and young teens roller skate and play frisbee, scores of photographers move around and stop at the most fruitful vantage points for taking pictures, and lesiurely strollers walk without an apparent destination. At the same time, pedestrians make short-cuts diagonally accross Copley Square, and flocks of pigeons temporarily occupy patches of ground until chased off for the entertainment of some person or group. In the late afternoon and evening, the site is slowly relinquished to fewer pedestrians and to the more visible presence of its homeless inhabitants.

Time lapse film documentation compresses a full day of concurrent pedestrian activities into identifiable patterns that may not be completely evident to the naked eye This method has been used to study traffic flow behaviors, peer-to-peer and peer-to-adult interaction as a way of collecting information about the design of a school environment.[27] The design of an urban setting is informed by a direct visualization of how the activities it supports will be proportionally accounted for in the layout of pedestrian amenities and spatial relationships. The documentation of these activities and their comparison with a proposed design provides a module for measuring the appropriateness of scale and functionality.

The Modulor was a system of proportioning developed by Le Corbusier and based on measurements of a six foot man in various positions, standing, sitting, reaching, lying down, etc..[28] Le Corbusier's goal was to establish the Modular as a univerisal standard for proportioning building components and industrial products. The juxtaposition of documentary footage with a design borrows the concept of module from Corbusier, but the usefulness of direct cinema is in establishing the unique parameters of a particular site location and not a generally applicable set of parameters. Corbusier directly translated the Modular into a grid for establishing the heights and widths of industrial products. Analagously, the patterns of activity at a given site location can be superimposed directly over the in progress drawing of a design proposal (see also Remote Transmission From Copley Square).

The interdependent and changing mixture of light, shadow and color derive from many sources within a building site location, including the movement of the sun, cars, people, plants and animals. Bacause these sources of light are constantly in transition, often unpredictably, they have the effect of continually changing the appearance of the built environment. Those transitions that are predictable may be accomodated in architectural design, and like patterns of pedestrian activity, may be used to establish design determinants. For example, it has been suggested that the form of

Gothic Cathedrals is entirely subservient to the movement of natural sunlight. The portions of a Gothic Cathedral that did not fall within direct sunlight, such as the aisles, ambulatory, galleries, and side chappels became narrower.[29]

The architect Gaudi experimented with still photography extensively in the study of movement and light. The still camera presented an opportunity to freeze motion and capture it without distortion. A photograph of children was used to prepare a stained glass window in the crypt of the Sagrada Familia. His method for studying sculptural models has been compared with the more scientific procedure of the French doctor Etienne Mary, who invented the phonophotograhic machine in 1882 in order to study the physiology of movement.[30] Two mirrors were placed vertically and a third was suspended above a them horizontally, similar to the way in which mirrors are positioned within dressing rooms. A subject at the center of these mirrors was reflected in five perspective images. The photographs obtained through this arrangement were used to study the impact of body movement on the play of light and shadow. These studies were used to predict the lighting effect that would be produced by a particular sculpture.

The shadows that fall on the exterior sculpture of Trinity Church

vary according to the angle of the sun, the condition of the sky, and the relative position of nearby trees and other buildings. Within the span of fifteen minutes, a piece of scupture may be darkened, softly lit, highlighted and then washed out in full exposure to direct sunlight. Unlike surrounding buildings, the depth and intensity of the shadows impose expressive qualities onto the sculpture of Trinity Church and affect a wide range of moods. Time lapse photography was used to record the sculpture under the changing light conditions. It was anticipated that the compression of time through time-lapse photography would make evident the changing nature of lighting conditions at a rate that was perceptible to a human observer.

As the sun set, the rate of photographic frames exposed per second was increased in order keep pace with increased movement in the play of shadows. The rate of time lapse photography was varied within a range of 1 frame per second to 1 frame per minute. Repeated experience at the site coupled with viewing the processed film was used to determine the rate of time lapse photography that would be appropriate within a particular situation.

