METHODS AND EVALUATION IN THE HISTORICAL MAPPING OF CITIES

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ABSTRACT:

Through a (re)mapping and spatial modeling of a city's past, exploratory web applications can be built to examine urban histories and dynamically engage scholars and the public. Working on Emory University's OpenWorld Atlanta project (OWA), researchers used geospatial technologies and methods to extract data from archives and other sources to build historical data models, geodatabases, and geocoders that enabled the development of web-based dynamic map interfaces. With a focus on the early stages of urban development of the city of Atlanta in the southeastern United States, this platform provides exploratory visualizations of city history along with a wealth of detail for specific time periods, specifically circa 1878 and 1928, given the opportunity provides by key map publications of the city. These dynamically enabled historical maps were then connected to digital images, geospatial vector data, descriptive text, and labels and then structured in a content management system.

While this project began as a digitization project centered on two atlases in the Rose Library collection at Emory University, it has grown to include contributors from several partner institutions. Therefore, this paper outlines the OWA project within a larger consortium of institutions and researchers focusing on production methods, platform development, interface design, and evaluation using open-data and open-source methods and software in cities' historical mapping and modeling. Drawing upon historical maps, city directories, archival collections, newspapers, and census data, projects like OWA allow researchers to analyze spatially grounded questions. In addition, they may serve the public as a valuable informational resource to learn about their neighborhood's past and even contribute materials from family archives or stories.

1. INTRODUCTION

Between 1870 and 1940, the urban environment of Atlanta, Georgia (USA) changed dramatically, reshaping the lives of its ever-increasing number of inhabitants. The city experienced rapid economic and demographic growth linked to the development of heavy rail and the electric streetcar, which influenced how people and goods moved through the metropole. By the 1940s, the public streetcar system was abandoned to make way for infrastructure centered around the commuter automobile, transforming the city into the sprawling landscape it is today.

OpenWorld Atlanta (OWA) leverages several tools and methods to collect data and analyze this period of Atlanta's history (ECDS, 2023). This project utilizes geodatabases of historical geographic features that are appended with information acquired from historical geocoders. For OWA, we created a data-rich and engaging web application for community and educational exploration of the city. The team comprises interdisciplinary faculty and staff members, researchers, and graduate and undergraduate students who work together to foster innovative methods and creative ideas to disseminate an existing body of work. Although this long-running project has undergone several name changes, its current state is known as OpenWorld Atlanta (OWA) and is intended to be functional and experimental in its design.

OWA seeks to provide public access to historical information about Atlanta during the late 19th century and early 20th century through engaging 3D and dynamic web interfaces. These interfaces organize and display a wealth of data extracted by the Emory Center for Digital Scholarship (ECDS) from historical maps, city directories, and archival collections spanning Atlanta's history between 1870 and 1940. Drawing upon historical maps, city directories, archival collections, newspapers, and census data, projects like OWA allow researchers to analyze spatially grounded questions (DeBats and Gregory, 2011; Janssens and Jongepier, 2015; Ferrighi, 2015). The project organized this content using geospatial databases managed within an open-source server containing historical geographic features. These features are then linked to assets organized in an open-source content management system containing digital images, text, and other content. The addition of the content management system uses Omeka which was developed Roy Rosenweig Center for History and New Media (Omeka, 2007), is relatively new; therefore, this article reviews the previous state, status, and expected outcomes of the application development, its functionality, and the evaluation of the usability of its interface.

2. GEOGRAPHICAL AND HISTORICAL CONTEXT

Atlanta was founded in 1847 at the convergence of major railways, on land the Muscogee (Creek) nation was forced to relinquish just two decades earlier. A key event in Atlanta's history is the burning of Atlanta by Union troops in 1864, towards the end of the American Civil War. It left the city in ruins and

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displaced most of its population. After the Civil War, the city quickly began to rebuild, with many new businesses and industries established in the aftermath of the conflict. In 1868, Atlanta became the state capital of Georgia, with a population of about 21,000 people, and by the 1880s, it surpassed Savannah in population. The city of this period of significant growth and development was characterized by low-profile buildings, horse-drawn streetcars, and several major railroads passing through it. The city was known in the Southeast United States for its production of iron and steel and its textile and manufacturing industries.

