HISTORY AND 3D CITY MODELS

An analysis of digital representations of the city evolution

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Abstract. Through the evaluation of advantages and limitations of 3D historic city models, this paper aims to analyze the contribution of those tools to the city history representation. One should overcome limitations such as incomplete information, impediments to acknowledge hypotheses representations, intense labor requirements or difficulties to encourage a historical reflection. We argue that creative systems that are carefully planned towards history’s thorough understanding are more effective than those applications which focus on the development of high quality images. Those issues are illustrated by the system prototype “Rio-H”, which presents an alternative to communicate the history of Rio de Janeiro, Brazil.

1. Introduction

Several models have been developed depicting cities in the past. Many groups that developed them or – I could speculate that – most of them were based or have straight connections to universities. This contribution intends to raise some issues related to those “academic” 3D models of cities that attempt to reconstruct their physical appearance in different periods in the past. In addition to that, those issues are considered taking for granted the historian approach. This means that the model accuracy is one of the key issues in the research process and what is worthwhile representing should be a frequent debate subject. Therefore, the validity of modeling cities in the past is also a meaningful concern of our research group, based on the Laboratory of Urban Analysis and Digital Representation, within the Graduate Program of Urban Design – Federal University of Rio de Janeiro, Brazil.

A parallel concern was suggested by Nezar AlSayyad, who coordinated one of the most recognized 3D models of a city in the past, the “Virtual Cairo”, developed at the University of California, Berkeley. In 1999, AlSayyad wrote an article which presented the modeling process, analyzing several solutions adopted by his group. At the end of the article, the author quoted Italo Calvino, stating that “we take delight not in a city's seven or 70 wonders but in the answer it gives to a question of ours, or in the question it asks of us in return” (Calvino, quoted by AlSayyad, 1999). Eventually, he concludes that electronic simulations of cities in the past only succeed when
Calvino’s point of view is sought by the model’s authors. (AlSayyad, 1999). The article, and particularly its conclusion, seems to convey an optimistic belief related to 3D models competence to present meaningful contributions to interpretation and representation of the city history. Nevertheless, AlSayyad remarked in a recent event that this particular article reported his disappointment with electronic simulations results in scientific researches about the evolution of historical cities.

At the core of this debate lies historical documents limitation to deliver adequate information about building and public spaces that constitute the city in its different historical moments. One of the electronic model premises is that its elements are represented through their numeric coordinates that precisely position them in relation to the other elements. In the case of historical models, those elements constitute the city representation in a particular moment in the past. Besides the remaining buildings, just a small amount of the structures that gave form to the city in the past are documented by recognized historical documents. Furthermore, those buildings are incompletely registered by historical data. The anonymous buildings, which do not come out in the city landscape, are imperative to define the city’s character. However, they carry nearly no records that could allow their accurate modeling.

2. Limitations of 3D historical city models

As already mentioned earlier, models of cities in the past are highly based on partial information of the buildings that constituted the city in the selected study periods. Those 3D models rest largely on their authors’ hypotheses. The hypotheses fill the numerous gaps caused by the lack of reliable records. Constructing hypotheses that would unite the disconnected pieces of historical data is one of the main historians’ tasks. However, this characteristic of the historians’ job presents some problems when it is associated to the precision of 3D models. It is not an easy task – or at least it is not searched in most 3D models – to differentiate historians’ hypotheses from pieces that are grounded in recognized documents. Electronic models of cities in the past present seductive representations. However, they exhibit, most of the times, speculations as the only version of those cities in that particular moment. The precision of the electronic model’s construction process is embodied in their visualization techniques, which do not display to the public a supposition idea. Thus, electronic models of a speculation process should be cautiously and responsively planned by their authors.