Lighting conditions changed at varying rates and according to a number of environmental influences that were difficult to predict. For example, a building stood for ten minutes between the sun and

Trinity Church and produced shadows that moved very quickly accross the western elevation of the church. Sunlight bounced off of nearby Hancock Tower for about five minutes and produced a diffuse light that lessened the contrasts provided by direct sunlight on Trinity Church. Using imagination, it is instructive to trace a particle of light that (a) is reflected off of Hancock tower, (b) bounces off of Trinity church, (c) is deflected from a passing ambulance, (d) has a randezvous with a dust particle on the forehead of a passing pedestrian, (e) which is sent aloft to join up with other dust particles to form a cloud, (f) and which in turn is responsible for casting a shadow (computer graphic ray tracing techniques are similar to such imaginative scenerios).

The difficuly of anticipating the sources of light in architectural design are underscored by this exercise. The value of film/video as a medium for sketching is that it can record dynamic lighting information useful to an architect who for lack of omniscience must work within a framework of predictable and unpredictable conditions. Pioneer efforts at mixing light from still photographs with that produced by computer graphics, as at Cornell University, are today too computationally expensive to be of practical value in assisting architects. Still, the long term potential success of this tool, assuming the anticipated increase in computer power and memory, might depend on the integration of motion pictures with real

time computer graphics in the depiction of lighting for a proposed building.

The nature of how sound is carried within a building can be diagrammed, measured, modeled, and constitutes a science and specialized discipline within architecture that is beyond the scope of this thesis. The accoustical architect or engineer has no doubt developed a finely tuned ear to the capacity of an enclosure to produce sounds. Of immediate interest are ways in which to provide sound in a direct sensory modeling medium, as clay is to the study of massing, that can provide a subjective experience for the listener in the context of "sketching" architecture.

The subjective evaluation and recording of sound can put us in the instructive mode of what Steen Eiler Rasmussen calls "hearing architecture." The building of the great cathedrals within Europe was interdependent with a co-evolution in accoustics, recitals, and music. Polyphonal music in Westminister Abbey can be attributed to the long term mutual adjustment of Latin vowel sounds and bulding form.[31] In designing bell towers for the Sagrada Familia, the architect Gaudi made careful studies of openings so as to take advantage of the sound effects caused by wind.[32]

In the presentation of the design for a Kuwaiti News Agency, the videotape used by TAC simulated a tracking shot into what appeared to be the main news room.[33] The moving vantage point was accompanied by the clicking noises of typewriters and teletape machines. The added sound was a clever vehicle that brought the graphic presentation to life, but it did not seem to have any importance to the design process for the building. The effort at recording sound on site such as Trinity Church could have instructive value at the schematic design stage when the protection and reduction of sounds is considered. The image of a site that evolves over the design process can include a projection of the associated sound environment, relying upon recorded sounds, special effects and the predictive capabilities of accoustical science.

The use of motion picture and sound media may enhance the description of a proposed design if carefully entered into the design model. The medium that can most fully expresses those environmental qualities that an architect modifies is best at providing a simulation model on which to visualize and clarify emerging design strategies. The videotape "sketch" of Trinity Church attempts to build an integrated model of the envionment to be used as a point of departure for design and to identify the domain for which an architect is professionally responsible.

REMOTE TRANSMISSION FROM COPLEY SQUARE

Description:

The Trinity Church sketching exercise, also based on this urban location, indicated the potential of including moving images and sound in formulating a model of the built environment. In the mid seventies, videotape was used in the process of developing a waterfront plan for the City of Berkeley, California.[34] Community residents were shown a model of the proposed development at a series of public meetings and invited to offer criticisms and design suggestions. These ideas were translated onto a videotape analog that used sound and motion picture. The videotape was updated and served as a basis for discussion at each subsequent session. It was later used in developing the final master plan for the waterfront.

Recent advances in interactive telecommunications media provide a more direct means of using video and sound in the design process. Two way telecommunications networks permit the immediate transmission of live images and sound between the public meeting hall, the design studio, and the remote site location. In this project, a "slow scan" telephone device was used to send images between Copley Square and the Visible Language Workshop Computer Graphics Lab at M.I.T..[35] This

prompted an ad-hoc design session where students at the lab could request live images of the landscape that were of immediate interest within a given progression of rapid sketches, and process those images on a powerful computer system.

Using the graphics and frame buffering capabilities of the computer system at the lab, each video image of Copley Square can be subdivided into grabable components, and each component can be used as a painting element. In this manner the windows of a existing building can be grabbed and painted over a portion of the original video image. Vegetation, cars, lighting fixtures and other architectural elements in the landscape can be modified, grabbed and used as "paint" media.