At the turn of the century, Atlanta continued to grow and develop as a major center for commerce and industry in the American South. The city's population had grown to almost 90,000 by 1900, becoming an important hub for transportation and manufacturing. Atlanta experienced a significant building boom during this time, with many new commercial and residential structures constructed throughout the city. Further into the first few decades of growth in Atlanta, the city's skyline was transforming due to the construction of skyscrapers, and the electric streetcar network became a prominent feature. By the 1920s, Atlanta began experiencing significant economic, cultural, and social changes. The city had become a central transportation hub, with several major railroads and highways passing through it, which made it an important center for commerce and industry. Atlanta was also emerging as a center for education and culture at the time. Many new schools and colleges were established, including Atlanta University Center in 1881, which became an important center for African American education and scholarship.

Throughout this growth, Atlanta remained a profoundly segregated city. Lawmakers implemented segregationist “Jim Crow” laws, and discrimination against Black residents was widespread. African Americans were forced to attend separate schools, live in separate neighborhoods, use separate public facilities, and confront legal discrimination, routine violence, and racist aggression in the city. By focusing on Atlanta's urban core and early suburbs between 1870 and 1940, OpenWorld Atlanta allows for new avenues for investigating the long and contentious histories of racial discrimination and its connections to the city’s geographical expansion and suburban sprawl.

Like much of the country during the Great Depression, Atlanta began seeing an economic downturn in the 1930s. Atlanta's economy was susceptible to falling demand and prices in the cotton industry and textile production. Its diminished ability to collect tax revenue also impacted the growing city. Nevertheless, by the 1940s, the population had surpassed 300,000 people, the last streetcars had been replaced by trolley buses and the automobile, and Atlanta began a period of intense suburbanization.

3. PLATFORM DEVELOPMENT & INFRASTRUCTURE

3.1 Geospatial Database and Geocoder Development

The geospatial database for OpenWorld Atlanta has been in continual development for over a decade; it comprises many vector layers, including administrative boundaries, roads, rail lines, buildings, and more (Page et al., 2013). The geospatial database was designed to store and manage geospatial data extracted and digitized from the pages of printed atlases published in 1878 and 1930, specifically for use in geographic information systems (GIS), geospatial data servers, and ultimately for the online web map platform. The 1928 atlas is of particular interest as it was the first topographically accurate map of the city, as it was aimed to serve as a tool in the function and management of the city. The atlas was produced by survey in 1928 using ground control points installed by the U.S. Coast and Geodetic Survey and printed by Williams and Heintz in 1930 as the *Atlas of Atlanta and Vicinity*, Atlanta Mapping Division, Construction Department (Floore and Killian, 1930).

Although the map is at two scales, 1:200 and 1:000, only the 1:200 scale maps were used to produce vector-based data for the OpenWorld platform. The map images, however, were not ideally suited for raster-to-vector conversion, and thus most layers had to be manually digitized in GIS. Students from the Department of Environmental Sciences and research assistants in what evolved as the Digital Visualization Lab of ECDS routinely contribute and enhance data for use in the geospatial database. Students digitized building footprints, streets, streetcars, railways, alleys, sidewalks, fire hydrants, utility covers, administrative boundaries, survey benchmarks, parks, and bodies of water. This process was later used to produce the geospatial database from *City Atlas of Atlanta, Georgia: Actual Surveys and Records* (Hopkins, 1878).