In 2000 the ABACUS research group, located at the University of Strathclyde, Glasgow, developed a CD-ROM about the history of Glasgow, the “Glasgow2000”. (ABACUS, 2001) This is an interesting example to demonstrate some of the issues in this discussion. ABACUS has developed one of the first city models in the 1980’s. They used the model of the current city as a base for the “Glasgow2000” images. The group selected six historical periods and illustrated the city configuration in those periods. They had already a 3D model of the city, which could be used to elaborate models of the city in the past. Nevertheless, they asked two artists to manually render watercolor perspectives of the previous periods and mapped an aerial photo on the terrain model to represent the current city. The artists also used
printed perspectives from the terrain and main buildings as a base for their drawings. The limited budget and time allocated for the project were the main reason to hire the artists. (Maver et al., 2001) The resulted images produced by the artists displayed some advantages of this technique over digital models. Whenever the artists were not sure about the city configuration they made blurred areas or lines that suggested the authors’ hypotheses. The images were powerfully used as location of historical events and to describe the city configuration in those periods.

Another shortcoming of historical electronic city models is the difficulty for the creation of automation processes. Some groups developed methods to overcome the lack of historical evidence for modeling the anonymous buildings, particularly the residential areas. AlSayyad and his team elaborated a method, based on fractal geometry, for the analysis and representation of the dwelling buildings in Cairo’s traditional neighborhood (AlSayyad, 1999). The authors of “Virtual time-space of Kyoto”, on the other hand, created an interesting system of “Microsoft Excel” macros, associated to GIS databases to model Kyoto’s traditional dwellings – the machivas – based on a group of prototypes and the lot dimensions (Takase, 2004). Those methods are effective in reducing the time of the modeling process and to construct a simulation of the areas within the model that have nearly no records. However, in those cases, it is important to prevent the image of a “complete” and exact city. The impulse to model “complete cities” presents a closed view of those cities, where hypotheses or the outcome of digital methods are not elucidated or distinguished from the sections modeled from historical evidences.

It is also important to clarify that cities are not just constituted by buildings, streets and squares. The complexity of people’s interaction is intrinsic to those spaces character. The social interactions, however, disappear or turn out to be very marginal in 3D city models. Even for models that represent current cities it is difficult to exhibit or associate the lives that dwell within those spaces. That limitation is even more evident when modeling cities in the past and interactions that no longer exist. The great challenge for those models is to highlight or associate those relationships throughout the urban spaces represented by those models.

Finally, as indicated before, 3D city models are very attractive, for both scholars and the general public. Navigating through those virtual spaces offers captivated images that are easily apprehended by the lay public. However, this seduction also inhibits a critical distance required for a reflection concerning the intricate set of relationships among historical events, the present and the future. Roegiers and Truyen (2006) mentioned a criticism about historical film, saying that “going from word to image means losing a grasp on the complexity of the matter, and leaving behind the self criticism and intersubjective dialogue of classic forms of historical reflection.” Continuing their analysis and relating to historical simulations, they quote Bolter in their statement considering “virtual reality a bridge too far, afraid of giving up ‘the distancing and abstracting quality of text’ in favour of ‘the illusion of perceptual experience’.” (Roegiers and Truyen quoting David Bolter, 2006). Therefore, facilitating a critical analysis about the city and its history is another imperative challenge for scholars who lead the process of modeling cities in the past.
3. Why should we construct digital systems based on 3D models of the city in the past?

3D city models facilitate the localization of buildings and public spaces within a city through spatial relationships. Maps have similar functions. The subtraction of the third dimension, however, establishes significant differences. If we wish to establish spatial relationships, the height data, associated to the xy plan, constitute a different way to visualize the space with obvious implications in those relationships. If we compare a 3D city model with a map or a 2D plan, the former hold greater possibilities of recognizing the area besides several other relationships which are identified or amplified with the height identification in the 3D model elements. The augmented spatial relationship, recognized through the 3D city model, is actually one of the key elements to be explored towards new contributions for the city history. City historians make relatively small use of images when they publicize their studies. They usually publish their work in printed formats, which limit the number of images. Understanding the spatial relations is decisive for a clear comprehension of the historical facts and analyses. For that reason, we argue that it many times is not so valuable to produce attractive images that simulate a configuration of the city in a past moment, which we have no conviction about its accuracy. Much more powerful for a deep understanding of that moment is the articulateness of the spatial relations and the historical facts and analyses.

![Figure 1](image-url) 3D models representing some of the most important buildings of Rio de Janeiro central area in 1910.

