Virtual Environment Design – Defining a new direction for architectural education

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This paper considers the design and development of virtual environments (VEs) and the way that it relates to traditional architectural education and practice. The need for practitioners who will contribute to the design of 3D content for multimedia and virtual reality applications is identified. The design of space in a VE is seen as being partly an architectural problem. Therefore, architectural design should play an important role in educating VE designers. Other disciplines, intrinsically related to the issue of VE design, are also identified. Finally, this paper aims at pointing out the need for a new direction within architectural education, which will lead towards a generation of VE architects.

Keywords*: Virtual Environments, architectural design, architectural education*

Background

This paper considers the design and development of *virtual environments* (VEs) and the way that it relates to traditional architectural education and practice. The design of space in a VE is seen as being partly an architectural problem. The aim of this paper is to point out the need for a new direction within architectural education, which will lead towards a generation of architects able to design space in VEs.

Following recent advances in software and hardware, supporting the generation of interactive three-dimensional content, this paper suggests that there is a need for professionals who will contribute to the design of space in VEs. Among the disciplines that could provide the knowledge base for such a profession is architecture. The majority of formal higher education courses currently available in Europe do not cater for this need.

A term often used in the context of architecture and virtual reality is the "virtual design studio", seen as a system supporting remote audio-visual communication between architects, architectural students and educators for learning and collaborative work purposes. It has to be clarified that this concept does not relate to the concept of *VE design* and as such will not be dealt with in this paper.

Considering the need for educating designers of space in VEs

Recent technological advances have enabled us to use computers for representing real-world phenomena in a symbolic, schematic or realistic, multi-sensory way. We interact with such representations via human-computer interfaces (HCIs). Walker (1990, p.444) has suggested that the latest generation of HCI is a virtual environment (VE), which "provides users a three-dimensional interaction experience that includes the illusion they are inside a world rather than observing an image". Humans therefore, interact with computers via human-computer interfaces (HCIs), in ways that give the interaction experience a predominantly three-dimensional, spatial character.

More so a VE is, by definition, experienced by the user as a kind of three-dimensional space.

As we approach the end of this decade, VR technology has developed and matured into a stable platform, adopted by a large number of commercial establishments for supporting real-world applications. These include aircraft and vehicle simulations for military or civilian purposes, medical simulations, architectural and urban planning, computer games, etc.

The computer games industry in particular, is one of the fastest developing industries world-wide. Currently, most computer games display action within 3D environments.
Additionally, 3D environments can be integrated in:

- multimedia applications,
- virtual sets for film or television production
- interactive TV
- urban design and planning
- Remote collaboration - Virtual office.

The emergence of the standard for 3D content on the WWW (VRML) has enabled the hypertextual integration of 3D worlds with multimedia content. Film directors have already used VR applications to design 3D interactive storyboards, as opposed to traditional two-dimensional, linear, non-interactive storyboards.

Among the most popular applications of such technologies so far, are 3D on-line communities like "Active Worlds", "WorldsChat" (Damer, 1996), "The Palace", "VUniversity", BT's "The Mirror", or Canal+ "Virtuel: the Second World". These interactive, three-dimensional, on-line worlds are used by multiple users for:

- communicating with others,
- educating themselves,
- performing certain tasks, which may benefit from taking place in a three-dimensional, on-line, environment,
- entertaining themselves or for
- virtual shopping (e-commerce).

It is likely that in the near future a large number of people will be spending a considerable amount of time 'inside' such worlds. If we are to live, even partially, 'inside' these worlds we must consider their architecture. The nature of space in VEs (Charitos & Bridges, 1997) however, is fundamentally different from the nature of real space and consequently the architecture of VEs will require a new theory and practice.

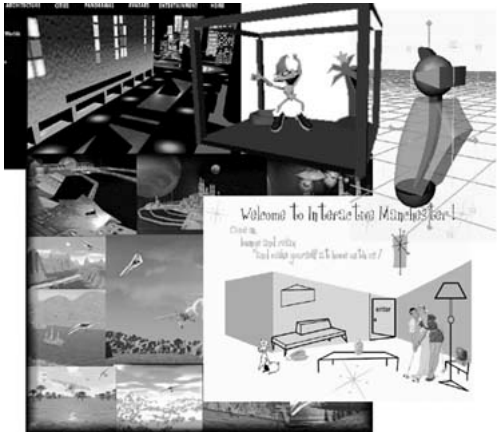
These issues are urging us to consider the growing need for designing space in virtual environments and the consequent need for professionals adequately equipped to perform this task. This paper argues that architects, if trained properly, are potentially able to fulfil this role. Moreover, architects could play an important role in the development of the infrastructure for generating cyberspace [A] as a new spatial aspect of life and communication in the next millennium. It is therefore suggested that an alternative direction of VE design, within architectural education, could prove very significant for the architectural profession.

