VIRTUAL EXPLORATION OF TEATRO OLIMPICO

Daniela Sirbu

University of Lethbridge, Lethbridge, Alberta, Canada

http://www.uleth.ca/ffa

Abstract (EN)

The experimentation platform for this research is based on the digital reconstruction of Andrea Palladio's Teatro Olimpico. The project aims to go beyond a simple description of architecture and allow investigating the Teatro Olimpico as a social and cultural habitat at various moments in its history. The project is funded through the WestGrid – Collaboration and Visualization Program promoted by the Canadian Foundation for Innovation and through a ULRF grant provided by the University of Lethbridge.

Keywords: Andrea Palladio, Teatro Olimpico, architecture, digital reconstruction, cinematic space

Zusammenfassung (DE)

Die Experimentierenplattform für diese Forschung ist basiert auf dem digitalen Wiederaufbau der Teatro Olimpico von Andrea Palladio. Das Projekt geht über hinaus eine einfache Beschreibung von Architektur und Genehmigung untersuchend das Teatro Olimpico als ein sozialer und kultureller Lebensraum an verschiedenen Momenten in seiner Geschichte. Das Projekt wird von WestGrid (Kanadische Grundlage für Neuerung - Zusammenarbeit und Vorstellungsprogramm) und ULRF (Universität von Lethbrigdge Forschungsfonds) fundiert.

Schlüsselwörter: Andrea Palladio, Teatro Olimpico, Architektur, Digitaler Wiederaufbau, filmischer Platz

Résumé (FR)

La plate-forme d'expérimentation pour cette recherche est basée sur la reconstruction numérique de le Teatro Olimpico par Andrea Palladio. Le projet vise à aller au-delà d'une description simple d'architecture et permet d'examiner le Teatro Olimpico comme un habitat social et culturel aux divers moments dans son histoire. Le projet est subventionné par le Programme de Collaboration et Visualisation promu par la Fondation Canadienne pour l'Innovation et par une ULRF allocation accorder par l'Université de Lethbridge.

Mots clés: Andrea Palladio, Teatro Olimpico, l'architecture, reconstruction numérique, l'espace cinématographique

I. Introduction

There is an established grammar of the film language with a solid foundation in both theory and practice. The richness of the visual material made available to the architectural historian through the use of computer technology raises the question whether the traditional scientific discourse in architectural history, which is mostly text based, can be supplemented in a viable way by a scientific discourse expressed visually, based on the language of the film grammar. Can this type of discourse respond to the rigors of the scientific inquiry?

Architecture, like any form of art, must be experienced to be understood. Digital reconstructions of buildings, unlike other types of visualization before, allow experiencing dynamically architecture translated into another medium. The present paper is concerned with issues raised by digital explorations of architecture for research and design purposes. From the perspective of architectural research, the main focus is placed on understanding how a visually based discourse can complement the traditional forms of text-based critical analyses. We also question whether it is possible that such type of visually based discourse

may acquire the status of an independent form of communication acquiring the accuracy and clarity of the traditional scientific forms of communication.

From the architectural design perspective, the main focus is on understanding if experiencing architecture in the digital realm is relevant for specific design purposes. These revolve around issues of space perception and, going a step further, may lead to the question if a concept of digital place is compatible with the concept of place in the real world. These cannot be separated from interests of the architectural history and may provide some answers to the intriguing question if digital reconstructions of buildings can go beyond a simple descriptive function allowing us to have a glimpse at how they have been perceived as places at different moments in time.

The computer reconstruction of Andrea Palladio's Teatro Olimpico of Vicenza, Italy, is developed as a case study for this investigation (Fig. 1). Aspects that are specific to perception of architecture in the digital realm are analyzed in relation to Teatro Olimpico with its cultural and historical characteristics. The research questions outlined above regarding the development of a sense of digital place, communication of clear ideas and finding relevant answers through cinematic and real-time explorations will be re-stated in relation to the particular case of Teatro Olimpico.

Further questions posed by the project analyze whether digital simulations provide a valid platform for investigating symbolic meaning in architectural projects of the past. Such a question would be whether we can go beyond the descriptive function of computer architectural reconstructions and rediscover the poetics of architecture that can only be revealed while experiencing architectural spaces. For this purpose, the value of real-time interactive exploration is analyzed is relation to cinematic exploration of digital architecture.

Fig. 1: Computer reconstruction of Teatro Olimpico -View of the proscenium. Architect: Andrea Palladio. Computer reconstruction by Daniela Sirbu

II. Basic Concepts

The problem of experiencing architecture in the digital realm is approached from the perspective of the place concept as defined in architectural theory.

Place in architecture, according to Norberg-Schulz (1980a, 1980b), has two main components: space and character. Space incorporates all concrete elements that participate in creating the physical environment. Character is filtered both by the individual and group experiences related to that environment and is thus a result of our memories of that space. The notion of place works simultaneously through our perception and projection - perception resulting from direct contact with the physical surroundings and projection resulting from the meaning we ascribe to space due to our previous experiences with it.

