Visualization of Virtual Architecture

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Abstract

This study constitutes a framework, a justification and a proposal for the opportunity to improve the use and efficiency of visualization of architecture in the virtual environment. It seeks a new platform to define architectural design communication.

The design process depends upon creation of models and virtual environment offers the medium of exchange where the design model can be shared and criticized by people other than the designer; various analysis can be applied and the results of both can be used to change or improve the design.

Possibilities offered by visualization do not fit into the paper-based way of architectural thinking. In order to benefit from the potential of visualization it is required to redefine architecture, architectural design process and architectural terms with respect to the virtual environment. This study introduces a transitional solution between the paper-based and the future ways of thinking in architecture by enabling the designers customize the visualization software according to their purposes.

Concept of modeling in architecture

Our perception, comprehension, implementation and communication with the environment are realized through mental models used to store, compare or change the information about that environment. We build up mental models to store the information about an environment and then whenever we are in need of changing or evaluating that environment we refer to that model.

Design and design communication depend on such models. Every architectural product is based on a design model created in the designer's mind. When designers create, they make up mental models loaded with various kinds of information (form, dimensions, relations, materials, colors, structure, etc. of spaces) about the design.

They then try to display the design model and communicate about it through various media until the design is realized in full scale; until the design is built [1]. Thus, every architectural product is in fact the physical representation of a mental design model. Nevertheless, physical existence is not the only difference between the design model and the architectural product, there is also the factor of time.

Architecture lives in four dimensions. Along with the three dimensions which make up the physical volume of architecture, time emerges as the fourth dimension. Time is a crucial factor to architecture since it determines a life span for the architectural product through which it will be perceived and maintained. The time coordinate of architecture runs parallel to history and offers every building a definite time period starting from construction to destruction. This coordinate might be called the actual time coordinate.

However, any design model created to carry information about the future architectural product acquires two time coordinates. One is (again) the actual time coordinate displaying the time period when the design takes place. This period is generally followed by the life span of the building. Other coordinate is the virtual time coordinate which offers virtual time periods to test, analyze and revise the design model, imitating the life span of the future building. These analysis include not only the performance analysis of different design alternatives (thermal, structural, acoustics, lighting, etc. analysis) and maintenance analysis (deterioration, resistance to fire, earthquake, etc.) but allows revisions to be implemented based on the results of these analysis [2].

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For a successful design communication, it is important that the implementations done on the virtual time coordinate of the design model to be displayable so that the analysis and the revisions can be shared with others, collegues and customers.

Visualization of architecture

Information processing

The commonly used media for displaying and communicating architectural design has been the paper-based techniques for a long period of time in the history of the profession. These techniques include sketches, drawings (plans, elevations, sections, perspectives, etc.), diagrams, along with any verbal or written material and mock-up models describing the architectural design.

One of the common properties of paper-based techniques is their lack of representing the mental design model completely. Such techniques can not cover the properties of the virtual time coordinate of the model. In other words, paper-based techniques lack the capacity to display the three most important properties of the mental design model: dynamic perception of space, performance analysis and instant adaptation which all depend on information processing.

Therefore, paper-based techniques alienate the architectural product from the design model [1]. They display only parts of the design model and display them statiely. And following Baudrillard's assertion on modern simulations becoming their own referents [3], paper-based representations become referents for themselves, loaded artistically but weak in providing design information.

Paper-based techniques are based largely on abstraction. This abstraction is graphical in drawings, verbal in writing and speech and physical in mock-up models. The value of the abstraction remains artistic most of the time in all the above mentioned media. We enjoy the sketches made by an architect aesthetically, not caring much about the information delivered by that sketch.

Thus, there always occurs a difference, an information gap between the design and its representation. Hoffman sees the representation at the service of the idea, not necessarily the architectural product. Efforts are directed more toward the creation, development and presentation of the graphic tokens [4]. It is not only the distance between the architectural product and its representation but, the distance between the model and the product since the product is a representation as well.

