

Rio-H: Historical 3D models in a web-based system



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Abstract

This paper aims to explore the use of information technology, particularly 3D models, for the city history research. Rio-H, a web-based system is as a digital alternative for the representation of the city history. Three systems developed by ABACUS research group, in Glasgow, are analyzed for its influence on Rio-H conception. The tool developed as a prototype is grounded on 3D models representing different periods of the city linked to a database of a great diversity of historical documents. Thus, the city history is accessed through images of the significant sites from the 3D models.

Keywords: 3D historical models, web-based system, database, historical narrative, Rio de Janeiro.

1. Introduction

Leonardo da Vinci is acknowledged for having created the first accurate map based on orthogonal view, which resembles our current modern maps. He was commissioned to elaborate the map of the small Italian town of Imola, in 1502. The Duke Cesare Borgia asked Leonardo to develop a plan for repairing the town's fortification, destroyed by an attack. The new ballistic methods required accuracy in the measurements in order to calculate the angles and distances. Therefore, Leonardo used a transit, a magnetic compass and a modified odometer to guarantee the precision to register the dimensions of the town. The accuracy of his map is demonstrated by the superposition of his plan with the 1984 plan based in photogrammetry techniques. (Bosselmann 1998)

The exactitude of previous maps was not a major issue. These maps actually, had some of its details deliberately placed out of scale in order to represent a hierarchy of some elements. Usually churches and castles were placed larger than they were, in other occasions they were represented in a perspective view while the other elements were drawn in orthogonal view. They were highlighted because the users of maps were searching mainly for these elements. Thus, even if the instruments to take accurate measurements were available at that time, there had been no demand for a correct measured map.

Maps, similarly to other forms of representation are reduced and incomplete versions of actuality and they depend on their authors' wish of how accurate and what will be exhibited through them. As

Dennis Wood (1993) noted, they represent a "reality that exceed our vision." Therefore, they are exposed to all sorts of influences such as social, political, cultural and technical.

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. Electronic technologies bring forth a great variety of resources that can facilitate various phases of history of the cities' research. Many of them remain untested or with few incursions done by historians. Some of them may even reduce the gap between the representations of such a complex theme and the great variety of lives that actually take place there.

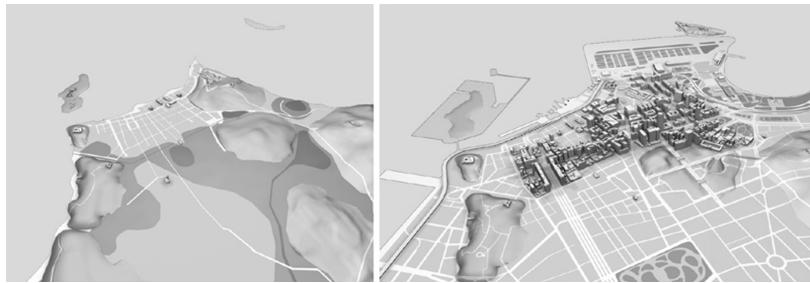


Figure 1: 3D model of Rio de Janeiro displaying two different moments of the city center.

2. Precedents from Glasgow: the 3D models developed by ABACUS

The development of the system Rio-H, described in this paper followed a long research initiated with the development of the 3D historical model of Rio de Janeiro and an analysis of precedents that elaborated historical models in different contexts. Some of the analyzed projects were developed at the University of Strathclyde, University of Waterloo, University of Bath, University of Sheffield, and by a PhD researcher for the Dutch city of Heusden. Those analyses were previously described in earlier publications (Kós, 2002). Therefore, this paper will focus on the experience developed by the ABACUS research group, from the University of Strathclyde, which was particular meaningful for our research. ABACUS group is a pioneer for developing 3D city models and that model originated different systems with various goals. In the 1980's the ABACUS (Architecture and Building Aids Computer Unit Strathclyde) research group engaged in a major enterprise for that time. The group led by Prof. Thomas Maver built a 3D model of Glasgow City Center. ABACUS was already researching with digital modeling and visualization and had a strong experience in this area. At the end of the 1970s they had developed a visualization software oriented to wire-frame lines models of buildings and urban scenes, called Viewer. This software could produce hidden line perspective from any chosen viewpoint, of computer generated 3D models.