Character relates to both individual and group levels. This is because any personal experience is mediated by the society, culture, and epoch to which we belong shaping the meaning we assign to it. Thus, the group is reflected in the notion of place developed through experiences with a certain environment.

The current research analyzes how exploration of space in the digital world is relevant to understanding architecture. We investigate whether space and character can be defined as components of an emerging concept of digital place in relation to computer reconstructions of buildings.

III. Research Methodology and Project Phases

The physical environment of the theatre is simulated through a 3D digital space. Different digital reconstruction approaches permit different forms of exploration in the digital realm generating qualitatively different experiences. Each approach leads to possible different perceptions of the space character for the same architectural reconstruction. Using the digital spaces created, we intend to analyze to what degree and in what ways the concept of digital space is analogous to the concept of place as defined in relation to the natural environment and real buildings.

Three types of explorations, using different approaches, were considered for the present research:

- Cinematic exploration using traditional 3D visualization programs like 3DS Max, Maya, or Softimage XSI;
- Real-time interactive exploration using the Virtools game-engine which permits a user to choose the navigation path in the simulated environment of the Teatro Olimpico;

- Virtual Reality exploration of the simulated space of the Teatro Olimpico which permits the user to actively determine the navigation path and immerse in the simulated environment of the Teatro Olimpico.

The virtual explorations are meant to permit experiencing rather than involving pure critical thinking of aesthetic, cultural, and historic aspects of Teatro Olimpico. The current paper discusses the cinematic and real-time interactive forms of navigation and the concept of place is developed and analyzed in relation to these types of environments. A short cinematic exploration of the reconstructed digital space is presented.

IV. Background

The theoretical and practical considerations at the basis of the present project stem from the previous work in computer reconstructions of architecture and from the general aesthetical and historical research on Teatro Olimpico as a Palladian building.

1. Background in Computer Reconstruction of Architecture

The technological development during the last two decades has generated a diversification of approaches to digital visualization in architecture. The published research in this area, up to the end of 1990s (Larson, 2000; Novitski, 1998; Riera Ojeda, 1996), shows a trend towards hyper-realistic representation. Some of the best works illustrating this trend include digital reconstructions of unbuilt projects that have reached such a level of photographic realism as to consistently integrate with photographic references from the built work of the architect (Larson, 2000). Other research, mainly projects and exhibitions during the last five years (Larson & Nagakura, 2001; Nagakura, 2005), shows an interest in using the language of the film grammar to formulate coherent ideas about architecture.

The present project is related to previous research developed by the author (Sirbu, 2003a) in the area of digital exploration of unbuilt architecture. Most of the work is concerned with the translation of architectural drawings into 3D navigable architecture maintaining in the digital reconstruction the pictorial style of the original drawing. As the drawing is the most direct expression of the reasoning and creative process of the architect during design stages, its translation into digital navigable spaces may envision possible design alternatives and provide unexpected insights into the architectural creative process. Another direction of this research is concerned with exploring symbolic meaning through cinematic investigation of digital architecture (Sirbu, 2003b). The current research builds on concepts advanced in author's previous work and goes further to investigate the concept of digital place. The computer reconstruction of Teatro Olimpico is analyzed as a realistic representation, as a representation of the original drawings in a 3D navigable version, and as symbolic space.

2. Teatro Olimpico: Brief Overview

The interpretation of the Teatro Olimpico is based on the existing body of scholarly research on this subject. Our focus is on understanding how the computer reconstruction of Teatro Olimpico allows experimenting with some of the ideas advanced by various researchers and by the author and how these relate to the existing textual analysis of these issues.

Two elements make Teatro Olimpico significant both in the history of theatre and in Palladio's work. Teatro Olimpico is the first permanent Renaissance theatre preserved to the present day (Tavernor, 1991; Oosting, 1981) and it is the last Palladian building. It has all the important characteristics of Palladio's mature architectural style, but some researchers (Puppi, 1986; Magagnato, 1992) consider that Palladio's original vision on theatre

architecture is not fully achieved in the building as it has been almost entirely constructed after his death.

From the viewpoint of theatre architectural and cultural history, we might expect Teatro Olimpico to mark a beginning as the first permanent structure of its kind. It is actually considered to mark an ending point based on the fact that Teatro Olimpico has been used very little after the opening production of March 3, 1584 and during the 17th century. According to some authors (Allen, 1983; Oosting, 1981; Tidworth, 1973) there is little or nothing to demonstrate that later theatrical architecture evolved from Teatro Olimpico.

From the perspective of Palladio's architectural work, Teatro Olimpico is seen more as a terminus point as well. Palladianism with its various forms of manifestation in England, France, Germany, and United States, and with repeated revivals throughout time, makes Palladio one of the most influential architects in the history of architectural styles (Tavernor, 1991; Wittkover, 1974; Guinness & Sadler, 1976). However, Palladio's last work, Teatro Olimpico, does not seem to have a marked effect on the immediate following development in theatre architecture and scholars find difficult to identify it as an important influence in any of the later Palladian revivals.