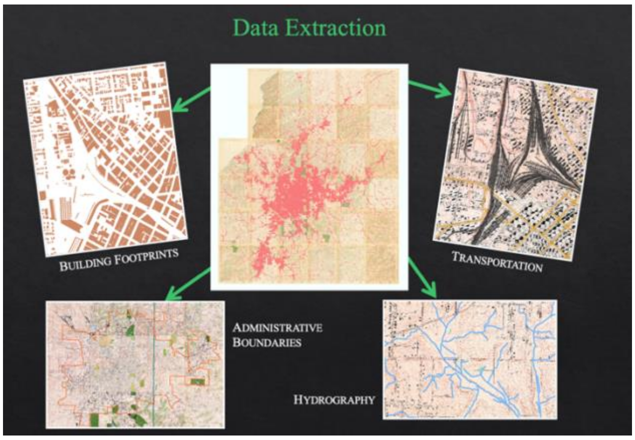

Figure 1. Data Sources for OWA

Another feature of OpenWorld Atlanta includes the indexing and geocoding of the building features. A 1928 historical geocoder was built for Atlanta by matching geographic coordinates to the residential, institutional, and commercial buildings and including their names, addresses, and other identifying information. Students from Emory digitized over 80,000 points of interest, matching point data with information from historic Sanborn Fire Insurance Maps, Atlanta city directories, and other related materials. With 1878 currently in production and other years planned, these resources will allow researchers and historians to map and analyze historical data using modern digital maps and other geospatial tools.

Historical geocoding is particularly useful for studying changes in urban landscapes and demographic patterns over time and identifying and analyzing historical events and phenomena in their geographic context. For example, within OpenWorld

Atlanta, users can select buildings and discover information about the occupants of a particular building. The production of these geocoders required some customized Python scripting to build a tool specific to the year being produced. Taken from an object character recognition (OCR) process, the captured text that initially came from a manual typewriter consisted of many errors which had to be addressed.

Through developing the machine-learning application, ECDS students could complete a historical geocoder for 1928 and extrapolate that data to the building footprints within the OpenWorld Atlanta platform. Students within ECDS would evaluate the output from the geocoder to verify that the scripting provided accurate results. Given the complex formatting of the city directories, as each year is almost entirely different, it is anticipated that developing 1927 and 1929 geocoder differences can be compared with the 1928 year. Thus, the approach would be reductionist or constructionist. Of note, 1926 will be particularly difficult given that Atlanta's entire address numbering system was redesigned (Torras, 1926).

3.2 Web Map Platform

The primary functionality of OpenWorld Atlanta is built upon Leaflet for the interface and GeoServer to supply the raster and vector layers. Leaflet is an open-source JavaScript library for creating interactive maps for the web. It allows developers to create mobile-friendly and customizable maps across different platforms and devices. It is very lightweight, simple, and flexible. It provides many features, including markers, popups, tooltips, layers, zooming, panning, and geolocation. In addition, with Leaflet, developers can integrate third-party plugins and services, such as map tiles, geocoding, routing, and data visualization. GeoServer, developed by the Open Geospatial Consortium (OGC), is an open-source server software that allows users to share and publish geospatial data using open standards that can be browsed or sourced to desktop or mobile web map interfaces (GeoServer Community, 2021). The platform can deliver a variety of data formats, such as shapefiles, GeoTIFF, KML, OpenLayers, and GeoJSON, among others.

The raster layers use the Web Map Service (WMS) protocol, while most vector data is simple GeoJSON served by the Web Feature Service (WFS) protocol. An example is the 1928 buildings layer which contains over thirty-eight thousand polygons. It is added to Leaflet as a vector tile layer via the Tile Map Service (TMS) protocol and the Leaflet VectorGrid plugin. Other layers include the evolution of city annexation, city wards, and streetcars. Modern base maps are added from public services hosted by Carto, Esri, and Mapbox with OpenStreetMap data. With OWA being built using Leaflet and other coding forms, it is designed to pull spatial data and map overlays organized and stored on Emory's instance of GeoServer.

The design includes multiple avenues for exploration based on specific years and unique themes. Using the historical geocoders, key vector datasets such as building footprints are updated to contain historical information, including use classification, people, race, entity name, addresses, and more (see section 4). Our collection of layers is expected to grow as we continue to add to the platform based on theme and year. Lastly, a section called "Spotlights" provides more immersive story and/or tour multimedia content, such as text, images, and videos, to create an engaging and immersive storytelling experience.

In addition to the two-dimensional mapping components of OpenWorld Atlanta, the project involves creating and integrating three-dimensional models of buildings that are extant in the historical maps of Atlanta. These models are created by analyzing historical sources, including photographs, maps, and blueprints. Thus far, 3D models in the project have been created manually using modeling software such as 3D Studio Max, Blender, and Maya. MapLibre GL will allow these 3D models to be displayed on the OpenWorld Atlanta map interface using Three.js and its glTF loader. 3D modeling concisely conveys information about building height, shape, materials, and context, allowing for a deeper spatial and experiential understanding of the city. A 3D reconstruction is also a tool for digitally preserving lost and threatened buildings, as it keeps a visual record of missing pieces from the ever-changing urban fabric. Incorporating the 3D content within the platform is in the early and experimental stages.