In 1986 ABACUS took the opportunity given by Silicon Graphic that wanted to

prove the capacity of their newly launched computer. The computer Iris "was revolutionary in that it had a dedicated graphics engine, specific circuitry devoted to the task of undertaking large geometric transformations at speed, giving the illusion of real-time animation." (Ennis and Lindsay, 1999) Although very powerful at that time, their computer had not been tested as a geometry engine processor in Europe. Therefore, main purposes for the model construction in the 1980s were related to an academic exercise. It was created to test the creation, storage, access and manipulation of a large quantity of data. The model later proved to carry other significant uses such as the visualization of design proposals inserted in the context of the city. This latter use helped to finance the extension of the model to cover 25 square kilometers with the building geometries. (Ennis and Lindsay 1999, Ennis and Maver 2001, ABACUS 2003)

The geometries of the city center were captured during the summer of 1986 by a group of six students. The topography was modeled through digitizing the contours of a 1:10.000 scale map for an area of 64 square kilometers. The street network was digitized for an area of six square kilometers from orthogonal plans. Later, the roads were superimposed onto the terrain model, assuming its shape. The buildings, according to Maver, constituted the most laborious part of the modeling process. They were constructed from 20 ordinance maps of the city in the 1:1250 scale, which were digitized. The heights were obtained from a variety of sources: stereoscopic analysis of aerial

photos, or previous projects which registered that information. (Maver 1987)

The resources presented in the Glasgow Model seem to be quite basic nowadays. However, they were revolutionary in the second half of the 80s, particularly for the amount of information modeled, and are still useful nowadays. That model, generated near twenty years ago, is still being used by several projects developed by ABACUS, related to the city of Glasgow. Three of those projects, which were related to Rio-H are briefly described below.

2.1. The Glasgow Directory

The Glasgow Directory (ABACUS 1999) was developed taking advantage of two main circumstances: the emergence of the language VRML for the World-Wide-Web and the award of Glasgow as the 1999 UK City of Architecture. (Ennis and Maver 2001) The model, which was enormously complex and needed a very powerful computer that could manipulate its graphics in the 1980s, proved to be currently simple enough to be transformed into VRML files allowing the navigation over the Web. An in-house software was created to translate the database model files into VRML models. Therefore, the model, with the geometry of the topography, roads network and 10.000 buildings, was divided into "28 neighbouring city 'chunks' which could then be interactively explored on the internet." (Ennis and Maver 2001)

This new project aimed to connect data related to buildings and streets to the 3D model. Users would search for the information navigating through the 3D models in a similar way they would do in the 'real' city. Information would be organized by different categories in a database, which would be linked to individual buildings of the 3D model.

The Glasgow Directory presents a creative method to apply the VRML language and the Glasgow Model. However, it also brings inherent difficulties of VRML models. The lack of details in the buildings,

which makes navigation through every regular street appear to be almost the same. Models which don't have many details are very efficient when viewed from far away but look poor when examined from a closer distance. Developing a VRML model to be downloaded over the Web carries always the dilemma of relation size/detail of the models. If the model is more detailed, the user may have difficulties to download it. On the other side, if the model has a reasonable size to be quickly downloaded by the average of users, it may be too poor to be navigated in a close distance. If the idea of the Glasgow Directory is noteworthy, sometimes the model lack of details does not facilitate the implementation of the authors' objectives.

2.2. The CD-ROM Glasgow 2000

The CD-ROM Glasgow2000: the history of the city (ABACUS 2001b) is probably the project that is closest to Rio-H. It does not present many images from 3D models and 3D models were not applied as a research tool for the CD development. Although the Glasgow's digital model cannot be noticed in the CD-ROM, it was actually used as a base for artists to traditionally render perspectives of the city in different periods. They prepared their historical renderings from large printouts of the model's perspective view. For that project, the possibility to manually elaborate the renderings was much more feasible due to the limited time and budget allocated to it. Thus, each period of the city was illustrated by watercolors and in "the most recent period of the city's development, actual aerial photographs were 'draped' over the computer generated topography." (Maver, Ennis and Jarvis, 2001) The fact that 3D models were not used to render historical images for the final product, demonstrates that, even if the research group had a quite complete 3D model of the existing city configuration, the transformation of that model into historical ones from previous periods would be a laborious task.