However, the mental model now is displayed fully for the first time in the history of architecture. The displayed form is the digitized model in the virtual environment. In the virtual environments we are confronted by the design before it is built. It is possible to perceive it dynamically, make performance analysis, test different cases, make instant changes, analyze factors pertaining to the maintenance, observe the information related to the building (materials, colors, standards, etc.), and form databases. Consequent to the latter factor it becomes easy to use the virtual environment as a library for finding and examining architectural examples in the virtual environment instead of magazines, books, or visual material archives.

With the advent of digital visualization it is possible not only to display the architectural design in four dimensions, but to make analysis as well. Knowledge, being a certain model of reality, helps us to foresee the results of our actions [5]. The visualization of the design in virtual environment is similar to a model in human mind since both allows information processing and relation analysis. The possibility of analyzing relations based upon a model is a chance for a designer benefiting from visualization.

The information gap between the design and the abstarct graphic tokens get narrower with the digital visualization (and is bound to close as visualization improves technically). Since "... through the means of three dimensional modeling programs and the emerging possibilities of virtual reality displays, the computer offers a direct way to deal with the elements of architectural design as a composition of three dimensional entities rather than a simple collection of lines" [6].

Architecture in virtual environment promises a powerful future, not only because of the potentials as a presentation media, but because of its advantages regarding the ease of change and intervention to the design before actual construction. Free of physical damages it may be used as an efficient medium in construction tests both for educational and practical purposes. Seeing the results of any changes applied to the structure is especially of importance not only to architecture students in learning to deal with structures, but to architects who attempt to make structural changes (like pulling down a wall, omitting several columns or adding new ones) within the space that was designed beforehand.

Moreover, all these advantages are present both for the architect and the client. Visualization in virtual

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environments may not only be considered as a radical new approach to architecture [1], but for design communication as well. If designers design in the presence of both consultants and the client in a 3D space, testing the results of design decisions by seeing them in full scale as if in the actual setting, that is bound to change the procedure of the whole design practice, provided that the problem of complaints on the familiarity of virtual environments versus paper-based techniques in design is resolved.

Familarity of visualization in virtual environment

If designers have had the possibilities of digital visualization before drawing with pen and paper, today the issue of familiarity would have had a new dimension and most probably cease to be an issue to be argued upon [1]. In the virtual environment our mental images turn into visual ones loaded with design data displayed upon request.

Lanier refers to the language of virtual environment as a post-symbolic one, indicating that in the physical world, we are not able to make physical changes quickly unless we form words that refer to all the possible changes wished to be made if possible. In a good shared virtual reality system, it is possible to form the world instead of using the symbols to refer to it. Then we are confronted with a new medium as big as language. Lanier sees it as no replacement of language but as alternate form of communication to exist side by side with language [7].

Within this framework, virtual environments may well be said to constitute a kind of alternate form of design and communication, not replacing the design language but, existing as an alternative. Then, the virtual environment turns out to be a very familiar design environment, since through digital visualization the design model in the designer's mind can be transferred to a medium where it can be shared by others.

It may then be argued that, a well developed virtual environment is in fact, a very familiar design environment in spite of the complaints that it is not 'familiar' to the way designers make their designs. The only case where the 'unfamiliarity' arises is the switch from paper-based techniques to digital visualization. As the creation process is handled by building mental models of what is thought to be turned to reality, drawing is not the medium of creation but, a medium for representing part of what has already been created in the designer's mind. Whereas in the virtual environment it is possible to design, test the 'what if' cases and display them all.

However, designers are very much used to the paper-based techniques. Even if they employ computer aid they develop the design as if it is going to end up on paper and use the computer as an alternative tool to display. Often enough they develop the design on paper and then transfer it to the computer.

With the emergence of visualization the whole design process (from initial diagrammatic sketches to final drawings, simulations, and representations) can be carried out digitally, the model becomes the design method itself. Designers in virtual environment, should no longer build models of what they design; rather they should build the whole procedure through which they reach the final design. [1]. For that, designers need to feel more comfortable with the visualization software, not be overwhelmed with the possibilities and need not to spend a lot of time to learn the procedure. The key to this lies in the degree of flexibilty given to the designer by the software to adjust it according to his/her needs.

