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The City as a Model for Hypermedia Applications

12 VISUALISATION OF HISTORIC URBAN DATA

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Three-dimensional modelling tools can be extended and applied to fields other than manufacturing and design. Such tools can prove useful for the visualisation of historical information both for research and within a museum exhibition setting.

This paper reports upon a set of software based upon a database of buildings, people, and lots from 18th century Montréal which uses computer visualisation tools to permit users to wander through onscreen three-dimensional models of the city. Interacting with the software gives the viewer a sense of spatial relationships within the town at various points during that century, and the visual dimension makes it easy to see changes in the structures, relationships between different forms of land use, and the tracing of property ownership over time. A subset of the information in this database (3 distinct areas of the city) was outfitted with a user-friendly interface, and formed an integral part of the 1992/1993 gallery exhibit *Opening the Gates of 18th-Century Montréal.*

In this paper we will first briefly outline the efforts of the Montréal Research Group (MRG) in gathering the historical information that forms the core of this database. We will describe the complex software that MRG researchers use to visualise the data, then we will discuss the more user-friendly but less complex access methods that were available to the public in the exhibition. Finally, we will place all of this within a larger context by discussing the sorts of problems "cutting-edge" exhibitions face, the likely impact of software such as this, and future directions which may be followed.

Background

For approximately 15 years, researchers from the MRG, now affiliated with the Canadian Centre for Architecture (CCA) have been researching lot titles, building contracts, and other historical material relevant to the built environment of 18th-century Montréal. Under the direction of Alan Stewart, for the past several years MRG researchers have been systematically organising this information in order to document the location, size, composition, use, and ownership of buildings throughout this period. Data (including spatial attributes) relevant to lots, people, and buildings has been placed into a database. Each of these data sets is quite rich, and much of the data has come from diverse historical sources. (For example the People records contain fields for all spouses, their birthdates and birthplaces, etc.)

Each of these data sets by themselves constitutes an invaluable source for historical research. But the belief that integrating this data with maps and visualisation tools to

create a new and far-reaching aid for the analysis of the built environment led CCA to begin planning for the addition of such software. CCA developed a 'research' relationship with the University of Toronto's Centre for Landscape Research (CLR), through which the CLR expanded and adapted their Polytrim software to more directly accommodate the types of historical data necessary for this type of urban form visualisation.

Visualisation of the database

The database contains attributes of each building from which its three dimensional form can be 'inferred'. Furthermore an archaeological survey was done to generate a three dimensional terrain model. Taken together, these create interactive spatial models of Montréal at 20 year intervals throughout the 18th century. Navigation tools permit viewing and exploration of the built environment. The user can position him/herself at any point (on a street, on top of a building, 1,000 feet in the air, a kilometre east- southeast of the city, etc.) Once an angle of view is selected (including both the full 360 plane plus upwards and downwards angles), the computer calculates the view from that position and angle and displays this view on the screen. The user can then step through the city at any given increment, and the computer will recalculate these views and display them in real time. This allows the user to simulate flying over or walking through the city in order to better view spatial relationships.

Other attributes in the database can be shaded in selected colours (including transparent/invisible). For example, one can choose to fly over the city viewing only the buildings composed of wood. Or one could walk through the city with buildings used for commercial purposes displayed in yellow and those used for service displayed in green.

Or one could wander through the area surrounding a particular gate to the city and use the shading to distinguish between French ownership and English ownership of properties, and whether these were used for commercial or service purposes. By doing this exploration at 20 year intervals, the user could explore the relationship between the growing English ownership and changes in property use from service to commercial in the area around the market. These visualisation tools allow visitors and researchers to see interrelationships between different types of information that would have been difficult (or even impossible) to derive from printed data. By turning these relationships into some physical form they can see, viewers can get a better understanding of how abstract ideas influenced and were influenced by the built forms.

Technical environment

The database resides on a Silicon Graphics (SGI) Crimson workstation. The Polytrim and CLRview software were designed by the University of Toronto Centre for Landscape Research (CLR) under the direction of Professor John Danahy and Rodney Hoinkes. The Silicon Graphics environment was chosen because of the speed in recalculating and displaying three-dimensional views in real time.

The underlying software is Polytrim. The CLR has made great strides in extending the user-friendliness of Polytrim with a public domain package they have written called CLRview. CLRview contains the tools necessary to query and visualise 3-D information in a wide variety of ways. Though it is not as powerful as Polytrim, CLRview is far easier to learn, and is currently being used by a wide range of organisations and individuals involved in urban and environmental design and planning.

Currently, the data sets are stored within Polytrim, but plans are well underway to move these into the Oracle relational database management system and to have Polytrim and CLRview access the data residing in Oracle.