Looking at Teatro Olimpico not from the viewpoint of its possible consequences, but from the perspective of the cultural context and immediate preceding events, we see the appearance of Teatro Olimpico and the form it has taken as an almost organic result of historical development – opinion that comes in contradiction with Oosting who sees it as an accidental occurrence (Oosting, 1981). Preoccupations in Renaissance theatre at that time, both in terms of architecture and in terms of literary forms, have lead to the cultural need to experiment with such a structure as Teatro Olimpico and some authors see Teatro Olimpico

as a culminant point of Renaissance experiments with ancient Roman theatrical forms (Bieber, 1961).

In the particular case of Teatro Olimpico, in the context of Vicenza and Accademia Olimpica, the decision on August 10, 1579 to build a permanent theatre came as an attempt to reinforce an interest in theatre previously manifested through various temporary experiments - the most important of which was Giangiorgio Trissino's play Sophonisba, the first vernacular tragedy in Renaissance Italian literature created in the spirit of ancient Greek theatre (Brocket & Hildy, 2003; Tavernor, 1991; Puppi, 1986) . Existing sources (Zorzi, 1969) show that both Sophonisba and another preceding play, L'amore Constante, very successful in Vicenza at the time, had been staged in temporary wooden structures that resemble in many ways the Teatro Olimpico. These previous successes created the emulation toward theatre as a cultural form and lead to the decision to build a permanent theatre in Vicenza.

The construction started in January 1580. On August 19, 1580 Palladio died and the construction was continued by his son, Silla Palladio, and Palladio's pupil Vicenzo Scamozzi who is the designer of the illusionistic 3D scenery with the seven streets of Thebes. The theatre was finalized in 1584 and the opening production took place on March 3, 1585 (Puppi, 1986; Magagnato, 1992).

The on site research and the virtual exploration of Teatro Olimpico enabled by the present project lead to a point of view that, building from ideas advanced by Lionello Puppi (Puppi, 1986), connect Teatro Olimpico with contemporary forms of computer visualization to which Palladian vision of theatrical space might be a very early ancestor.

V. The Digital Reconstruction of Teatro Olimpico

The computer reconstruction of Teatro Olimpico uses on-site photographic documentation and the plan, section, and elevation drawings of the present Teatro Olimpico provided in the published research of the Centro Internazionale di Studi di Architettura "Andrea Palladio" (Magagnato, 1992) as well as other sources (Beltramini, 2001; Beyer, 1989).

At this stage, the reconstruction focuses on the interior of the theatre (Fig. 2, Fig. 3, Fig. 4) including the scaenae frons with the two lateral wings, the orchestra pit, the cavea, the loggia, the painted ceiling above the cavea, the coffered ceiling above scaenae frons, and the 3D perspective scenery representing the seven streets of Thebes. The bas-relief decoration, the statuary, the Composite order columns, the balustrades and mural paintings are included although not entirely finalized at the present time due to the large amount of details that must be dealt with. Within the limitations of the available data, an important emphasis was placed on preserving the scale and proportion of the relative components of the theatre.

The 3D computer reconstruction simulates the physical environment of the theatre for the cinematic, real-time, and Virtual Reality explorations. The present paper concentrates on the first two forms of navigation.

It is best to develop separate optimized versions of the 3D theatre model for each of these applications. In general, multiple uses of the same model are not recommended. This is because of obvious technological limitations imposed by the real-time interaction and Virtual Reality programs which do not allow obtaining the best visualization quality possible with the 3D programs currently available. These programs operate with polygonal models only and are not compatible with a large range of sophisticated tools that most of the 3D modeling

and animation programs offer. Heavy limitations are imposed on the use of various tools for modeling, texturing, lighting, animation and effects. However, for the Teatro Olimpico reconstructions, one model has been used for all three types of explorations and the rationale for this decision is explained below.

Fig. 2: Computer reconstruction of Teatro Olimpico -View of the proscenium. Architect: Andrea Palladio. Computer reconstruction by Daniela Sirbu

Fig. 3: Computer reconstruction of Teatro Olimpico -View of the proscenium. Architect: Andrea Palladio. Computer reconstruction by Daniela Sirbu

Fig. 4: Computer reconstruction of Teatro Olimpico -View of the proscenium. Architect: Andrea Palladio. Computer reconstruction by Daniela Sirbu

1. The 3D Computer Model of Teatro Olimpico

Contrary to the general recommendation introduced above, the present reconstruction is based on one scene model for all intended uses with some differences applied from one application to another. This decision was taken based on the fact that, in spite of the high performance computing equipment made available for this research through the Canadian WestGrid program, the extensive use of very heavy scenes in terms of both number of polygons and other texturing, lighting, and effects techniques involved, would make the rendering process very tedious. All three applications are developed to allow a certain ease of navigation within the virtual space and, whether cinematic or real-time navigations are developed, all require careful management of resources unifying to a certain degree the restrictions imposed to the scene model and justifying the use of a unique basic scene for all applications. This ensured great economy in terms of the modeling effort (one version of the Teatro Olimpico was developed instead of three) and brought the project into a manageable range. However, we do not compromise on the high quality visualization that can be obtained with current 3D programs, but rather pay attention in the selection of tools and techniques employed - a careful management of resources in the construction of the 3D world.