In addition to that, two noteworthy characteristics of digital media present significant contributions to this process and justify the time and resources invested in the development of 3D models of cities in the past. The first characteristic is the integration and interaction among different media
types such as texts, drawings, films and sound. Digital media allow the association of various files from different sources. Through those files it is possible to reproduce the characteristics of most remaining historical documents. Therefore, one can evaluate the content of the historical documents, associated to others, without trusting just the historian interpretation. The second characteristic is the possibility to create dynamic and interactive systems, notably through the Internet. Thus, one is able to access different documents, dynamically associate them to other type of documents through different forms and without a pre-established sequence. The system allows also both the authors and the final users to add or change the available files. Those features offer the possibility of more democratic history publication. Systems have the potentiality to offer different versions as opposed to just the historians’ closed interpretation of historical events. Users can also constantly check the original document, used by the historians to elaborate their view. (Roegiers e Truyen, 2006)

Historical information is “immediately strange, not to say exotic, simply by virtue of their distance from us in time and their origin in a way of life different from our own” (White 1978). Historians’ text bridges past cultures to ours. The strangeness of those documents is reduced in those texts as it is related to our universe. One of the most effective methods to reduce the strangeness of city history is spatial connection. Although the city that was once the stage of historical events is quite different from ours, its space still shares several similarities to the current city. The old street character within the city or its proximity to other spatial features that still exist can be recognized in our current cities. Therefore, one’s experience and memories through the city can be very constructive as an instrument to bridge the gap between cultures from different epochs. Therefore, placing a historical document or fact within a 3D model is actually an effective instrument to associate a past event to a place we recognize in the city.

4. An alternative to the city history representation

The system Rio-H was developed as a prototype version at the Laboratory of Urban Analysis and Digital Representation. The system presents an alternative for historians to represent the city history. Rio-H is introduced in this paper as an alternative approach that could confirm some of the raised ideas towards creative digital contributions for cities’ historians. The Rio de Janeiro city model was initially developed for a research project that analyzed the city urban evolution during the colonization period. (Kos, 1998)

The 3D city models applied in Rio-H are variations of that original model. Rio-H is a prototype of a large system, which could gather the main archive institutions that hold historical documents about the city of Rio de Janeiro. Those documents should be provided through the Internet with no costs to students, researchers and the city inhabitants. Similar to the Glasgow’s images described above, the city of Rio is represented in different moments with different models. As most historical city models, we started from a model of the city in the year 2000. New buildings and public spaces were subtracted from this model while others were added accordingly to their appearance in the city. The model displays just the constructions that had historical evidences. Therefore, most of the lots display no buildings while
the model depicts the terrain with hills, beaches, and rivers; the street system and the main buildings.

The fundamental question is: why do we construct 3D models to represent the city in the past? And, what is important to be represented in those models? Attractive models are not always the most effective ones. In fact, if we consider an academic oriented model, the most seductive model is, most of the times, a model that diverts the attentions from “historical reflection”. Thus, what are the most important features of 3D models that could facilitate a critical approach towards information?

It is important to clarify that we are not concerned with the question, whether or not to represent every city component, even if we do not have enough information. What we consider critical to the process of modeling a city in the past is how one is aware, when visualizing the model, of what in an author’s hypothesis and what is validated by unobjectionable data. Several authors question when historians present their hypotheses in texts as a “historical truth”. That issue is amplified in 3D models. One can easily write a text about a city in the past, when there is limited information about is. Modeling the same city is very different. Parts that could not be considered important will be viewed in the same way as the more important parts. In addition to that, models, as stated before, convey the idea of precision differently from texts. Unless advised, one expects to receive an accurate view of the city through 3D models.

The option adopted in Rio-H of modeling just part of the buildings does not mean that we consider it the only – or the best – solution for 3D historical models. In our case, the visualization the complete urban fabric is not important for the project objective. Spatial relationship between past and present are more meaningful for Rio-H and, we considered we could get it with the natural landscape, street network and some of the buildings.