Along with Leaflet, the initial interface design was developed by ECDS students. React, a JavaScript library for front-end development is utilized to manage state and routing within the application. Additionally, Bootstrap, a CSS framework offering pre-built interface components, was leveraged to expedite the development of the user interface. Future interface development will address the usability study findings while supporting 3D models and polygon extrusion. This will require replacing Leaflet with a platform like MapLibre GL.

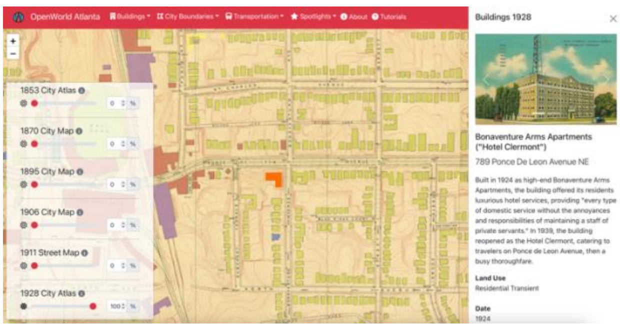

Figure 2. OWA website interface with building details

3.3 Usability Study

Historical mapping interfaces provide a valuable way to explore and understand historical events, places, and people. They allow users to visually navigate and interact with historical maps, overlaying different layers of information to gain new insights into the past. With a well-designed historical mapping interface, users can gain a deeper understanding of the past and explore historical events, places, and people in new and exciting ways. However, designing a historical mapping interface that is both effective and user-friendly can be a challenge. This is where conducting usability studies becomes crucial.

Usability studies play a vital role in improving the user experience of the historical mapping interface, and an integral aspect of the OpenWorld Atlanta project recognizes the necessity of usability and user experience studies. Usability studies are research that evaluates how well a product or service meets the needs of its users. In developing a historical mapping interface, usability studies can help designers and developers understand how people interact with the interface, what features are most important to users, and how to improve the interface to meet user needs better. There are several important reasons why conducting usability studies is essential when developing a historical mapping interface:

1. Identify User Needs: One of the most important reasons to conduct usability studies is to identify user needs. By watching users interact with the interface, designers and developers can gain valuable insights into how users use it, what features they find most valuable, and what they struggle with. This information can then be used to improve the interface and make it more user-friendly, ensuring a seamless and intuitive user experience.

2. Improve User Experience: Usability studies can also help improve the user experience of a historical mapping interface. By observing how users interact with the interface, designers can identify areas where the interface is confusing or difficult to use. They can then make changes to the interface to make it more intuitive and user-friendly.

3. Ensure Accuracy: Historical mapping interfaces often involve complex data sets and layers of information. Conducting usability studies can help ensure that the data is accurate and presented in a way that is easy for users to understand. In addition, by testing the interface with real users, designers can identify areas where the data is confusing or misleading and make changes to ensure accuracy.

4. Increase Engagement: Historical mapping interfaces can be a powerful tool for engaging users with history. However, users may become frustrated and lose interest if the interface is difficult to use or confusing. Usability studies can help identify ways to increase engagement and make the interface more appealing to users.

5. Optimize Design: Finally, usability studies can help optimize the design of a historical mapping interface. By testing different design options with users, designers can identify the most effective design choices and make changes to improve the overall design of the interface.

Conducting usability studies is a critical step in developing a historical mapping interface. By identifying user needs, improving the user experience, ensuring accuracy, increasing engagement, and optimizing design, usability studies can help create an interface that is both effective and user-friendly. By involving users in testing, designers can modify any potential inaccuracies, inconsistencies, or misinterpretations in the displayed historical data. This iterative feedback loop allows for necessary corrections, fostering trust and credibility in the interface and its underlying data sources.

