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Modeling the City History

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This paper explores the idea that 3D city models integrated with hypermedia systems can facilitate the sense of belonging to a place. 3D models are powerful tools for buildings and urban space analysis as artifacts, which synthesize men's reality and aspirations. As such, combined with hypermedia resources, they can strengthen the spectator's actual experience in the analyzed space.
The focus of the investigation is 3D models constructed to represent and analyze city evolution. The experience of developing the models of Latin American cities – Rio de Janeiro, Brazil and Havana, Cuba – developed at PROURB (Faculty of Architecture and Urbanism, Federal University of Rio de Janeiro) is explained with an overview of its methodology.
Keywords: *3D city model; hypermedia; sense of place; city evolution; Latin America.*

Introduction

> "A Reality Beyond Our Reach. And this, essentially is what maps give us, reality, a reality that exceeds our vision, our reach, the span of our days, a reality we achieve no other way. We are always mapping the invisible or the unattainable or the erasable, the future or the past, the whatever-is-not-here-present-to-our-senses-now and, through the gift that the map gives us, transmuting it into everything is not … into the real." (Woods, 1993)

3D city models, as we know them today, have their origins in traditional city maps. Even though digital tools bring about many new possibilities, digital models roots and motivations are closely related to maps. An investigation of 3D city models should depart from these considerations in order to verify its aims and possibilities. 3D city models have many different objectives. We have identified three main groups that have developed them: academic, governmental and private institutions. Those models are usually constructed to represent, analyze or communicate a specific situation which exists or not or they can be used to examine a proposal to change a particular state. These goals can be blurred and one model may be used for different purposes or users. The focus of this paper is the investigation of 3D city models developed mainly by educational institutions in order to analyze a city based on historical explorations about its evolution.

3D city models, like maps, are powerful when they can locate a set of information and make it clearer. In the same way that the location of information facilitates its understanding, the place can be better understood with the embedded information. When Christian Norberg-Schulz (1984) analyzes Heidegger's concept of dwelling, he associates it to an "existential foothold" and states that "man dwells when he can orientate himself within and identify himself with an environment, or, in short, when he experiences the environment as meaningful". An analysis of the shaping of built environment is a powerful way to grasp

the meaning of the place and hence, to facilitate one's feeling of belonging to that place. The aim of this paper is to demonstrate that 3D city models can be very effective in this process, particularly when associated with different file sources in an interactive multimedia system.

Transcending the city modeling

The notion of meaningful stressed by Norberg-Schulz (1984) has a poetic connotation and goes beyond a "scientific understanding". However, through the scientific understanding, it's possible to create a foundation which facilitates the perception of poetic connotation. Revealing some of the hidden structures and sub-systems of a city to an inhabitant or visitor can support the development of a sense of being part of that place which transcends the act of being in a place. Norberg-Schulz also demonstrate the belief that "architecture represents a means to give man an 'existential foothold'." A 3D city model can be a powerful tool for analysis of buildings and urban spaces as artifacts, which synthesize men's reality and aspirations. Usually, the knowledge about an architectural artifact's context strengthens the spectator experience. It could be possible to speculate that one can recognize the 'meaning' of places after the exploration of its creation and conception.

There are important examples of successful written texts which analyzes a city structure and raises this poetic connotation. Two different approaches of noteworthy texts are Walter Benjamin's (1999) XIX century Paris through the analysis of commercial passages and Rem Koolhaas's (1994) XX century Manhattan by means of the city grid and its architecture investigation. Both books demonstrate that hypermedia doesn't represent a revolution into traditional texts' linear discourse. They resemble a hypertext system structured by fragments of texts, which can be read independently. In both cases, the act of reading is similar to the process of experiencing the city: a patchwork of juxtaposed layers of information, which are combined by the readers as they progress in their 'experience'.

Other remarkable experiences, using digital tools, can be enumerated: the Glasgow digital exploration developed by ABACUS - University of Strathclyde (ABACUS, 2001 and Ennis, Lindsay and Grant, 2001) and Kiko Goifman's prison investigation (Goifman, 1998). One of the former example's main qualities is the multiplicity of information collected and presented about the city. Besides being one of the precursors of 3D city models, many other Glasgow related initiatives were developed. The Glasgow Virtual Open Door project, for example, exhibits a significant contribution to the city understanding (ABACUS, 2001). Building interiors are presented in a CD-ROM. Those interiors, hidden by most visitors and even inhabitants of the city are digitally exposed, revealing aspects of how people dwell in their buildings. Goifman brings a very different approach displaying his research about prisons in an instigating hypermedia system. Navigation turns out to be the main tool to communicate the space character. In his work, it's more important the way the space is apprehended than its architectural characteristics.