The degree of freedom of the designer in determining his own method and procedure of design in digital media, determines the actual degree of aid of visualization to the practice [1]. Having the flexibility to adjust the virtual environment, it is very probable for the designer to feel familiar to the environment. We need a transitional solution to introduce to the designers in using the virtual environment until they can free themselves form the paper-based way of thinking and return to the essence of design.

Degrees of information processing and visualization

Within this framework, we have been working on a transitional solution which will enable the designers to customize the software they are using. Initially, we need a new platform on which we can define architectural design and design communication. The following three scales are developed to find a common platform to define the degree of information processing and visualization in architecture (Fig.1).

The interactivity scale (I), meaning the possibility to interfere to define and execute tasks, expands from non-interactive to immersive. From the immersive end onwards is the region of virtual reality experiences.

The time scale (T) expands from non-real time to real time indicating the time of the display versus the actual time required for the represented act. The values of this scale varies between 0 and 1.

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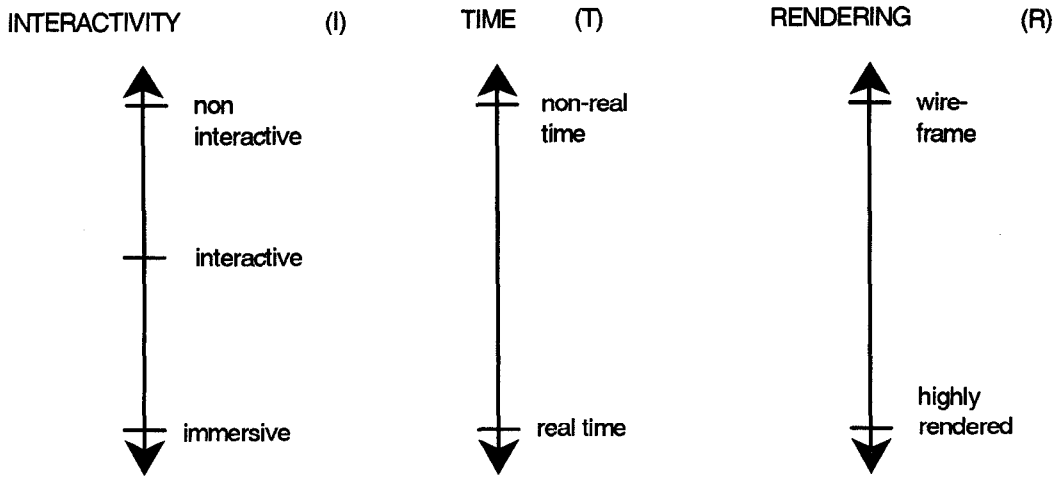

Figure 1. Scales of means of architectural communication

Finally, the rendering scale (R) expands from trivial and boundary line quality to highly rendered, colored, material conscious, and illuminated versions upon which performance analysis can be applied [8].

Using the three scales mentioned above a 3D coordinate system can be formed to define the following (Fig.2).

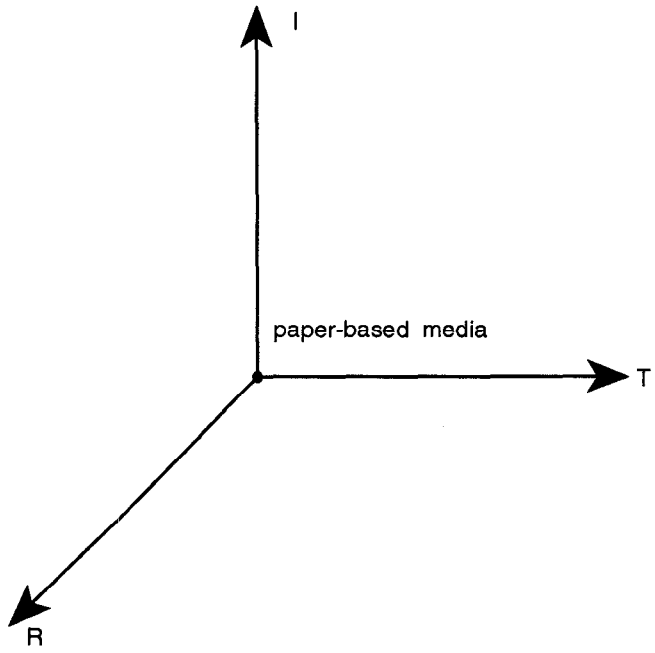

Figure 2. 3D coordinate system based on the scales of means of architectural communication