The current state of architectural profession and education

Architectural profession has undergone a series of changes since its conception. Seeking alternative directions and practices is inherent to the nature of architectural education and is not associated to unemployment, as is often the case in other professions. Architects have always been curious to investigate new ways of expressing themselves. In recent years, the scope of traditional architectural design's contribution to construction is slowly changing due to:

- The finite amount of economically viable space, available within most cities of the developed world; cities are largely saturated, so there is limited potential for designing newbuilt, as opposed to refurbishing old building stock.

Figure 1 (right). Examples of 3D content in Virtual Environments



- Advances in construction via prefabricated systems, as well as limitations imposed on designers by building regulations,
- Change of working patterns in the architectural profession, which result from advances in information technology and communications (e.g. tele-working, etc.)
- Current trends and economic patterns imposing a more frequent rate of refurbishing commercial space.

Additionally, the theory and practice of architecture, in the traditional sense of the word, are being influenced by electronic media, which are currently used by many architects in the process of design. Taylor (1993, p.15) argues that "As pen and paper give way to computer-aided design and virtual spaces whose reality is thoroughly simulated, the very methods, tools and techniques of architectural design are undergoing a thorough transformation". Novel and unique architectural forms, which would probably never have been designed by traditional media, are being designed by computer-based systemsæa good example is the Guggenheim museum in Bilbao, designed by Frank O. Gehry. The use of computer aided design tools is also instrumental to recent attempts towards pursuing novel directions in designing form and space (Toy, 1995, 1998a & 1998b).

Although architectural education should have taken these facts into account and adjusted its direction accordingly, the main relevant change that has happened in architectural curricula over recent years has been the introduction of computing and CAAD classes. Recently, there have emerged a series of higher education courses, which partially address the issue of designing VEs. It is worth noting that the majority of the undergraduate (BSc and BA) courses are organised within computer science departments, whereas faculties of art, design and architecture organise the postgraduate (mainly one year MSc) courses. Although the existence of these courses confirms the previously identified need for educating people in the design and development of 3D interactive content, the knowledge they offer is still seen as supplementary to traditional architectural or computer science education.

The architecture of VEs

The disciplines of architectural design and virtual reality technology may be related in two ways:

- architectural design may employ virtual reality techniques for aiding the design process and
- virtual reality may employ architectural design knowledge, for informing the design of virtual environments.

Architecture making use of VR technology

One of the most common uses of VR technology today is for approximating the experience of moving within an architectural environment of any scale. This type of simulation is called "architectural walkthrough" and can be employed for evaluating, communicating or documenting a designed environment.

Architectural walkthroughs may be employed at several stages in the design of an environment:

- during the iterative design process, for evaluating the design or
- after the completion of the design process,

for communicating the design:

- before the actual construction, or
- for presenting the process of construction or
- after the construction, for remotely experiencing the designed environment.

Historically important buildings, which have been constructed at an earlier point in time, may also be simulated in order to enhance the decision making process in planning control (Bourdakis, 1997) (Fig. 2). This method could be used:

- when a building is still maintained in a very good condition or
- when it is somehow damaged and in need of reconstruction or
- when it does not exist today.

It is also essential to mention the possibility of manipulating the form of a represented object, while being immersed in a representation of an environment displayed by a VE. Real-time, interactive modification of surface representations, may enable designers to perform modeling of objects and surfaces and consequently real-time design of environments, while being immersed in a VE (Slater & Usoh, 1994). By modeling and designing whilst inside a VE, designers can approximately experience the result of their design, in real-time, while actually manipulating elements of it. This way the designer can carry out the modeling process, while being in a very direct relationship with the model. VE systems, which support this level of interaction with the participant, are still at an experimental stage of development and most of this research is done with non-immersive VR systems (Kameyama & Ohtomi, 1993, Fernando et al. 1994). Finally, Slater and Steed (1994) and Slater & Usoh (1994) have also experimented with systems which support modeling of generic objects by an immersed participant.