If hypermedia systems didn't produce a radical change into conventional narrative, we can't deny that those systems introduce powerful resources to communicate and organize information. Hypermedia systems are particularly effective when information is associated or described with images. In this context, hypermedia systems based on 3D city models can be extremely efficient to exhibit part of the information complexity inherent in a city. According to Woods, "It is the ability to link the territory with what comes with it that has made maps so valuable to so many for so long." The similar characteristics 3D models have with maps, make this assertion also valid to them. Besides that, they have additional features that can strengthen the linkage to the place and the manipulation of the territory representation and its embedded information. The impact of those additional features turns out to be evident when the area or information represented becomes more complex. The more thorough the analysis, the greater is the difference with traditional maps.

Michael Batty (2001), writing about information systems for urban planning, stated that “the digital world is about convergence. It is about representing information in digital form in such a way that data and information that previously were considered to be quite unlike one another can be juxtaposed to make their correspondence and linkage considerably clearer.” For a city, graphic representation, both 2D and 3D, is a powerful ground for this convergence. A city is automatically linked to the idea of place. Thus, placing an information about the city is very efficient to make it understood. 3D models are effective tools to make clearer this location and hence they are critical to link various layers of information to a precise and recognizable territory.

Managing different type of files with 3D models in hypermedia systems is a complex task and should be planned cautiously. Each media has peculiarities, advantages and limitations. Texts, for instance, have some limitations to display an image realistically. Many times, however, the text inherent characteristic of hiding part of the context makes the message more open, powerful and “poetic”. That may sound paradoxical. The same occurs to modeling – a very realistic 3D model can frequently reduce the potentiality to convey effectively the message.

The evolution modeling process

An existing 3D city model can be used as a base to develop an evolution model of the city. The technique employed should be selected according to the way the model will be used and the available historical information. The model can be used as a separate tool, which generate material for an autonomous hypermedia system or it can be manipulated in the final system. The latter is more elaborated and usually requires more complex tools. The most common tools for this task are VRML (Virtual Reality Modeling Language) and GIS (Geographic Information Systems). Both systems however, have limitations. VRML originated as a virtual reality 3D systems and have shortages in the manipulation of databases related to the 3D objects. GIS systems, created to manage large quantities of data related to maps have limited resources with the manipulation of 3D objects and to provide access to the information in autonomous systems, without the need of costly and complex GIS systems. For these reasons, many systems are elaborated with programming languages such as Java3D to attend the developers goals.

The use of VRML is a standard for describing interactive 3D objects and worlds. An interaction with a database can be created with Javascript, added to both VRML model and HTML (Hypertext Markup Language) files, and viewed by standard browsers with specific plug-ins. Some tools have been developed to reduce some of VRML limitations. The control over changes in time is specially useful to demonstrate the evolution of a 3D city model. The VRML History was created with this goal at the University of Siegen, in Germany, as an extension of VRML97 (Luttermann and Grauer, 1999). With this tool, temporal or spatial-temporal data can be examined in the model, allowing the understanding of evolving processes.

The procedure of modeling the evolution of the city is similar to modeling the present situation of an existing one. It’s accuracy is a major issue in both cases. In the former, however, the method to obtain the data is more difficult, uncertain and should be more flexible. Often alternative solutions should be applied in order to deal with lack of information of a particular time or situation.

In most cases, constructing the model backwards is the most utilized alternative. The data of the present city is frequently the most accurate and, in many cases, the model can be started from an existing digital base. A critical decision in the process of developing those models is the definition of a base, which will orientate the insertion of all collected information. Since data is acquired from different documents with various scales, formats and also many discrepancies, it needs to be adapted according to the most precise and complete document. That document is usually the last version available from the department of planning of the city. Elaborating a 3D model of

previous moments is frequently a laborious job. Older maps often present incomplete 2D information. The modeling has to be based on iconographic information that displays information partially and inexactly.

The orientation of the final hypermedia system will dictate the method for modeling. Since iconographic data is often inexact, modeling a historical setting should apply an 'undefined' form of representing the imprecise data. Thus, defining the final product depends on the modeling and vice versa. Both processes run in parallel until the project conclusion. Besides that, modeling becomes an analytical stage where many hypothesis origin.

The research at Universidade Federal do Rio de Janeiro

The research based on 3D city modeling in the Graduate Program of Urban Design (PROURB) started more than six years ago. The objective of the project was to analyze Latin American cities through the investigation of their evolution based on 3D models. The approach taken since the beginning was related to the use of the model to prepare images and animations that would identify and manifest hypothesis about those cities.