The Glasgow2000 introduces the city in six different historical periods. Each one is presented with an aerial view of the city, displayed in the larger window on the screen interface. A cursor that moves through this window selects the areas of the city that will be zoomed on a separate smaller window. Therefore, the users can always evaluate a closer view of a specific area in the city while they locate this area in the overall image of the city. When an historical period is chosen, the navigation is done through two columns of items that the users can select. The column on the left is named 'Landscape' and displays elements that are connected to locations in the city while the right column with the title 'Concepts' is constituted by elements which are not related to places such as 'Government,' 'People,' 'Taxes,' and so on.

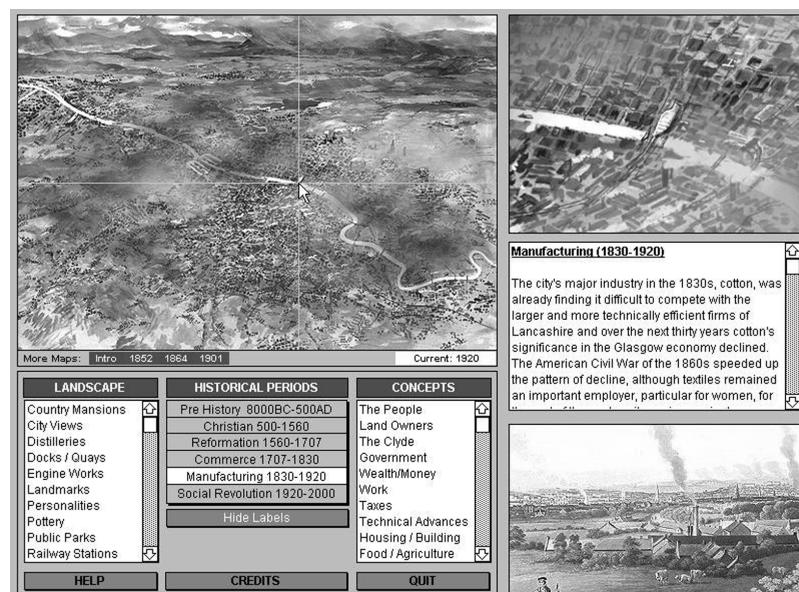


Figure 2: The Glasgow2000 graphic interface.

It is important to acknowledge the authors' aim through the CD, to "give a sense of 'place' and to link all of the information to geographical locations." (Maver, Ennis and Jarvis 2001) The authors make use of a great number of historical documents from several file types, such as sound or video clips, photographs and written documents, connected to city locations. Traditionally, those files, when

displayed in historical works, are only accessible in limited number and connected to some texts on specific topics. Seeing, hearing or reading many of them, in a chosen order and linked to known areas of the cities is a powerful move. One has a comprehensible feeling of the city's environment through those pieces of information and the comparison of the present city's urban spaces.

Although the 3D model was just a support to generate city's historical representations, this project suggests significant use for it. From the digital base the artists could render freely what the city looked like in previous times following the correct location of rivers, streets, and other elements that relate to current roads and other physical features of the city. The advantage of the watercolors over the digital models is that the former are less precise. The images are often blurred suggesting some configurations for the city without exactly asserting how it was physically constituted. From a distance, the lack of precision was not a problem and, actually, was probably more efficient than a complete model of the city in the past. Those images successfully achieved their goal. Anyone who is familiar with the city will recognize its spaces and will relate the events displayed, to the known places in the city. The watercolors exhibit distant views of the city. Thus, they are often similar to maps but, since they are perspective views, it is possible to identify the hills and rivers and how they directed the city growth. The watercolors facilitate the recognition of the places from the past and locate the events described by the files included in the Glasgow2000. The files exhibit the main events and, particularly, how people lived in the different places in the city. Therefore, the most valuable issue of this project is to link those files that present the human interactions within the urban spaces to the aerial views. They exhibit a city we cannot grasp with our senses when we are walking through its streets. Both of them are meaningful representations of the city.

One presents what is missing in the other. However, they are seldom put together in usual city's representations. Although this CD-ROM presents a limited amount of information and the texts presented are relatively short, it is an invaluable contribution to those who research creative forms of presenting the history of the city.