The economy in scene geometry must take into consideration a number of restrictions. For example, the rendering mechanism of the real-time interaction software used is based on geometry density of the object and, in particular, a larger number of vertices on a certain area considerably improve the rendering quality for that surface. This affects both the surface quality (texture details and perception of material type) and the perceived quality of the three dimensional volumes. The problem is most evident for large flat areas like walls, where traditional techniques allow obtaining excellent quality with very low polygon count and

high-resolution texture maps. However, to maintain an acceptable quality for real-time rendering in interactive environments, the geometry density must be increased for this particular situation. The level of geometry density for various parts in the scene has been established empirically, through trial-and error, in order to obtain a workable compromise between the visual quality and the ease of navigation.

Similar compromises are applied for objects with curvilinear shapes. The mesh density must be substantially increased in order to preserve the smoothness of the curved forms. Texture mapping may alleviate to a certain degree this increased need for denser meshes, however, very often the use of textures may not offer sufficient camouflage for the rough geometrical forms and more polygons have been added to achieve the desired result.

The Teatro Olimpico's decoration is rich in details (the statuary, the bas-relief and the details of the composite order) that easily may raise the polygon count in the scene to millions of polygons making it impractical for real-time navigation. There are 21 bas-reliefs and 49 statues in the proscenium, 51 statues in the auditorium, and more statues, columns, and other decorations (among which numerous other statues and columns) are in the 3D illusionistic scenery behind the proscenium. The Composite order columns also add significant detail to the scene geometry. Some of the details are not entirely modeled and whenever the use of texture mapping could suggest details well enough to maintain the characteristic appearance in the theatre, the geometric modeling of details has been avoided as described above.

The interior of the theatre has been modeled with polygonal modeling techniques ensuring a very tight control of the polygon count and geometry distribution throughout the 3D scene. All authoring programs for real time interaction applications and Virtual Reality are using polygonal models only, but this does not necessarily restrict the use of other modeling

methods like nurb and spline modeling. Objects can be converted to simple meshes at the end of the modeling process and no matter if polygonal, nurbs, or spline modeling has been used, the program is able to provide the required polygonal models at the end of the process. Nurb and spline modeling have been carefully avoided for the present reconstruction because of difficulties raised in controlling the polygon count and the distribution of geometry.

The polygon count that we have been aiming for the entire scene was 600 000 polygons with a maximum limit of approximately 150 000 polygons for every frame in real-time navigation – a minimal condition for ensuring natural movement with the computer technology available for the project.

The program used for the 3D modeling of the theatre is 3DS Max 7 from Discreet. Other 3D programs have been considered for this purpose as well (Maya, and Softimage XSI). 3DS Max was selected because it is the most stable 3D program; it also offers high quality visualization capabilities comparable with those of Maya and Softimage, and it is the recommended software package for visualization applications in architecture. In addition, 3DS Max also has, so far, the best compatibility with real-time game engines or any other authoring environment for real-time interaction applications and Virtual Reality software. For the real-time and Virtual Reality interactive exploration the software used is Virtools 3.0 – Virtools Dev and VR Pack components - from Behavior Company.

2. Texturing

While the same basic 3D geometry has been used for the development of cinematic, real-time, and Virtual Reality applications, different types of texturing are used depending on the application and the purpose of the particular navigation.

The texture maps are mostly based on processed photographic material collected on site at Vicenza. This original material has been adjusted for the following main purposes:

- perspective corrections:
  - adjustments to ensure correct full geometric frontal view of the bitmap;
  - adjustments to eliminate shadows projected on the surface in the original photographs;
- adjustments to ensure adequate aspect ratio of the bitmap in relation to the geometric area it has to be applied to;
- adjustments to ensure correct proportional relationships and scale of the texture maps in relation to the object areas which is particularly important for the quality of the 3D visualization and for obtaining a realistic rendering of the object surface.

The program used for maps processing is Adobe Photoshop CS.

The preferred texturing methods used are UVW mapping and Unwrap UVW mapping associated with the use of multi-subject materials. At sub-object level, simple bitmap textures have been applied through the diffuse channel. Bump mapping has been applied occasionally – although the use of bump mapping has been avoided whenever possible as it may easily double the amount of texture maps used. The scene is very complex and any supplementary texturing that increases the total amount of bitmaps associated to the scene must be reduced to a minimum.

Self illumination and opacity maps have been used as necessary, but reflection, refraction, displacement, glossiness, specular level, and specular colour mappings have been consistently avoided because they usually do not import well or are not supported by authoring programs for real-time interaction and Virtual Reality. These also do not recognize

or misinterpret 2D and 3D procedural maps that the modeling program can generate and, as a consequence, have not been used. These types of mapping could be applied in the development of the scene version meant for cinematic explorations. However, their application was still very economical as their use may significantly increase the rendering time.