Examining the system in detail, following relations are observed [Fig.3]. At the intersection of presently available ends of the axis of interaction and axis of time lies the verbal description of an architectural design, since it can answer to various questions as if executing different tasks and can represent the design rapidly.

At the intersection of presently available ends of the axis of rendering and time lies a highly developed walkthrough recorded on video tape. It is highly

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rendered, including color, lighting and displays of various performances of color, lighting and material properties due to different situations. It is also in real-time, without any time lapse.

Finally, at the intersection of the presently available ends of the axis of interaction and rendering lies the 3D CAD model, which is capable of meeting the needs of different tasks required and is highly rendered with the possibility of performance analysis [8].

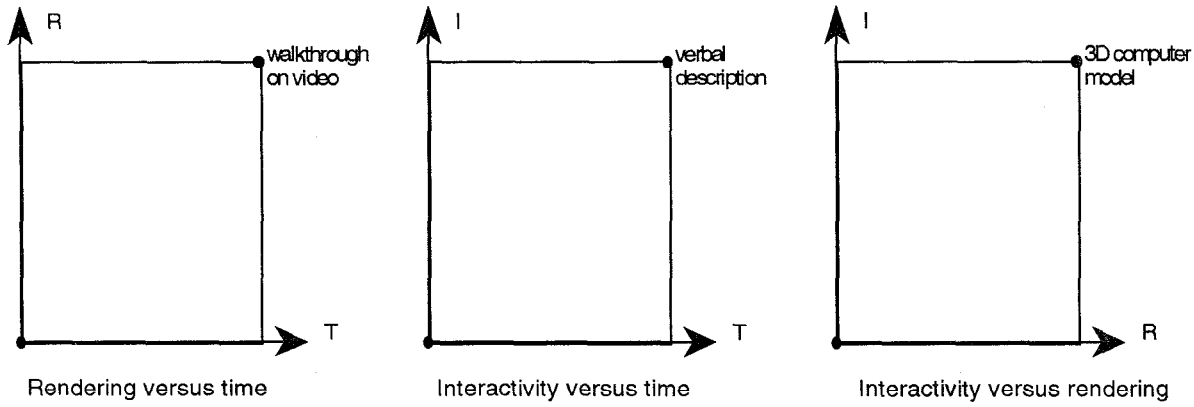

Figure 3. Definition of means of architectural communication

To test our system to see whether it covers all means of architectural communication, a cube is formed in the 3D coordinate system the vertices of which stand for one of the means of architectural communication (Fig.4).

Here, the vertices stand for the following; 1 (traditional drawings), 3 (verbal description), 5 (walkthrough on video), 7 (3D CAD model), 8 (actual building itself). As can be seen, the dynamic simulations in digital format can be defined on a line expanding from vertex 1 to vertex 8. However, vertices 2, 4, and 6 are used for defining other vertices; they are the ultimate points reached so far technologically on their axis and do not have any reasonable definition beyond that.