Use in museum exhibition

In the summer of 1992 the city of Montréal celebrated its 350th anniversary with a series of special events. As part of this celebration, in early September CCA opened an exhibition focused on the growth and changes in this city during the pivotal 18th century. *Opening the Gates of 18th-Century Montréal* featured documents, maps, and artefacts from more than 40 archives and repositories in Canada, the United States, France, and Britain. In addition, two videotapes and an interactive computer workstation were incorporated into the exhibition.

The database and visualisation tools were used in four basic areas for this exhibit: historical research for preparing the exhibition, the creation of visual illustrations for the exhibition catalogue, the preparation of videotape installations that formed a part of the exhibition, and as an interactive tool that sat in the centre of the exhibition.

The visualisation tools allowed researchers preparing the exhibit to view relationships that were difficult to see any other way, and to create visual aids that were incorporated into the exhibition catalogue. For example, two dimensional illustrations of changing land use in a particular neighbourhood (complete with different shadings for different types of use) were generated onto photographic film for the exhibition catalogue.

Still and moving images generated from the database were edited into two videotapes which were an integral part of the exhibition. One videotape - ***The Fortifications of Montréal*** - visually demonstrates the development of the town's fortifications in the context of the physical terrain, existing urban structures, and the expanding population. Attention is also given to the geometry of the walls to show how defence with muskets and cannons influenced the urban form. A second videotape - ***Changing Land Use*** - shows how Montréal evolved from a town of gardens and wood buildings in 1725 to a densely built town of stone in 1805. Factors that contributed to this change - population growth, increased commercial activity, and fire - are animated on maps of the town. For a number of aesthetic and practical reasons (noise in the exhibition, attendees who spoke only French or only English), no audio was used. However, some text was necessary to convey a message, and this was kept to a minimum. An English and a French version of each tape was presented as part of the exhibition installation.

The centre gallery of the exhibition was devoted to a presentation of the research methodology and preliminary findings, acting as a link between the galleries on economic development and settlement and that of the built environment. Centrally located within this gallery was the interactive workstation that demonstrated some of the potential of the database and visualisation tools. Using a touch-screen, visitors could select one of three areas for detailed viewing - the Place d'Armes, the old Place du Marché, and the Place Jacques Cartier. Reconstructed lot plans, three-dimensional renderings, and 18th century plans and views vividly depicted these three sectors that were so important in the religious, commercial, and administrative life of the town. Exhibition visitors could use the interactive workstation to explore on their own the areas and themes depicted in the surrounding exhibition.

Using touch-sensitive directional arrows and icons on the screen, visitors could step their way (onscreen) through 3-D renditions of various streets (getting a feel for the height and spacing of buildings), could view and zoom in on relevant paintings, maps and land-grant

documents from that time period and could examine lots in several different neighbourhoods using a plan view. With this plan view museum attendees were able to see the distribution of property use (commercial, service, etc.) and of ethnicity (French and British), and how this changed over time. Touching the screen on any property generated a pop-up window displaying more information about that property and its proprietor at that particular point in time.

Of critical importance is that, unlike with conventional multimedia exhibits, the viewer is interacting with the actual database in real time. The viewer is free to ask a wide range of questions that were not pre-determined by the exhibition designer. This allows for greater exploration, and the public can begin to appreciate some of the kinds of things researchers do. At the same time, the design for the interactive workstation does not give the viewer access to the entire range of Polytrim's capabilities; a number of parameters are not changeable so that the viewer can easily learn to operate the software with no training. In addition, only three neighbourhoods are available for viewing. MRG staff hope to eventually extend this interactive interface to other portions of the city. The interactive workstation is still in its prototype stage.

The development team for the videos and the interactive interface included historians, museum professionals, instructional video, and computer graphics experts working in collaboration.

Problems in placing cutting edge technology within an exhibit

Being among the first to use a relatively new technology within a particular environment can pose enormous problems. Most of these centre around the lack of experience (anywhere in the world) in attempting to try anything that the vendor did not anticipate.

For example, CCA was likely the first institution to propose placing a Silicon Graphics Crimson computer within a museum exhibition. The design called for building a free-standing enclosure to house the computer so that it could be placed in the centre of an exhibition room. CCA exhibition designers received specifications from Silicon Graphics personnel as to air circulation needs and power draw, and designed an appropriate enclosure that was supposed to guarantee that the temperature would not exceed the 77°F maximum tolerance of the computer. But when the computer was loaded into the enclosure approximately one week before the exhibition opening, within one hour the temperature had reached 92°F (and was still rising).