2.2. TheGlasgowStory

TheGlasgowStory. (ABACUS 2004) is one of the results of the United Kingdom support with governmental funds of great initiatives that provide learning and research material online. The project TheGlasgowStory is being carried out by a large consortium including two Universities and every public library that carries archives related to the city; it aims to digitize archives of different institutions about the city of Glasgow, bringing together the material and providing online access to the public, particularly educators, students and researchers. The authors of the project aimed to digitize about 15,000 images located in several recognized institutions such as university, museums, libraries, art galleries and other archives. The digitalization process was carefully planned and for each digitized image, a caption was created. These captions explain the images and the online survey from the database. Additionally, several writers were hired to elaborate around 500 essays of 250 to 1,500 words, on topics of the city history in which they specialize. The digitized images are associated to essays and captions directly through the database. The most remarkable characteristics exhibited by TheGlasgowStory are its size and the importance of the digitized material distributed via the website. The material owned by libraries, museums and archives is always seen for the economic value associated to its historical value and uniqueness. In this case the institutions which participated in the consortium were the most prominent in the city. They all agreed to give away medium size resolution copies of their collections to any one who would freely access the

database through TheGlasgowStory. That is a remarkable issue, particularly to researchers and students, whose access will be extremely facilitated. It is most probably that the number of people who have access to those historical archives will increase exponentially. Historical books always present a small selection of images due to the typical limitations of printed material. Thus, students, and sometimes researchers, are exposed to a restricted number of all available images concerning the history of the city. Similar initiatives will start to change the way history is communicated and apprehended. Therefore, those pioneer projects that organize and distribute that material should be carefully analyzed. As 'revolutionary' vehicles, they will influence the way users choose the distributed material and consequently, how they learn from those instruments.

One of the main drawbacks of this system is the lack of spatial references. If the CD-ROM Glasgow2000 is always connecting the historical information to places in the city, that does not happen in TheGlasgowStory, at least not with images. Names of neighborhoods were always mentioned, the same thing happened to streets and rivers. However, the users do not have a device to facilitate their spatial location within the city. Even maps are seldom displayed when a neighborhood analysis is done. When users who are not much familiar with the city visit TheGlasgowStory, they have difficulties to locate the places mentioned with those they know. In a project that aims to present the city history, it is important to verify spatial relationships among events even for the Glasgow dwellers.

3. The system Rio-H

The three projects developed by ABACUS research group influenced the conception of Rio-H and its characteristics were defined after a cautious analysis of the former projects. Rio-H is presented in this paper as a prototype version of a larger scale proposed system. It was con-

ceived as a web-based alternative for the presentation of a place's history. Rio-H embodies two main characteristics, which differentiate it from usual historical documents:

- 1- users do not follow it sequentially or if there is any sequence it is rather a spatial sequence since the documents are organized according to places in the city;
- 2- users can explore a diverse group of documents concerning one subject - many of them can present opposed versions.

Rio-H rests on a database of historical documents related to specific places within the city of Rio de Janeiro, in Brazil. These documents are searched from 3D model's images of different periods in the city's history. The database entries are text, image or even sound and movie files. They are digital versions of historical documents taken from a great variety of sources. Each database entry can be linked to up to five different places in the city model, five different historical periods and five keywords for searching the information. Every search starts from places represented in the city models. Thus, the information is organized according to the space in the city and the users are always aware of the city spatial organization and relationships. The database entries are classified in different categories such as photographs, newspaper articles, paintings, fiction books and official documents. Therefore, the users can search documents which present different versions or aspects of a place's history. They should be able to elaborate their own historical narrative from the spaces within a city.