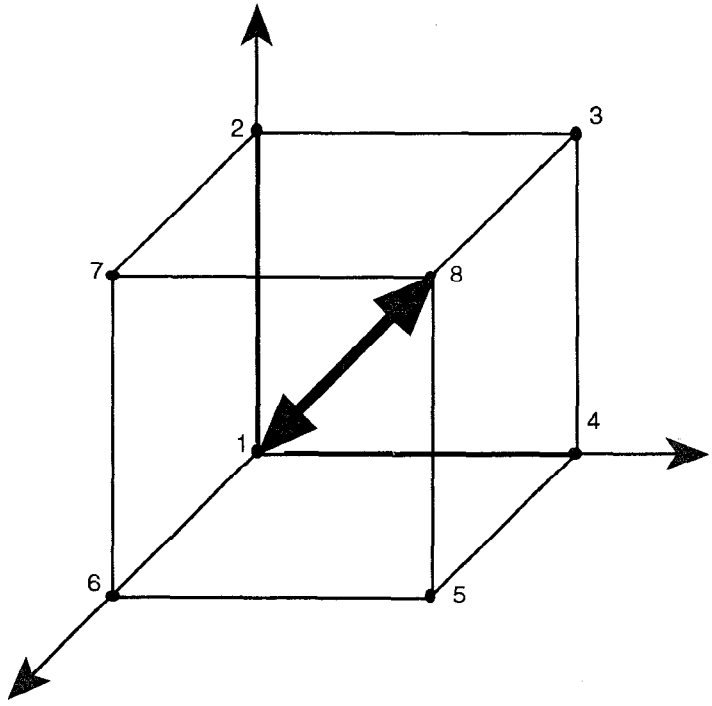

Figure 4. Architectural communication as a cube in 3D coordinate system

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Thus, the cube can be used to determine the level of visualization. Next, we sought ways to combine the level of visualization with the three major properties on the user's side which needs different levels of data and information processing:

- purpose of simulation
- experience level of the user
- target audience [8](Fig. 5).

The combination led us to the formation of an optional customization scale menu (CSM). CSM aims to enable the user to define the levels of I, R, T according to his/her purposes, experience level and/or the target audience and be able to determine automatically the global level of visualization. The model we construct is to be used with any visualization software, provided that each menu item of the software is addressed with the three values of I, R and T. CSM offers the three scales to the user, each spanning from levels 0 to 3, allowing three regions on the scale. Thus, according to the user's choices of these three values via CSM the menu items will either be assigned standard values or be available for the user's assignments.

The value of I is the determinant if default assignments. If I is between 0 and 1 default values will be assigned, if between 1 and 2 the suggested value will be displayed with the possibility of user's intervention and if between 2 and 3 the user will be handling the assignment of the menu item.

The value of R indicates the level of information. If R is between 0 and 1 the display contains data on wire-frame model, if between 1 and 2 color is involved, if between 2 and 3 the results of performance analysis are rendered with texture and light .

The value of T determines the speed of performance and display. If T is between 0 and 1 the display is still, if between 1 and 2 the display consists of snapshots in sequence and if between 2 and 3 the display is a motion picture.

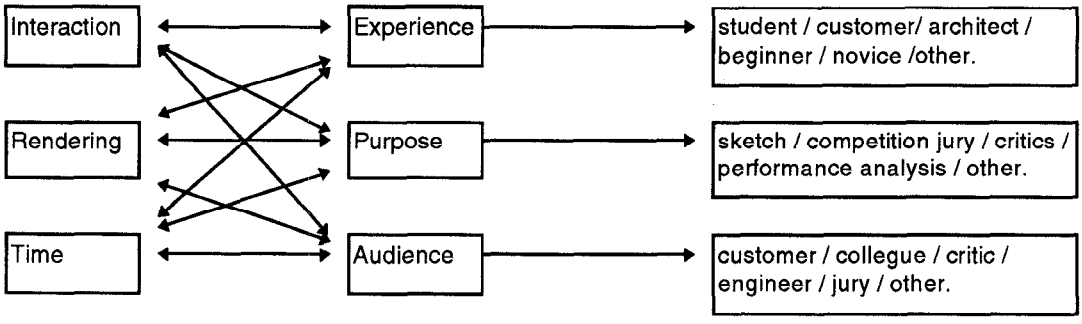

Figure 5. Relational scheme between scales of visualization and properties of the user

The more relevant the context, higher the value and longer the life-span of information [9]. CSM aims to give the user the opportunity to render the context of information processing relevant to his/her purpose, audience and background so that the the efficiency of use of the visualization software will be more.