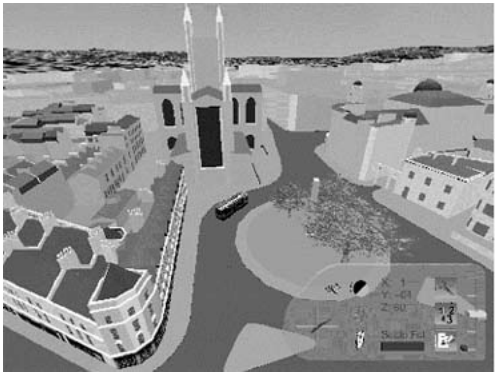


Figure 2 (left). View of the Bath model

Such experiments may lead towards systems, which support the design of form within a VE. Such a system is very significant because it provides the designer with a tool contemporary CAD systems lack; that is, visual feedback of what you design, when you design it, as if you were inside the designed environment (Smets et al., 1995, p.204, Kurmann et al, 1997, pp.809-819).

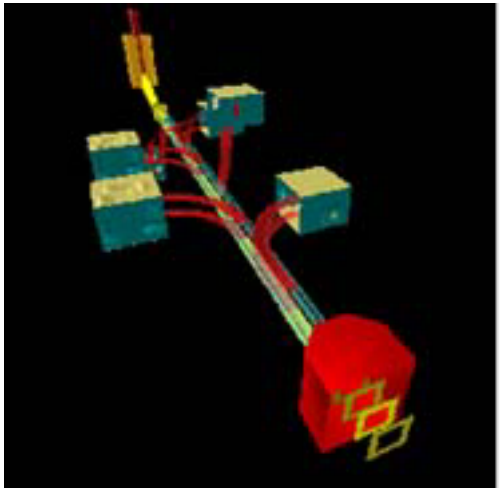
Utilising architectural knowledge in VE design

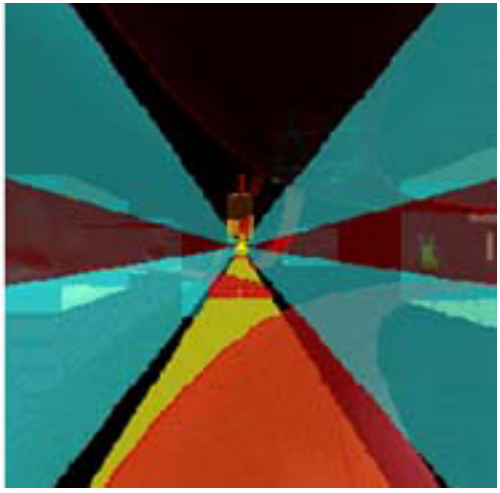
While the use of VR technology as a tool for aiding architectural design and communication has been established so far, it is still necessary to explain why we may need to apply architectural principles in order to impose a certain spatial structure in the design of VEs.

VEs are, by definition, built on the principle of imitating the spatial experience afforded by real environments. Therefore, the experience of a VE has a predominant spatial character. A VE is experienced by humans as a kind of three-dimensional space, comprising several objects and events, which do not necessarily have real-world counterparts. The synthetic environment defined by these objects and events is a setting, which may accommodate human activities like:

- navigation,
- interaction and
- communication

Figure 3 (right). Path world (D. Charitos)





and which can potentially support the creation of viable communities. Consequently, this paper argues that the design of a VE is an architectural problem as well, and as such it may benefit from the use of architectural design knowledge.

In the real world, architecture is the discipline, dealing with the construction of spaces, accommodating our needs. Such spaces are necessary in order to:

- protect ourselves from the forces of nature,
- delimit the vastness of our world into a more comprehensible network of meaningful spaces, which gives form and structure to our everyday experiences and within which we can move and act for our everyday needs.

Architecture and planning are the disciplines responsible for creating such networks.

Space in a VE is infinitely expandable and physically limited only by the computational power of the system, which supports the VE. There may be no need to protect participants from natural hazards but there is still a need for delimiting space in a VE in order to make it

- more legible and therefore easier to navigate
- easier to remember when experiencing a VE more than once.