As a general rule, we found that the basic texturing methods presented above are better supported when scenes are imported in Virtools. Any other mapping methods usually create unexpected problems. As a result, a lot of the texture mapping effort went into collecting and processing bitmap textures. These have been prepared to provide enough quality to be used without any improvement from within 3DS Max like, for example, output color maps or other output parameters applied on diverse channel maps.

3. Lighting

Scene lighting is aimed at obtaining the interior lighting theatrical effect of the present Teatro Olimpico. The reference material used for this purpose is mostly based on the on-site photographic documentation.

Lighting is fundamental for creating the illusion of three-dimensional space and for building mood in a given scene. Methods used to project mood in the scene are not analyzed here, but it is worth mentioning that typical lighting solutions used in film have been adapted to lighting the 3D computer scenes. Only the basic procedures applied to improve the three dimensional appearance of the scene and objects in the scene for the real-time interaction medium are presented here. These are similarly applied for the Virtual Reality environments.

The cinematic exploration may use all lighting capabilities offered by the 3D program. For the real-time interaction and Virtual Reality applications, the lighting process started in 3DS Max and was completed in Virtools. In 3DS Max, all available lighting facilities have been used in a normal fashion to obtain best possible results. Texture baking techniques have been applied to generate texture maps with shaded areas corresponding to the volumetric characteristics of the objects in the lighted scene. The scene was re-textured with these new maps and then it was exported into Virtools where an acceptable level of volumetric effect is ensured from the first place and only limited additional resources have been necessary. Further improvements have been obtained with dynamic lighting applied from within the authoring program. A serious limitation comes from the maximum eight dynamic lights allowed in Virtools. This makes absolutely necessary to apply the texture baking techniques in the 3D modeling program enabling the transfer of lighting effects in Virtools in a very inexpensive way from computational resources viewpoint.

Unfortunately, lighting in Virtools is fairly limited and diverse artifices must be applied in the original modeling program in order to obtain an acceptable level of visualization quality in the real-time interaction medium.

VI. Digital Exploration of TO

The digital exploration of Teatro Olimpico introduced in this paper is concerned with the digital place concept. Therefore, the case study focuses on issues of space and character in relation to the virtual theatre. Based on the 3D reconstruction described in section V, the following applications have been developed or are in development process as a platform for experimentation with the digital place of Teatro Olimpico:

- Real-time interactive exploration of the Teatro Olimpico,
- Virtual Reality navigation of the Teatro Olimpico,
- Cinematic investigation of the virtual theatre - focus on Renaissance cultural values,
- Digital Teatro Olimpico as a platform for virtual theatre,
- Teatro Olimpico as virtual museum.

1. Real-time interactive exploration of Teatro Olimpico

Based on the analysis of the architecture, aesthetic considerations, cultural aspects, and historic context of the Teatro Olimpico (see section IV), the exploration of the virtual theatre was intended to:

- provide a simulation of the physical environment of Teatro Olimpico;
- allow cinematic and free user exploration of the virtual space of the theatre;
- analyze in what ways this exploration complement the real Teatro Olimpico or brings new issues into consideration;
- analyze if the definition of the place concept can be applied to the digital theatre.

2. Real-time Interactive Exploration of the Virtual Teatro Olimpico

Basic considerations regarding the computer reconstruction of the Teatro Olimpico's physical environment are presented in section V. The focus of the present analysis is on dynamic aspects regarding the simulation of the theatre.

The virtual exploration of Teatro Olimpico is developed within the range offered by built-in capabilities of Virtools Dev 3.0. Interactive behavior is created based on code segments delivered as buildings blocks that can be activated from within Virtools Dev authoring environment. Although free user exploration of the environment is possible with Virtools, it is difficult to simulate the interaction we have with surroundings in real life.

First person camera views cannot equal the feeling and the rich sensorial input the human being experiences while moving through environment. The first limitation is due to the fact that incoming information is mainly visual and acoustic. Spatial depth can only be simulated based on visual cues and these can be represented to a limited degree in the real-time interactive environment. One problem derives from the fact that the digital camera has equal clarity throughout the scene and the visual focus (attention) of the human eye cannot be simulated. We could eventually change the digital environment to suggest how our visual perception works on objects that recede in the distance or are situated at the periphery of our field of view. The problem raised by this approach is that the effect is diminished and can be lost with the change of the user's position in the environment. It can only be practical if the user's movement is confined to a certain zone in the space.

Another major problem of the digital navigation is due to the fact that viewpoint changes in the medium must be actually operated with our hands using keyboard input, mouse clicks, or a joystick. All these reduce drastically the feeling of immersion in the medium, but could be effective for:

- free exploration of the virtual theatre,
- closer investigation of various parts of the environment,
- exploration/rotation around objects,

- taking various angles of view.