The first two cities modeled were Havana and Rio de Janeiro (Kós et al., 2000). They were chosen due to the information availability and the contrasts between both of them. Since the research was based in Rio, it was easier to collect information of that city. On the other hand, the complexity of its natural setting caused many delays in the modeling process, which explained the advance of the Havana model over Rio's. While Rio de Janeiro had much digital information, although 2D and imprecise, Havana was totally modeled from analog iconography – maps, photographs and paintings (fig 1).

In both cities, the model started from the current city situation with the modeling of topography, the ocean front and the street grid. The situation of the streets over time and in the case of Rio, also the ocean front and the topography which changed a lot. The information was taken from every existing map and adapted to conform to the model of current state. At that time we started to define some of the hypothesis, which would be investigated, and model significant buildings and areas on the model representing important places for the analysis.

The focus of the research was the recognition of important "forces" which would shape the city. The selection of the "forces" varies among the cities researched. They can be: religion influence, dwelling typology, different social groups location, political decisions, fortifications, natural elements, architectural icons, cultural tradition and economic physical concentration. They are many times hidden in the

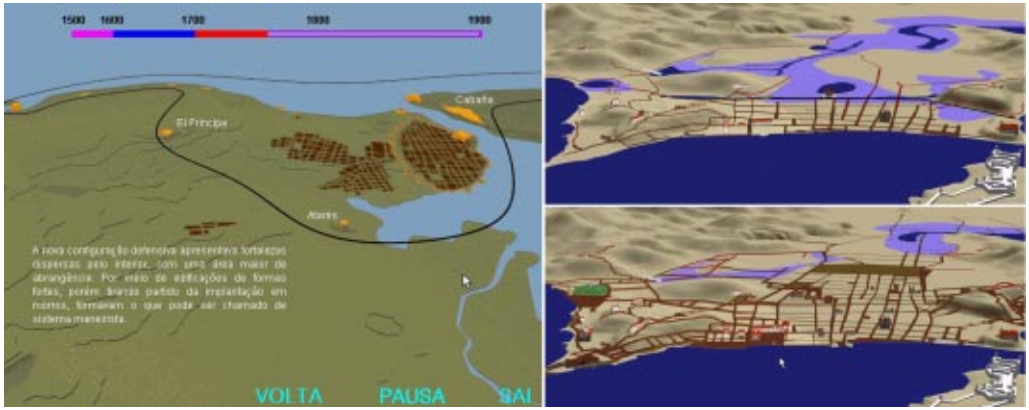

Figure 1. 3D city models of Havana and Rio de Janeiro's central area evolution.

current city but once they are identified in the physical environment, their relationship become clearer and it's possible to understand many feature of the actual city through that analysis. Abstract concepts, when linked to a place modeled according to a specific time support the elucidation of territory roots, which are materialized in the actual place. Placing these roots facilitates the consciousness of the relationship between human beings and where their life take place (fig 2).

Most hypermedia systems developed by our research group are edited with the software Macromedia Director and they do not allow the manipulation of the 3D model by the user. From the 3D model, images and animations are generated and imported into the hypermedia document according to the topics explored in each part of the document. There are seldom examples developed that the user can manipulate the model in the final document. An example of this initiative can be found in the VRML exploration of the relationship between the Catete Palace, in Rio de Janeiro, and its gardens (Kós and Segre, 1998).

One of the next steps of the research group is to link 3D objects to a database that could juxtapose different information in a single location. That's very important because the shaping of the city depends on many different issues and they should not be analyzed separately. This approach is already used in the current stage of the research but the linkage between 3D objects and a database would allow the 'readers' to structure their own research.

The information for the hypermedia systems have been addressed mainly to architects but prepared in such a way that lay users can easily understand the overall concept. Information synthesized in 3D model images can be very powerful method to communicate a complex message to a person lacking extensive knowledge of urban or architectural matters. The potential to transmit specialized information to the inhabitants or visitors intensifies their relationship with the subject presented and, therefore with the actual city. The hypermedia attributes allow also the possibility to convey different levels of information in a single document, where users can search for deeper idea, as they feel knowledgeable about it.

Final remarks

A challenge for our research group is to use models constructed with very straightforward systems based on mathematical logic**,** to contribute to bring forth the sense of belonging to a place. It's impossible to convey the actual space experience with a hypermedia system. However, there are many details of the space missed by the actual experience. A more thorough observation can be achieved after the acquaintance of some of that missing information.

According to Ramesh Jain's article, in a recent issue of *Communications of the ACM* devoted to the future of technology, "Experience is fundamental to

Figure 2. Analysis of the Ministry of Education Building's site evolution.

human existence. The desire to share it will continue to be the motivating factor in the development of exciting multimedia technology in the foreseeable future." (Jain, 2001) Besides technology advancements, we need much more experimentation in the integration of 3D city models and hypermedia systems, in order to make use of their full potential.

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