In order to delimit space in a VE, as we do in the real world, this paper argues that there is a need to impose a certain form and structure onto the space. For the purpose of doing so, we need to develop an architectural framework, as a system of meaningful spatial elements in this VE, ultimately making our interaction and navigation within the VE a structured and meaningful experience.

It is useful to attempt conceiving the role an architect could play in a project of designing a VE. Frericks (1994) proposes the term *"virtual architect"* for describing the designer who may contribute architectural knowledge to the process of designing a VE. He then goes on to suggest a possible iterative process, through which the developers of a VE and the "virtual architect" may cooperate in order to design and develop this VE:

- Firstly, the application requirements are defined by the developers.
- Then the architect has to come up with the spatial composition, which defines the

geometry of the environment, including all graphical and non-graphical objects for interaction.
- Consequently the developers use this spatial composition to implement an initial version.
- From that point onwards, the developers and the architect may work together on the basis of mutual feedback, in order to optimise the VE for the requirements of the particular application.

An experienced designer may note that the collaborative process described above is analogous to the role of an architect within a typical large-scale architectural design project. It is understood, however, that the design of a VE is a very complex task, requiring input from various other disciplines as well – e.g. software engineering, cognitive ergonomics, perceptual psychology, graphic design, mechanical and electronic engineering, etc. It would not be possible for "virtual architects" to have the knowledge for providing solutions to issues relating to these disciplines. It is however essential that they know enough to be able to collaborate with software engineers, psychologists, graphic designers and engineers who specialise in VR technology issues (I/O devices, motion platforms, etc.), during a VE design project. This implies that the education of "virtual architects" should include fundamental knowledge from these disciplines, which are intrinsically related to the complex problem of VE design.

Conclusions

VR technology has been widely used for supporting the evaluation or communication of architectural design. However, this paper has mainly focused on the way that architectural design knowledge may contribute to the design of VEs.

3D content exists in several multimedia or VR applications, computer games, virtual sets or online communities. There is a need for designing 3D content for all these applications and consequently a need for practitioners who can perform this task. Consequently, a series of courses have emerged, attempting to supplement traditional architectural / computer science education with computer related design issues, among which is the design of VEs.

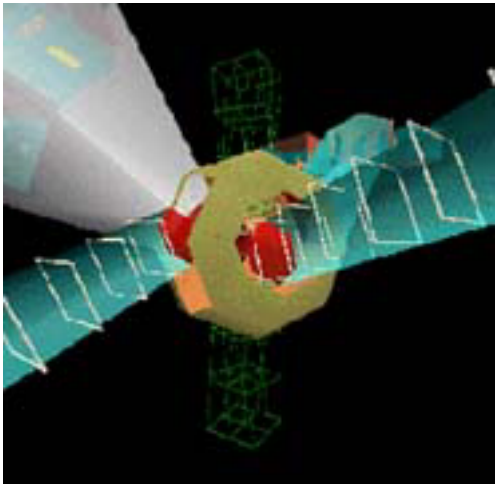


Figure 4 (left). Intersection (D. Charitos)

As is the case in the real world, we need architectural design for imposing a certain structure onto a VE thus making the experience of being in it functional and meaningful. It has been clarified however, that the design of a VE requires contribution from other disciplines as well. "Virtual architects" therefore should be trained so that they have an understanding of fundamental issues from other disciplines, relating to the development of a VE system, thus making them capable of collaborating with a series of specialists from these disciplines. On the other hand, traditional architectural design expertise, on composing form which determines functional space, is equally important for designing space in VEs as it is for the real world.

By way of conclusion, it is believed that all necessary knowledge for designing space in VEs could neither be provided by an architectural course nor by a computer science course. A new direction parallel to architectural education but at the same time focussing on the issue of VE design would have to be

introduced. “Virtual architects” could follow the studios of traditional architectural education. Additionally, since the nature of space in the real world is fundamentally different from space in VEs, they should be provided with background knowledge from disciplines relating to issues of VR technology rather than knowledge of technical issues relating to construction in the real world.

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Notes

[A] This paper takes into account the Gibsonian (1984, p. 67) definition of cyberspace as a three-dimensional, on-line, network of computer generated worlds.

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