Being able to define the level of visualization, the designers in virtual environments will have flexibility required to make the use of visualization in architecture more efficient, familiar and powerful.

Final words

Our work is designed to act as a transition link between the old and the future definitions of architecture. Architecture faces a new era where it will be re-defined. It may not be a far future when we will see architects, designing buildings, interiors, and settings for the virtual environments. There awaits a new potential field of design in virtuality.

Architecture is a profession which everybody in one way or another practices sometime during one's lifetime. Everybody is an architect to an extent. We pragmatically build small gadgets, modest structures, and organize the interiors we live in during our everyday life. In the virtual environment, architects are by no means the only designers by definition. Any participant (especially the client) may implement the environment with ease. So, one question to ask is; will architecture in virtual environment be practiced by both architects and the users? If not, does it not limit the user's freedom; if so, how will the architect's designs be permanent? Do they need to be permanent or will every virtual environment be temporary?

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Mitchell [10] sees architecture "...to be concerned with the skin-bounded body and its immediate sensory environment -with providing shelter, warmth, and safety, with casting light on the surfaces around it...Now they must contemplate electronically augmented, reconfigurable, virtual bodies that can sense and act a distance but also remain partially anchored in their immediate surroundings".

Novak [11], introduces the notion of liquid architecture defining architecture in virtual environment. He says that music, which was the most temporary of all arts became permanent by technical means like recording and digitizing but, on the other hand, architecture, the most permanent art is becoming temporary by being dematerialized in virtual environments. "For architecture this is an immense transformation: for the first time in history the architect is called upon to design not the object but the principles by which the object is generated and varied in time"

Virtual environment is formed by the continuum of the discontinuous objects, continuum of the principle which creates temporary objects. Thus, architecture faces an era to redefine itself in, if architects do not hesitate to see the possibilities offered by visualization. Only then we can free ourselves from the "... physical world whose properties we have come to know well-through long familiarity". Unlike the ability to predict we have in the physical world, we lack corresponding familiarity in the virtual environments. Visualization gives us a chance to gain familiarity with concepts not realizable in the physical world [12]. To acquire such familiarity in the future is possible through the formation of a flexible use of visualization of virtual architecture today.

References

1. Şenyapılı, B. and Özgüç, B. Proposal for Improving Computer Aid in Interior Architectural Design. *Architectural Science Review*, 37:4, 171-179, 1994.

2. Şenyapılı, B. The True Model Concept in Computer Simulations Used in Architectural Design. B. Martens (ed.) *6th Conference of the European Full-Scale Modeling Association (EFA).* Vienna: Vienna University of Technology, 133-140, 1996.

3. Baudrillard, J. *Simulations*, translated by Paul Foss, Paul Patton and Philip Beitchman. New York: Semiotext(e), Inc., 1983.

4. Hoffman, M. C., Cyberpunk, Generation X and the Ataxia of Space. *ACSA/EAAE Schools of Architecture Conference.*. Prag: Czech Technical University, 1-9, 1993.

5. Cox, D. The Tao of Postmodernism. *Leonardo (Computer Art in Context Supplemental Issue)*, 7-12 , 1989.

6. MacLeod, D. Computers: Virtual Reality. *Progressive Architecture*, 73:4, 55-56, 1992.

7. Porter, S. Interview: Jaron Lanier. Computer *Graphics World*, 15:4 61-70, 1992.

8. Şenyapılı, B. Proposal to Improve the Use of Dynamic Simulations in Architectural Design. A. Robertson (ed.) *4D Dynamics.*. Leicester: DeMontfort University, 151-155, 1995.

9 . Sanders, K. *The Digital Architect*. New York: John Wiley & Sons, Inc., 1996.

10. Mitchell, W. *City of Bits.*. Massachusetts: MIT Press, 1995.

11. Novak, M. Liquid Architectures in Cyberspace. M. Benedikt (ed.) *Cyberspace: First Steps.* Massachusetts: The MIT Press, 225-255, 1991.

12. Rheingold, H. Virtual *Reality.* New York: Simon & Schuster, 1991.

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