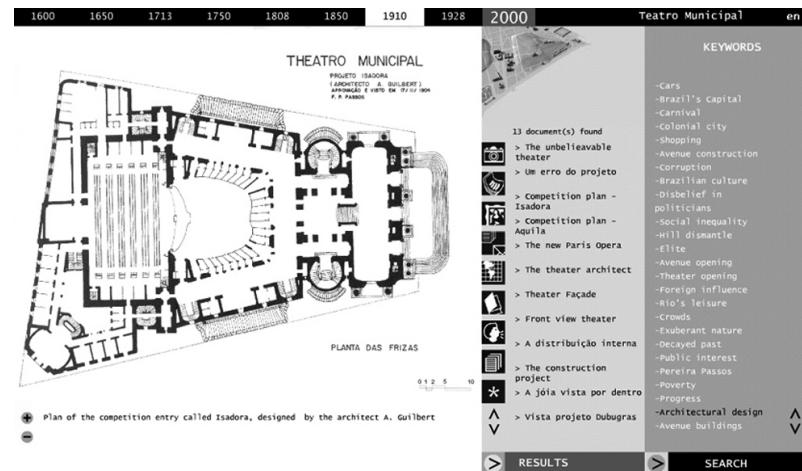


Figure 3: An architectural plan selected from Rio-H historical document's database

Rio-H's complete system should be a large-scale project, which would be carried out by a multidisciplinary team. It is composed of four main parts, which, even for the prototype, were developed separately. In the definitive project, different people or teams should develop them. Therefore, the construction of the 3D historical models; the development and maintenance of the historical database; the collection of historical documents; and the elaboration of the web-based tool constitute the whole system. All four phases are already structured but the system is not yet fully functional in the prototype. Only after feeding it with meaningful data, it can be useful to most users.

3. The Rio de Janeiro 3D historical models

The 3D models of the city of Rio de Janeiro were elaborated in the Laboratory of Urban Analysis and Digital Representation (LAURD-PROURB) at the Federal University of Rio de Janeiro. They have been used in several projects related to the city. Those models render historical periods in the city, represented in cuts selected from available antique maps or aerial photographs. The models were constructed from the existing city 3D model with the support of the historical graphic information. The current city model represents the existing situation of

the city in the year 2000. Thus, each historical model was elaborated backwards based on previous maps and in the remaining constructions and streets, deconstructing the changes which occurred over the years until 2000. In order to facilitate their construction, every model was structured in three main parts: the natural landscape, with the topography and the shoreline; the street network; and the main buildings.

The representation of the landscape is critical for this project due to the history and characteristics of the city. The relationship with the natural landscape has always driven the city growth. Sometimes this relationship required a defensive or laborious attitude and in others, the natural assets supported urban enterprises. Thus, mountains and the waterfront have changed several times over the history to conform to major urban changes. Infill and hill dismantling are not unusual in Rio's urban evolution. Besides that, the city dwellers always used the waterfront and the mountains as guiding resources or references for places. Until today, the city is better known for its natural configuration than for its built environment. The city landmarks built by its inhabitants are often exhibited near the natural landscape. Therefore, even requiring complex modeling solutions, the topography was constructed with fairly rich details. The topography was always the

most problematic part of the model. It required a lot of workstation's disk and memory to manage the models and elaborated procedures to place streets or buildings in it.

The Municipality of Rio de Janeiro granted their digital topography files to the project. However, since they were used mainly for 2D printing, they had several problems for transferring to three dimensions. Thus, the contours have been redone over the official ones in order to provide good quality curve lines to extrude the hills and mountains. The level of detail used to model the mountains increased accordingly to the proximity to the city center.

The street network was produced from the official current model, superimposed to old maps. The maps were adapted to conform to the official representation and the width of existing streets or the changes in others that disappeared were modified from the 2000 version of the model. Every change was registered in the historical models and was important to guide the readers in the past models.

Just some selected buildings were modeled for the historical models. Most of them have changed or disappeared since they were built. The lack of precise information was a problem to elaborate them. Since few had plans or sections available, they were mostly built from paintings or old pictures. They were selected due to their importance in the urban environment and the amount of historical documents. They were modeled with few details to facilitate the manipulation of the city model, already complex because of the elaborated topography. The models were elaborated with Auto-Desk AutoCAD and Discreet 3DS MAX. Mostly undergraduate students, who were more proficient with those pieces of software, developed the historical models. Therefore, even though, those tools were not the most suitable for the job, they were chosen for practical reasons. Although most of the topography of the "Greater Rio de Janeiro" was modeled,

only part of the city center had the street network and important buildings constructed. Therefore, the tool Rio-H is currently restricted to the center of the city, where it originated. It is important to notice that before the XVIII century, the city was mostly circumscribed into that area. Even though urban areas did not occupy the mountains, it is important to have them modeled in order to understand the surrounding configuration and the feeling of the city center's natural environment.