Architecure and the Use of Cable Television:

It became clear in the course of performing this exercise that sketching a site by remote transmission does not substitute for the experience of sketching it on location. The opportunity to walk around the site, to discover what may be hidden around the corner, to feel its textures, feel the wind and temperature, and "hear" its architecture, are still outside the reach of telecommunications. Unencumbered by television equipment and in the possession of a light and portable sketchpad, there is a great freedom of movement and fewer intermediaries between the eye, the subject and the rendering medium.

The guidelines for spontaneous shooting in direct cinema may apply to the use of video equipment in those circumstances where it is useful as an environmental modeling tool, and bring it closer to the economy of use of a sketchpad. A tripod restricts the freedom of camera movement and the ability to capture the short-lived events that may be important to the description of a given site. Similarly, the use of bulky sound equipment, teams of support specialists, provide even greater restrictions on the ability to respond to sudden and unanticipated events, and to observe them unobtrusively. Separation of camera and sound equipment allow for the placement of each tool at its most profitable vantage point.

Proceeding on the basis of patient observation rather than working from a predefined concept helps to ensure that each "sketching" opportunity will result in a fresh set of observations. Shooting activity can be guided by the objective of looking for a story, as in the case of the Sagrada Familia, whose portal was to contain the evolutionary history of man.[36] In relationship to architecture, a story might also involve the cycles of activity with a space, the performers and their objectives, habits, and spatial needs. If it is true that architecture is in the externalist view a "translator of the ethos, zeitgeist, material or technical needs of society", then in the shaping of its criteria, there appears to be some role for a story telling medium that can articulate these needs in the form of visual images.[37]

Transmitting these images over a large telecommunications network can be used to put critical design issues before a large community audience, but does not ensure equal participation or the development of a common perspective. In the experience of some practioners, such participatory events may leave the architect in the position of shouting to be heard".[38] Access to and coordination of the public debate takes on as much importance as having the power of persuasion.

The HI-OVIS (Highly Interactive Optical Visual Information System) project in Japan demonstrated the potential for a modest sized community to be linked within a two way telecommunications system. The system offered 250 subscriber households 1) two-way interactive television broadcasting, 2) a video request service, and 3) a character and still picture information service. Each household was equipped with a terminal controller, keyboard, camera, microphone and a color television.[39] There was a reserved participation in the use of the two way visual communications as individuals were embarrassed to observe their own faces on television. Greater success was experienced in the conducting of "tele-votes", where participation was more than 50% in all programs because viewers did not have to see their own faces. It might be inferred from this experience that a wider range of public reaction can be measured from such a system, but it may not provide a greater opportunity for the input of specific suggestions. The public seems to prefer anonymity.

The use of telecommunications networks has been characterized by conflicts over invasion of privacy, administrative control, censorship, public and private access rights, and the location and decibal level of public monitors.[40] The use of a telecommunications system is perhaps more contentious in the context of architectural design where there are organizational ambiguities and varying approaches to the design process. If the design process is in the public domain, then the modification of the design model may need to be coordinated and overseen by a central authority responsible for maintaining coherency and resolving conflicts. If design is an autonomous act, then the use of a telecommunications network must work in such a way that provides input into but does not interfere with an intimate creative process.

The "town media parlour"[41] model advocated by David Lee subjects a design proposal to a wide public debate with the apparant objective of bringing into focus as many critical issues as possible. Also, public acceptance of the proposal may depend upon their sense of input into the design process, and collaboration on building a set of positive images. At the same time, it is often said by architects, who do not like to have their aesthetics interfered with, that the best client is one who leaves a big check, goes away on vacation, and doesn't return until the project is done.

The process of shaping and responding to public taste before a large telecommunications audience may put the architect more in the position of "addman" than designer. This raises the question of whether architecture is a transformation of the built environment that reflects a highly individualistic step foward in the realization of new living patterns, or if architecture is the reflection of popular likes and dislikes, and must satisfy the varying requirements of the highbrows, the middlebrows and the lowbrows.