The growth of Rio de Janeiro has always been associated with the natural characteristics of the region. Thus, modeling the natural features and their changes through time is critical for the understanding of the city evolution. Infill and changes in the hills’ configuration were very common in the city history. Actually, the city grew pressed between the sea, the flooded land and the mountains. Understanding the natural environment constrains and how they direct the growth of the city or the relationship between the city dwellers and the natural landscape is one of the main objectives of the model. Those relations are more difficult to be visualized in a 2D map and become key attributes to our 3D models. The “cariocas” (designation for those who were born in Rio) have always applied natural features as orientation marks. Therefore, the natural features are cautiously represented within the model. However, the research group has not aimed to develop a realistic view of both natural and built landscapes. The model displays simplified and abstracts views of the city. They are more important for their capacity to reveal relationships among the element that constitutes the city than to the possibilities to realistically represent a specific moment of the city. Each model should be accessed as a reduction of a physical fragment of the city in the past. Therefore, its role as a spatial representation is mainly to locate the “historical image” – or “dialectic images”, as Benjamin states (Benjamin 1999) – elaborated by the readers in the space of the city they already know. The simplicity of the model, based on a digital Cartesian system, is critical to bring about the great complexity of city history.
Figure 2. The graphic interface of Rio-H, displaying the association of historical documents to a building represented in the 3D model.

Rio-H is a web-based system, which connects a database of historical documents to the historical city models. The system is structured from a Macromedia Flash movie file connected to a Microsoft Access database using ASP (Active Server Pages) pages to query the database and relay information back and forth. The Flash movie file is the front end, which presents the dynamic content to the users. The historical documents are associated via the database to buildings and public spaces and organized through keywords. Therefore the documents are searched through spatial elements within the city. Each building and space selected opens a list of keywords that are associated to the building. Each keyword links to another list of files. The files can be primary documents such as letters, photographs, official maps, official documents and also other sources like journal articles, historians’ texts and even fictional texts. The files are divided in nine different categories: photographs; newspaper and magazine articles, from the searched historical period; paintings, engravings and other visual art documents; maps, plans and other architectural drawings; letters and official documents, contemporary to the searched period; fictional books and novels, also from the searched period; non-fictional books or historical books and articles, which were written after the researched events; personal testimony and users contribution; and other types of documents which don’t fit in the previous categories.

The system does not allow the navigation through the 3D model. The system development turned out to be much simpler without the navigation, which was not considered important for the research objectives. The 3D model is used to render views that are imported into the Flash movie and buildings and public spaces are mapped in each still image to afford interactivity. That choice was adopted to allow a broader access to anyone that had Internet access and basic equipment. The user choose one historical period that opens up the still image with links to the buildings and public
spaces. When selecting the building or public space, the user gets a keyword list, which organizes the historical documents that will be searched.

The searched files depict different versions of facts related to the spaces, such as different newspapers presenting the same event, sometimes, with opposed accounts. The user who accesses the information is confronted to a broad view of the facts, and sometimes, to the social conflicts which produced the different versions. The system stimulates, through this process, the user’s reflection. The conclusion, or the interpretation of those documents, is not offered by a single historian – who could also be one of the versions available in the system – but is constructed by the users. They access the different versions and relate them to the city they know and live in, through the spaces recognized within the 3D model image.

5. Final remarks

The system is still a prototype and information is limited to one building. Therefore, it is difficult to verify, at this moment, how users construct their own narratives while navigating the system. However, it is possible to conclude that 3D city models are effective instruments to facilitate the city history comprehension. They hold meaningful features that allow the historical information democratization, through the organization of different versions of a historical event; the association of historical events and places within the city; and the association of those historical events to the experience the users have of the city, particularly when it is the city they inhabit. We assume that those connections supported by 3D model based system should favor the sense of belonging to a place for the city dwellers.

We believe that research for digital systems for history representation should not depart from the search for technology state of the arts. They are usually very attractive to both historians and the users. However, as we mention above, creative systems that are carefully planned towards history’s thorough understanding are more effective than those applications which do not go beyond seductive images. It is imperative that those researches are generated from the study of new media’s essence and how it can contribute to the field of history’s research and representation.

References