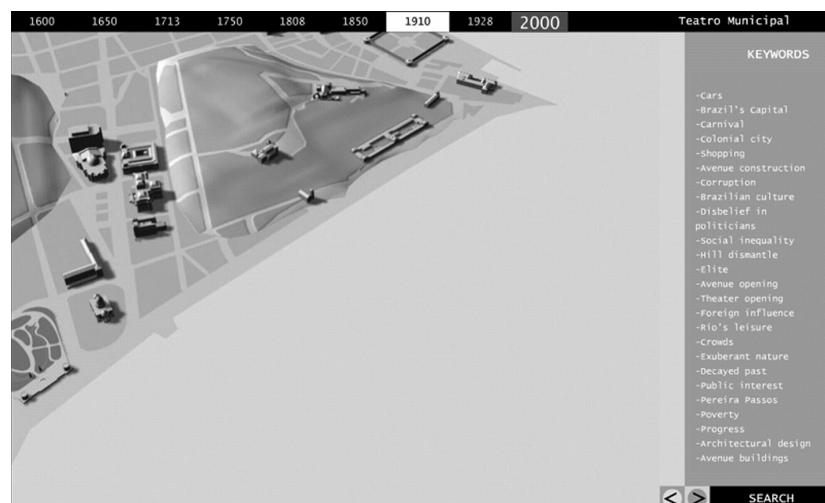


Figure 4: Rio-H graphic interface with a detail of the 1910 3D model

The central area of the city has eight historical models and one current model of the city in the year 2000 in this first stage of the research. The dates for the historical models were chosen due to the interval between the models and the quality of the available information, mainly maps or aerial photographs for the most recent years. Thus, the years 1600, 1650, 1713, 1750, 1808, 1850, 1910, 1928 were selected to be represented in the first historical models, which were included in the prototype. Those historical models of the city were not constructed to be realistic representations of the city. Actually it is important to emphasize their abstractionism. Each model should be accessed as a reduction to 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 Walter Benja-

min 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 the city history. The organization of historical urban 3D models poses additional important issues. It is much easier to represent an existing situation than past moments of the city, which are never completely documented. Latin American cities, for example, suffered radical changes, particularly from the end of the eighteenth century. Most buildings in the city center were demolished and few records remained from them. Even with a relatively short age, those cities are very difficult to represent with historical 3D models because few buildings remained from the previous centuries. Therefore, modeling an "incomplete" and more abstract version of the city can overcome lack of information problems and also facilitates the users to construct their own images of that period. That could be done with the support of other historical documents associated with the users' knowledge of that existing space in the city. 3D models have an important role to locate within the city, past events and associate present and past spaces. It is more important to place those events in the city space than trying to realistically reproduce an environment from the past.

5. Final considerations

Historical publications rarely utilize 3D city models in their works. Their use is critical in Rio-H and the choice to include renderings from those models as a point of departure to search information has several reasons and implications. As already mentioned, the renderings generated by the models are simple and do not intend to be photorealistic. They may resemble perspective maps developed for tourists with only city landmarks or even antique maps. The renderings from the 3D models of the past should not attempt to convey the complexity of reality in that moment because they could never reproduce it. When the 3D renderings

support the location of the historical information in the city, they contextualize it and help to clarify a puzzling set of relationships from past society. Therefore, the space organizes the historical information, taking for granted its complexity but trying to display it in an organized form.

Rio-H's concept of collecting historical documents, which disclose the history of Rio de Janeiro is a response to several issues analyzed throughout the research project. This paper presents just a few of them. Rio-H does not resolve all of them but its contribution should be the presentation of an alternative to narrate the history of the city and its dwellers, exhibited in each of its built fragments. Susan Buck-Morss' expressed Walter Benjamin's methodology for the analysis of Paris history in this last statement. Our wish is that a final version of Rio-H would follow similar aims.

"... each of these 'small, particular moments' was to be identified as an ur-form of the present. Benjamin's commentary, in which those facts were embedded, provided the rivets that allowed the fragments to cohere as the philosophical representation of history as a 'total event.'" (Buck-Morss 1991)

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