This meant that either the entire exhibition layout would have to be redesigned, or that just the video display and touchscreen would be placed within the enclosure and that the main systems unit would have to be placed on another level of the building. But neither Silicon Graphics nor the touchscreen vendor knew how far away one could place the screen from the systems unit. CCA staff were forced to experiment with various lengths of wires before determining that they had to find a place for the systems unit within 28 feet of the touchscreen enclosure.

Impact

The linking of these data sets and the visualisation tools offer incredible capabilities for many different types of exploratory research. For example, genealogists could not only make use of the detailed biographical records, but could view the entire built environment in which an individual owned property, walk down their street, see whether the river was visible from their second story window, and find information about the owners and use of neighbouring properties.

This software and data will also provide an invaluable set of tools to urban historians trying to examine what life was like at a particular point in time, to social historians trying to gain insight into influences and how environments changed over time, and to architectural historians looking at the changing relationships between neighbouring built structures.

This information forms an important historical record that needs to be both preserved and disseminated. The textual portion of the database will become available to the general public through the Archives Nationals du Québec starting in 1994. There are no current plans to make the visualisation tools accessible other than to staff and researchers visiting the CCA.

Future directions

Unless explicitly stated, the views in this section are those of the author, and do not necessarily reflect the position of CCA or the MRG.

The primary design issue facing this project is that of layering the various pieces and linking them together using internationally recognised standards. Currently, the data storage and query structure are tightly linked within the Polytrim software. Plans are underway to move the data into a relational database management system (Oracle) and to have Polytrim access this data using standard SQL calls. This important first step will allow staff (and potentially external users) to access the data through other applications and from machines other than Silicon Graphics. Eventually, this data should be accessible remotely through the Internet.

But when the data becomes accessible, this does not guarantee that it will be readable or useful for other applications. As international standards emerge for the representation of spatial data, MRG needs to make sure that this data set conforms to those standards. And as standards emerge for describing sets of spatial data (such as the US Federal Geographic Data Committee's draft Content Standards for Spatial and Metadata), CCA needs to make sure that it can contribute at least portions of this data set to an international community of researchers.

Methods need to be developed to help distinguish between known values and intelligent guesses. For example, the actual heights of most buildings are estimated; the number of stories indicated on the building contract are multiplied by the known average height for either stone or wooden stories. But if a building contract explicitly states a height, this value is recorded in the database. For the average viewer, a visual display indicating differences between know values and estimated ones is both irrelevant and confusing. But some types of advanced researchers will need to be aware of the cases in which these height values are actually known. And as research tools like this come into common usage, we need to be keenly aware of how today's "estimates" will be treated as "fact" by future researchers.

Much work still remains on the user interface. From the exhibition experience and continuing use by MRG staff, the CLR has made great strides in extending the user-friendliness of Polytrim with CLRview. These efforts are continuing within a defined collaboration between the CCA and the CLR. In addition, the interface for the public (designed to be used with no training whatsoever) needs more rigorous evaluation and revision. Problems with the installation enclosure (outlined above) had the unintended side benefit of providing a second video display in an area remote from the exhibition hall. Researchers could watch this display and have a completely non-intrusive view of all interactions with the touchscreen in the exhibition. These observations led to a number of

refinements. In addition, each touch of the screen was logged, and the approximately eight weeks of data gathered still needs to be analysed.

Currently, the database is only capable of examining information at 20-year intervals (known as a *static* or *time-slice* approach). Initial plans have been developed to add a fourth dimension to the database software (by date-stamping the entities) so that changes can be visualised dynamically across time (known as a *temporal* or *dynamic* approach). Development of the tools to do this is well underway.

This is a data set covering the built environment in one particular city in North America during one period (the 18th century). We can expect the eventual creation of many other such data sets covering this and other cities at various points in time. (Indeed, the MRG is seeking funding to expand the information in the database to include both earlier and later time periods.) It is likely that, at least in the immediate future, most of these data sets (like MRG) will use Arc/Info software as the underlying base for 2 dimensional mapping, making both the learning skills transferable from one set to another, and making it easier to tie independent sets to one another. Imagine urban historians being able to examine the growth of different cities over the same period of time ***from their own desktops***. The possibilities for comparative studies are only limited by the number of data sets and the lack of standardisation between them.

As standards develop, inroads need to be made with governmental agencies, allowing contemporary sets of information to be linked in such a way as to provide similar access to built environment information of the recent past, and to assure future scholars access to information from today without combing through disparate records. We need to be working with records managers from city planning agencies as well as census bureaus and even newsgathering agencies, to assure that future generations will have access to the tools to analyse our contemporary society.