The partners from Yonsei University shared their expertise and innovative ideas on visual analytics and human-centered design principles, which are being incorporated into the OWA platform. Researchers at Yonsei and Emory Universities collaborated to evaluate the platform's ease of use and overall user experience. The usability study's goal is to find areas of improvement in the user interface and user flow and to gather feedback on the product's design and functionality. In December 2022, we ran a UI test with ten student workers at ECDS. This user-centered approach provided valuable insight for the further development of the project, ensuring that the interface is tailored to the users' needs, resulting in increased user satisfaction and engagement. Testers voiced a need for a more comprehensive tutorial. They asked for a page or pop-up window that would give a more extensive introduction to the project and the website – explaining its goals and providing a road map of how to approach and use the data. Our testers particularly enjoyed the thematic layers, like the one displaying Atlanta’s streetcar system in the 1920s.

A primary goal is to serve as an example of and future framework for usability studies centered on diverse use groups (insider vs. outsider, academic/public, etc.). Therefore, test participants were grouped by level of familiarity with Atlanta to capture the diversity of users of the platform. In addition, this investigation focused on analyzing and evaluating user experience to explore data and content, conduct analyses, and directly contribute via feedback or to the resource. Therefore, our key questions in these groups sought to address how to better design interactive web maps of city histories to accommodate diverse user groups.

Engagement is critical to historical mapping interfaces, as it facilitates users' immersion in historical contexts. Usability studies can uncover ways to increase engagement by identifying elements that capture users' attention, evoke curiosity, and provide meaningful interactions. By analyzing users' responses and preferences, designers can refine the interface to deliver an engaging and captivating experience that motivates users to delve deeper into historical narratives. Usability studies aid in optimizing the design of historical mapping interfaces, ensuring that the visual and interactive elements are cohesive, aesthetically pleasing, and functional. By collecting user feedback, designers can assess the effectiveness of design choices, such as color schemes, typography, layout, and iconography. Iterative improvements based on user testing helped refine the interface's visual appeal, making it more intuitive and visually appealing.

4. RESULTS

4.1 Digital Content Production and Management

Scans of the individual sheet maps from the 1878 and 1928 atlases were some of the first digital assets produced for OWA. The map sheets from these atlases were made available in Emory's Digital Media Gallery using the Common Software Platform LUNA Insight. However, the variety of content types produced during the growth of this project, including images, historical documents, and audio-video files, led to the selection of the Omeka content management system (CMS) to streamline data and metadata management activities (Omeka Development Team, 2007). Widely used by GLAM (Galleries, Libraries, Archives, and Museums) institutions, Omeka is an open-source CMS that enables us to upload, describe, and share products of our scholarship using standardized and collaborative workflows for metadata creation and web publishing. This new strategy allows our diverse project members to contribute content more easily with rich metadata into OWA’s data infrastructure.

Our Omeka instance allows students to create and enhance the geospatial data to provide crucial historical context for the site users. We provide a brief description and historical summary of the buildings in the 1878 and 1928 layers, including metadata about residents, architects, and other fields. To populate these fields, teams comprised of graduate and undergraduate students conducted research online, in the library, and in local archives. The students engage with faculty and staff to collect historical information from newspapers, archives, and online resources and enter the data into the database.