3. The Cinematic Investigation of the Virtual Theatre

The cinematic investigation is an artistic interpretation of the interior space of Teatro Olimpico. It builds on Palladio's concept of the proscenium as an inversed triumphal arch unifying the auditorium space and the scene space in a common universe. In this perspective, the movie refers to Palladio as a conceptual precursor of immersive virtual theatrical spaces – an emergent concept in the contemporary digital culture.

The movie explores the computer reconstruction of Teatro Olimpico as a space with multiple historical and contemporary connotations and cultural clashes. From these clashes new ideas erupt suggesting a digital rebirth through Palladio's only building that has been considered a dead end in the Palladian oeuvre. The movie thus plays on the notion of cycle, with the idea of death and rebirth, and attempts to throw the audience in a world of digital myth inspired by the beauty of Palladian architecture and by the intensely evocative character of the Teatro Olimpico space.

The movie explores Palladio's design concept as anticipating the future looking back for inspiration into the past. The 3D illusionistic scenery is interpreted as an expression of the Renaissance need for immersion into lost worlds of the past and looks at the rebirth of this dream in the digital age, when the illusion of exploring intangible worlds is revitalized by the possibilities opened by digital technology.

As curiosity is a component of creativity, the Renaissance infatuation with antique cultures is interpreted as part of a creative act. The movie looks at the Teatro Olimpico as an expression

of this form of creativity, which is at the base of the great cultural rebirth signified by Renaissance.

4. Teatro Olimpico as a Setting for Virtual Theatre

Short performances can be simulated in the Teatro Olimpico using keyframe animation, which is considered tedious by many, but it is most often the choice of professional animators who need high control over the animation quality (Kerlow, 2004). Motion capture from a real performing actor can also be used, but this poses a number of problems. In order to capture the best performance of two or more actors in interaction, it is necessary to capture the performance of all actors involved simultaneously. A high performance expensive motion capture system is necessary and scenes involving more than two characters are difficult to handle and impractical. Another possibility is to capture separately the performance of each actor, but the adjustments require a significant animation effort and sometimes it is preferable to animate the performance from the first place rather than capturing it.

A simulated performance in the digital Teatro Olimpico allows changing the angle of view in ways not possible in any other medium and even situating the spectator's viewpoint on the scene among actors. This kind of freedom is not always desirable, but it certainly brings into discussion the problem of virtual theatre as a new form of performing art in the digital age. This opens a separate avenue of research and, although the subject is not developed further here, it will make the object of future work stemming from the present research on the virtual Teatro Olimpico.

VII. The Cinematic Investigation of Teatro Olimpico

A short digital 3D movie has been developed to explore the space structure and theatrical forms of communication enabled by the space of Teatro Olimpico. This movie represents a first stage in a larger analysis and the focus is on controversial design elements in the architecture of the theatre. Disputes are interesting in bringing diverse viewpoints about how Palladio envisioned the theatre as performance space and how diverse forms of theatrical communication might have been enabled by his space concept. Finally, the point of view advanced by this space exploration challenges the idea that Teatro Olimpico is a terminal point in theatre history and looks at the Palladio's theatre as an early exploration of the concept of immersive space. This concept has been tackled more profoundly only in the twentieth century when the technology allowed its implementation in the virtual domain.

The movie investigates the static/dynamic space, the space into space structure, and the open/closed space as features of Palladio's immersive theatre space design expressed in Teatro Olimpico

1. Static/ Dynamic Space of Teatro Olimpico

It is generally recognized that Teatro Olimpico has been designed in Vitruvian spirit. Some authors (Tavernor, 1991) describe the *scaenae frons* as being inspired by an antique palace façade bringing forward a more static space concept, while others (Magagnato, 1992; Puppi, 1986) see it as an inversed triumphal arch suggesting a more dynamic space design. The latter interpretation favors the idea that Palladio envisioned the building as an "arrangement of spaces within spaces with the pictorial quality of the structural elements and decorative features providing the yardstick and definition." (Puppi, 1986)

The movie explores the static versus dynamic concept in the Teatro Olimpico space. It builds on Palladio's concept of the proscenium as an inversed triumphal arch unifying the auditorium and the proscenium space and thus bringing the spectators into the imaginary world of the play – one of the early attempts at immersive virtual spaces. In this perspective, the movie refers to Palladio as an early precursor of an emergent concept in the contemporary digital culture which can be formulated as immersive virtual theatrical spaces.

2. Teatro Olimpico as "Space in Space" Immersive Structure

The idea of immersive spaces in Teatro Olimpico is reinforced by the thesis (Magagnato, 1951) that the elliptical form of the *cavea* is not only a functional adaptation of the circular Roman theatre auditorium, but there could also be an intention of bringing the audience closer to the scene and enable a type of communication that is more related to contemporary theatre forms. Oosting tackles this interpretation on the grounds that there is no proof to support such an assumption and that it is difficult to believe that twentieth century theatrical forms of communication underlie Palladian design (Oosting, 1981). However, new forms of expression in art and architecture have always been anticipated by early experiments and it is not impossible that Palladio might have been attracted by the idea of a more direct communication between performers and audience, which could be facilitated by the design of the theatrical space. Whether such an idea could be advanced or not can be decided by experiencing the space of the theatre – because architecture must be experienced in order to be understood – providing a valuable source for the critical analysis of the architectural design.