The application of telecommunications to architecture supplements the highly personalized drawing board with a medium that provides an opportunity for the public dissemination of information at an unprecendented scale. The personalized and private use of the medium can take advantage of the ability to collect and juxtapose information from a wide variety of sources. The opportunity to draw images on a powerful computer that are transmitted from a remote location provides a convenient means for building a studio model that has continual access to the transitory conditions at the building site and can borrow directly its observable symbols and images. Communicated to the public, this model is conveyed on a medium that the public is familiar with and likely to respond to, even if the majority of public reaction is made by ballot. Although the medium can be used to open up the design process to greater number of participants, its private use appears to be more likely to contribute to the creative process of the individual designer.

CONCLUSION

Simulating a new computer graphics product has been found to be a successful stratagem for measuring potential market interest and raising capital before research and development funds for it have been expended. The operating principle for this practice may be that the perception of reality is more important than reality itself. That concept may also apply to the role of media in an architect's design process. The perception of a building that is transmitted through a communications medium is the substance that an architect works with. It is the reality that will become transformed into the built environment.

A metaphor or an unfamiliar description of architecture may be expressed to intiate a new perception:

- "The whole life of the average house, it seems, is a sort of indigestion." (Frank Lloyd Wright) [42]
- "True architecture ... is the expression of the inner structure of our time, from which it stems." (Mies van der Rohe) [43]
- "Architecture is light." (often quoted statement of Louis Kahn's)

These statements may lossen our conceptions of architecture. They disengage an architect from the accustimed framework for designing. Le Corbusier's Modular measuring system was in part a reaction to the limited framework provided by the metric scale: "I am seriously angry with the meter (forty millionth part of the meridan of the earth) for having desubstantialized itself as it has done, and for having placed itself so perfectly, so dangerously, so unhappily outside the human scale."[44] The tool that Le Corbusier brought into the world may have anticipated the introduction of ergonomics in 1949.

The iconoclastic architect is unsettled by the established form of architecture, sets forth new assumptions, and, pending acceptance, may set up a new school of thought. After the turn of the century, Classical Revivalism yielded to Modernism and to Bauhaus. In more recent times, Post-Modernism succeeded Modernism, and so on. That these swings of the pedulum or evolutions of style may have resulted from shifting modes of perception is implicated, although not proved, by this thesis.

It is not the arguement of this thesis that the new film/video and computer graphic tools will necessarily lead to better architecture. For example, CAD/CAM tools may be displacing the role of the draftsman in the architectural office. If that would occur, it could dismantle

the slow and unhasty process by which apprenticed architects become familiar with the design process of professional offices.

A greater danger is that the design process may also be interfered with. An essay printed in 1975 noted the arrival of a new generation of CAD systems, but cited "an imbalance between research efforts in design science (the design process) and the (much greater) development effort in computer aided design systems."[45] Within the last decade, the design process has become a significant field of enquiry, but the successful application of this field to CAD systems has yet to be realized.[46]

In the closing defense of his treatise on the Modular, Le Corbusier places it on the draftsmans table side-by-side with the T-square, the set square and the pencil.[47] The purpose of this, if interpreted a little freely, may be to portray a designer being offered a new tool with "no strings attached". The tool may be used for an indeterminate amount of time. The danger is that the tool may do a disservice to the design process. But the design process, described a bit idealically, is the cause and essence of architecture. In the long run, it will modify the tool or abandon it.

FOOTNOTES

1. The Chicago Manual of Style, Thirteenth Edition. Chicago: University of Chicago Press, 1982, p. 25

2. A presentation by Gregory Downs of the TAC videotape was made to a Telecommunications and Architecture Seminar held at the Harvard Graduate School of Design, March 1982.

3. David Lee presented his concept for a "Town Media Parlour" at the Telecommunications and Architecture Seminar held at the Harvard Graduate School of Design, March 1982.

4. Eyes Which See. Washington D.C.: Pamphlet printed by The Association of Collegiate Schools of Architecture, 1979, p. 4

5. Blowen, Michael. "Education in Independent Filmmaking" The Boston Globe, 2 July 1981.

6. Catalano, Frank J. "CAD Vendors Persue Architectural Market" High Technology (January 1985): 60.

7. Schuster, Carolyn. "Computers: What Some of the Small Firms are Doing" Architecture Record (October 1984): 31

8. Ibid., p. 31-38

9. Tountas, Christos. "CAD: The Wows & The Wherefores" Progressive Architecture (May 1984): 135-160

10. Negroponte, Nicholas. The Architecture Machine. Cambridge, Mass.: M.I.T. Press, 1972, p. 19

11. Ibid., p. 17

12. Ibid., p. 19

13. Grossier, L. and Nicholas Negroponte, "Machine Vision Models of the Physical Environment". Funding Proposal, M.I.T., p. 2, 1970.