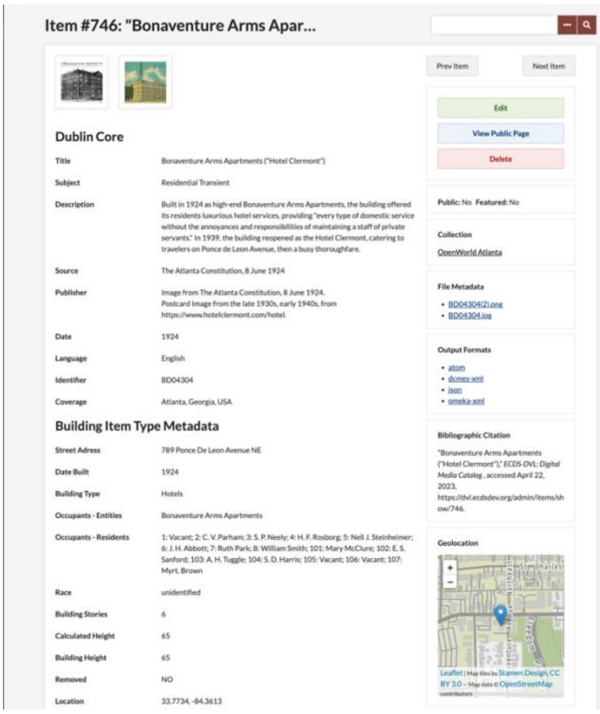

Figure 3. Omeka Content Management System Interface

Given that we currently have a database with over fifty-thousand building entries (addresses and occupants from historical city directories and maps), we had to prioritize our approach to the historical research. First, we defined a set of "key buildings" as the first target of our research, point of interest content usually associated with a building in the 1878 and 1928 layers. Next, we defined key buildings as landmarks associated with an address and a name – for example, the Medical Arts Building, the Georgian Terrace Hotel, or the Phelan Apartments. This yielded a subset of about three hundred buildings that we used to develop workflow guidelines and best practices for our team of student researchers.

Metadata plays an especially significant role in the function of the OWA platform. Geospatial features are then linked to records and the corresponding pieces of information, data, and digital objects, including images and 3D models. Throughout this project, metadata has informed all aspects, from providing context and quality control and enabling searchability and interoperability. We use a modified Dublin Core schema in Omeka with categories designed to fit better the geospatial and historical data collected. For example, the fields for the buildings of a data layer include architects, date built/demolished, racial classification of residents or businesses, head of households (from census data and city directories), and references to additional resources.

The OpenWorld Atlanta project is an excellent opportunity for students to participate in multi-disciplinary research teams. We assigned different Omeka Dublin core fields to students and then had others review each building to ensure all the data points were correct. Students working in ECDS login to the Omeka platform and upload metadata, edited images, and captions. The OpenWorld Atlanta platform then dynamically draws upon this content management system to provide digital assets and association data.

4.2 Consortia

The OpenWorld Atlanta project is part of the Urban Spatial History Consortium, a consortium of international scholars and practitioners who seek to transform historical-geographical data and knowledge of urban settlements into innovative and accessible digital resources. The members of the Urban Spatial History consortia engage in each other's projects, from consultation to production to sharing resources to produce platforms and data sets that are open-access and open-source (see for example, Ferreira et al., 2017). Current members include Emory University & Yonsei University (OpenWorld Atlanta), UNFESP (Paulicéia 2.0, São Paulo, Brazil), and Kaziranga University (Mapping the Ahom Kingdom, India).

This consortium was formed to pool resources, expertise, and knowledge to accomplish a project or undertake an initiative that would be difficult or impossible for each individual member to achieve alone. While the group may have varying degrees of participation and financial commitment from each member, it aims to advance urban spatial history research and the technology and methods in historical web mapping. The authors of this paper include collaborators from Emory University, Yonsei University, Stanford University, and The University of Arkansas. Further, other collaborators include The University of São Paulo (USP), a public research university located in São Paulo, Brazil, and Kaziranga University, a private university located in the state of Assam, India, both of which are engaged in similar or related projects. The collaborators of these projects seek to share ideas and methods surrounding the historical mapping of cities.

5. CONCLUSION

OWA is a multi-platform, interactive research project leveraging several digital tools to collect and disseminate urban history data. OWA was built on open-source methods and philosophy and seeks to be experimental and functional. Overall, the concept of OpenWorld is often associated with openness, exploration, and freedom of thought and action. By design, creators, and collaborators envision it as a continually evolving platform where new techniques can be explored and tested. Developing a fixed and objective reality about early Atlanta is quite challenging. OWA strives to provide an informational venue, open to interpretation, and fosters subjective experiences by providing access to historical data, maps, and images.

Research on Atlanta between 1870 and 1940 is limited by the accessibility and volume of information for that time period compared to that available for more recent decades. Therefore, the design of the project's data structure, interface, and web map features combined with its methods in calling both spatial data and digital objects is intentionally intended to be accessible, transparent, and open for use and analysis by anyone. Furthermore, the processes of incorporating usability studies in this project, the building of consortia, and the inclusion of students in the process of building, coding, and evaluation have proved extremely valuable. We hope the site will be interesting and useful to academic researchers, local communities, and interested members of the public.

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