The movie explores the virtual space of the Teatro Olimpico reconstruction in order to offer possible insights into relationships between the spectator situated in the *cavea* and the space

of the *scaenae frons*. The unexpected proximity between the auditorium and the performance space is investigated and various angles of view from the *cavea* are analyzed. As the orchestra pit is sometimes used to create additional seats for the audience, spatial relationships between the orchestra pit and the s*caenae frons* are also explored.

While the movie favors the "space into space" design idea also present in other Palladian late buildings, the possible separation of spaces through the two front lateral scene walls (Pane, 1961) is also considered for investigation.

3. The Open/Closed Space of Teatro Olimpico

Divergent opinions regarding Palladio's solution for the ceiling opens the analysis of the Teatro Olimpico from the open/closed space perspective.

A historical dispute has developed around the possible ceiling designs for Teatro Olimpico. The oldest available documentation of the ceiling is based on Ottavio Revese Bruti' s drawings of 1629. The ceiling is presented as a painted sky above the auditorium and as a coffered ceiling above the proscenium. This is the version that we can see in today's Teatro Olimpico representing the result of the 1914 restoration (Agosti, 1991). This ceiling design favors the separations of *cavea* and *scaenae frons* spaces.

There is also material to support a ceiling design linking the proscenium with the loggia through a single canvas painted with a star-spangled night sky. This can be seen in Magrini's *scaenae frons* elevation and *cavea* section drawings (Oosting, 1981) and it is the design implemented by the 1755 restoration (Agosti, 1991). This ceiling design brings the loggia, auditorium and the proscenium into a shared open space.

The movie explores both designs through the virtual reconstruction of the theatre allowing insights into the possible closed/ open spaces in relation to static/ dynamic connections between the spectator and the performance on the scene.

4. Teatro Olimpico as Pictorial Space

Puppi (1986) emphasizes that the decorations and structural elements in Teatro Olimpico have a pictorial quality that give the specific character of the space. Although we are not sure that any of the ceiling designs previously presented belongs to Palladio, it is interesting to observe that these, together with the 3D setting, attempt to create the illusion of an extended pictorial space. The loggia balustrade seems to continue through the paintings on the walls, one can see an illusory sky above, and the proscenium seems to keep in sight the illusion of an existing city through the wood construction of the seven streets of Thebes.

This extended illusionary world is recreated digitally in the movie and special attention has been paid to maintaining the pictorial quality present in the real Teatro Olimpico. The 3D movie explores this illusionary world of the theatre allowing a glance into the Palladio and his successors' need for immersion in lost or imaginary worlds that are not available for exploration.

VIII. Virtual Teatro Olimpico as an Interactive Museum Space

The problem of immersion and simulation of the Teatro Olimpico in ways that closely reproduce the real life experience of visiting the theatre remains a challenging problem for the present level of technological development.

The interactive navigation of the Teatro Olimpico as a digital space – in the form it has been developed through the present project - is definitely informative for the user. The Teatro Olimpico becomes available for the exploration to visitors who are far away from Vicenza and this dynamic exploration allows an understanding of the architectural space in ways that are not possible through static images or cinematic visualizations of the theatre.

Cinematic visualizations can present the space while communicating a coherent message about what is seen while the interactive exploration of the space allows the user to form personal opinions and address personal interests regarding different parts of the theatre.

IX. Conclusion

The research preceding the project development, the documentation visit to Vicenza, and finally the digital reconstructions of the Teatro Olimpico, support the conclusion that Teatro Olimpico is the great ancestor of the 3D computer visualization phenomenon that emerged during the last two decades - when the technological development made the creation of three dimensional navigable worlds truly possible. The present computer reconstruction of the Teatro Olimpico is part of this phenomenon.

Some (Tidworth, 1973) define Teatro Olimpico as a monument of idealism that failed because it was impractical as theatrical architecture. This opinion is largely based on the fact that the following development in theatrical architecture did not reflect the direction materialized by the Teatro Olimpico. Teatro Olimpico did not serve well the needs of its contemporary and following forms of theatre. But although this building is a theatre, it may open the way for something else – another form of art - that might be rooted in theatre as it is rooted in architecture.

The inversed triumphal arch of proscenium with the seven streets of Thebes in the background creates an illusion immersing the spectators in the space of the arch designed by Palladio. The Teatro Olimpico is an attempt to recreate the entire setting so that the spectators will become part of the virtual world.

Looking at the inversed triumphal arch of the proscenium with the seven streets of Thebes behind, the viewer sees a three dimensional reconstruction of a world that we cannot reach, an illusion that the spectators are being immersed in the space of the arch as designed by Palladio. The Teatro Olimpico is an attempt to recreate not only the story, but also the setting, that immerses the spectators. It is the first attempt of this kind and also the first precedent to what we now define as 3D computer immersive environments.