14. Tountas, Op. Cit., p. 154

15. Greenberg, Donald. "The Coming Breakthrough of Computers as a True Design Tool" Architecture Record (September 1984): 150-159

16. Pane, Roberto. Antoni Gaudi. Milano: Edizioni di Communita, 1964, p. 248

17. National Academy of Sciences, Report from the 1984 Workshop on Advanced Technology for Building Design and Engineering. Washington D.C., August 1983, p. 21

18. Descharnes, R. and C. Prevost. Gaudi The Visionary. New York: The Viking Press, 1982, p. 124

19. This discussion was the central theme of the seminar "What the Architect Gaudi Would Do With A Computer" held in Barcelona Spain, May 28 - June 8, 1985.

20. Descharnes, Op. Cit., p. 223

21. Backer, David S. and Andrew Lippman, "Future Interactive Graphics: Personal Video", Architecture Machine Group, M.I.T., research report to the Office of Naval Research, Undated.

22. The Barcelona Seminar on Gaudi provided the opportunity for many informal discussions. Herbert Lundqvist, Sculptor and Lecturer at the National Academy of Arts and Design, Sweden, suggested that playing with the computer would "burn holes" within the user, and that is how its potential as an art tool would be discovered.

23. Meyer, Martin. About Television. New York: Harpur & Row, p. 261

24. Negroponte, Nicholas, "Books Without Pages", Architecture Machine Group, M.I.T., p. 56-1.1

25. Descharnes, Op. Cit., p. 17

26. Rasmussen, Steen Eiler. Experiencing Architecture. Cambridge, Ma: M.I.T. Press, 1962, p. 16-19

27. Taylor, Anne P. and George Vlastos. School Zone: Learning Environments for Children. New York: Van Nostrand Reinhold, 1975, p. 138

28. Boesinger, Wily. Le Corbusier. New York: Praeger Publishers, 1972, p. 84-85

29. Von Simson, Otto. The Gothic Cathedral. Princeton University Press, 1962, p. 4-6

30. Descharnes, Op. Cit., p. 118-192

31. Rasmussen, Op. Cit., p. 214 - 237

32. Descharnes, Op. Cit., p. 60

33. Downs, Op. Cit.

34. Gerdes, Harmut and Peter Basselman,"Making the Most of Film and Video" Journal of the American Planning Association (November 1980)

35. This project occured at M.I.T. in April, 1981.

36. Descharnes, Op. Cit., p. 65

37. Robbins, Edward, "Architecture and Culture: A Research Strategy" Design Studies. Surrey, England: Butterwork & Co. Publishers Ltd., Vol. 5 No. 3, July 1984, p. 176

38. Hack, Gary and Mitsy Canto, "Collaboration and Context in Urban Design" Design Studies. Surrey, England: Butterwork & Co. Publishers Ltd., Vol. 5 No. 3, July 1984, p. 176

39. Mukato, Toshiko, "Development of Communications Technology in Japan, The HI-OVIS Project" Videodisc/Videotext (Summer 1981) Vol. 1 No. 3: 149-153

40. Salloway, Niti S., "Conflict in Systems Interface, M.I.T. Cable Television, A Case Study", paper presented to Conference at Catholic University at Louvain, July 10-14, 1979

41. Lee, Op. Cit.

42. Wright, Frank Lloyd, The Future of Architecture. New York: Times Mirror, 1953, p. 144

43. Blasser, Werner, "A Personal Statement by the Architect, 1964" in Mies van der Rohe. New York: Praeger Publishers, 1972, p. 10

44. Jeanneret, Charles Edoward, The Modular, Cambridge, Mass.: M.I.T. Press, 1977, p. 115

45. Purcell, Patrick, "Great Britain" essay in Computer Aids to Design and Architecture. Edited by Nicholas Negroponte. New York: Petrocelli/Charter, 1975, Chapter 21, p. 221. Parenthesis in quote were added.

46. From my notes on the Design Process Seminar held at M.I.T. on May 6, 1985.

47. Jeanneret, Op. Cit., p. 220

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