Teatro Olimpico with its beautiful Palladian architecture and 3D illusionistic perspective designed by Scamozzi, is a living monument of the human need to recreate and explore worlds that are out of our reach, worlds that might have existed in the past, purely imaginary worlds, or worlds that might be possible in the future.

Completing the circle, the 3D digital immersive worlds may offer in the future the medium for a new form of theatre in which real actors may interact with imaginary settings, with virtual characters, or even with spectators embodied in digital avatars actively participating in digital forms of theatrical improvisation.

The reconstruction of Teatro Olimpico will provide the platform for further various experiments with both the architectural space of the theatre and with various forms of theatrical performance in the digital realm.

References

Agosti, Alessandra. Guide: Teatro Olimpico. Trans. Jeremy Scott. Vicenza, Italy: Gilberto Padova Editore, 1991.

Allen, John. A History of the Theatre in Europe. London: Heinemann Educational Books, 1983.

Beltramini, Guido, Antonio Padoan, and Pino Guidolotti. Andrea Palladio: L'oeuvre Architecturale. Flammarion, 2001.

Beyer, Andreas. Palladio – Le Theatre Olympique. Architecture Triomphale Pour Un Societe Humaniste. Paris: Adam Biro, 1989.

Bieber, Margarete. The History of Greek and Roman Theater. London: Oxford University Press, 1961.

Brocket, Oscar G. and Franklin J. Hildy. History of Theatre. 9th ed. Boston: Allyn and Bacon, 2003.

Guinness, Desmond and Julius Trousdale Sadler Jr. Palladio. A Western Progress. New York: Viking Press, 1976.

Kerlow, Isaac V. The Art of 3d Computer Animation and Effects. 3rd ed. New Jersey: John Wiley and Sons, 2004.

Larson, Kent. Louis I. Kahn: Unbuilt Masterworks. Monacelli Press, 2000.

Larson, Kent and Takehiko Nagakura. At the End of the Century: One Hundred Years of Architecture Exhibition. 2001. http://architecture.mit.edu/~kll/body2.html. Available: http://architecture.mit.edu/~kll/body2.html. August 6 2005.

Magagnato, Licisco. "The Genesis of Teatro Olimpico." Journal of the Warburg and Courtland Institues XIV (1951): 209-20.

---. Il Teatro Olimpico. Novum Corpus Palladianum. Milan: Electa, 1992.

Nagakura, Takehico. "The Magic of Visualizing Unbuilt Modern." Architecture that isn't There: Virtual Recreations of the Destroyed, the Altered and the Never Built. Ed. Elizabeth Riorden. Cincinatti, Ohio, 2005.

Norberg-Schulz, Christian. Genius Loci: Towards a Phenomenology of Architecture. London: Academy Editions, 1980.

---. Existence, Space and Architecture. New York: Rizzoli, 1980.

Novitski, Barbara J. Rendering Real and Imagined Buildings: The Art of Computer Modeling from the Palace of Kublai Khan to Le Corbusier's Villas. Vol. Rockport Publishers: Gloucester, Mass., 1998.

Oosting, J. Thomas. Andrea Palladio's Teatro Olimpico. 1970. Theater and Dramatic Studies. Ed. Bernard Beckerman. 2nd ed. Ann Arbor, Michigan: UMI Research Press, 1981.

Pane, Roberto. Andrea Palladio. Torino: Giulio Einaudi Editore, 1961.

Puppi, Lionello. Andrea Palladio: The Complete Works. Trans. Pearl Sanders. 2nd ed. Milan: Electa, 1986.

Riera Ojeda, Oscar. Hyper-Realistic Computer Generated Architectural Renderings. Rockport: Rockport, 1996.

Riorden, Elizabeth (ed.). "Architecture That Isn't There: Virtual Recreations of the Destroyed, the Altered and the Never Built." Ed. Elizabeth Riorden. Cincinatti, Ohio, 2005.

Sirbu, Daniela. "Digital Exploration of Unbuilt Architecture: A Non-Photorealistic Approach." Connecting: Crossroads of Digital Discourse, ACADIA 2003. Ed. Kevin R. Klinger. Indianapolis, 2003. pp. 234-45.

---. "Architectural Multi-Dimensional Spaces: Digital Exploration of the Unbuilt." Convergent Practices: New Approaches to Art and Visual Culture, CHart 2003. Ed. Trish Cashen Anna Bentkowska, and Hazel Gardiner. London: UK: CHart, 2003. pp. 234-45. Vol. 6.

Tavernor, Robert. Palladio and Palladianism. London: Thames and Hudson, 1991.

Tidworth, Simon. New York: Praeger Publishers, 1973.

Wittkover, Rudolf. Palladio and English Palladianism. London: Thames and Hudson, 1974.

Zorzi, Giangiorgio. Le Ville E I Teatri Di Andrea Palladio. Neri Pozza Editore, 1969.